60c ■ MAR. 1973

Radio-Electronics®

FOR MEN WITH IDEAS IN ELECTRONICS

SPECIAL ISSUE—4 CHANNEL STEREO

BUILD A 4-CHANNEL AMPLIFIER
60 Watts rms Per Channel

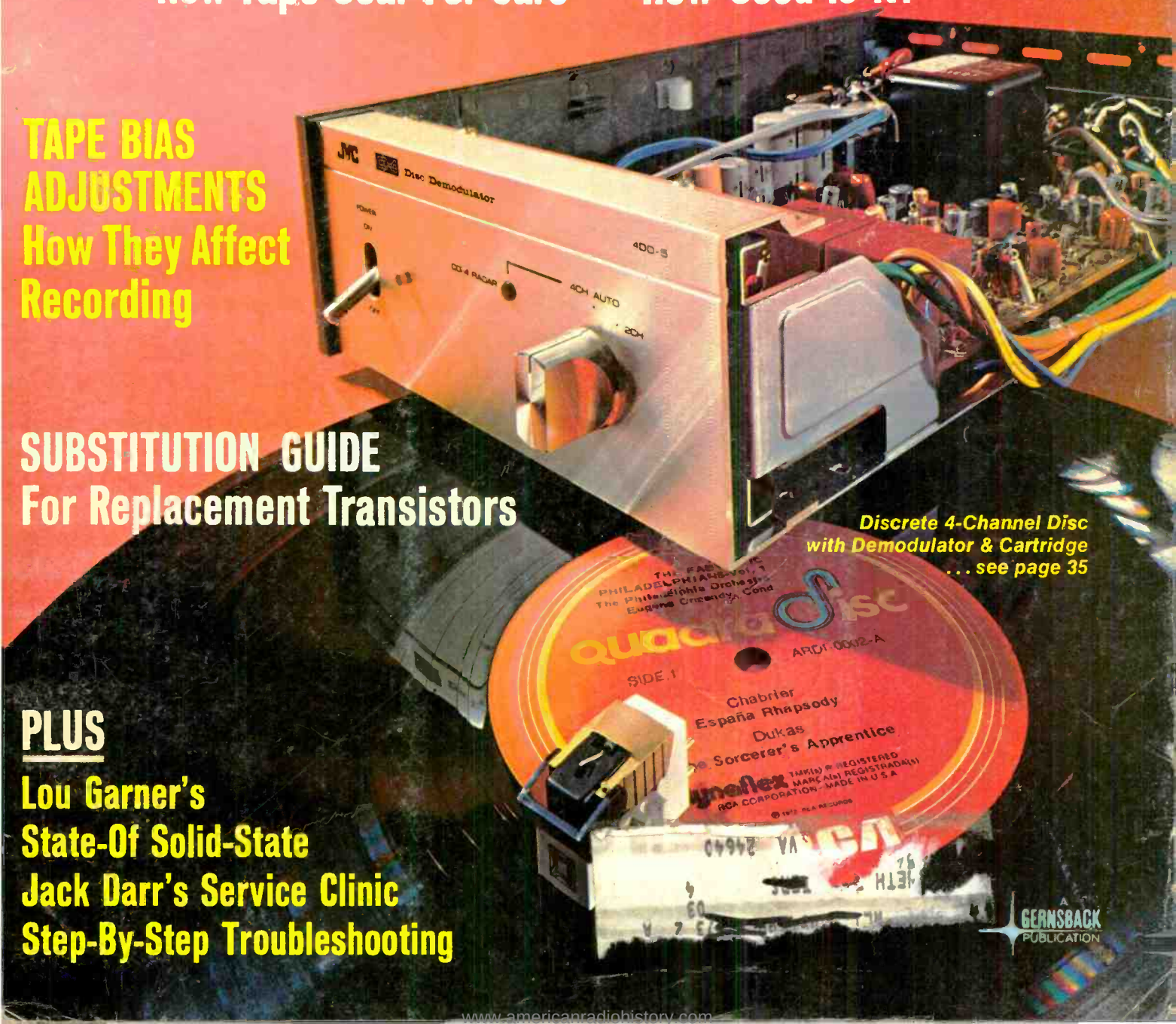
OFF-BEAT SPEAKER SYSTEMS
For The Rear Channels

4-CHANNEL ON THE GO
New Tape Gear For Cars

4-CHANNEL MATRIX
How Good Is It?

TAPE BIAS ADJUSTMENTS
How They Affect Recording

SUBSTITUTION GUIDE
For Replacement Transistors



Discrete 4-Channel Disc with Demodulator & Cartridge
. . . see page 35

PLUS

Lou Garner's State-Of Solid-State
Jack Darr's Service Clinic
Step-By-Step Troubleshooting

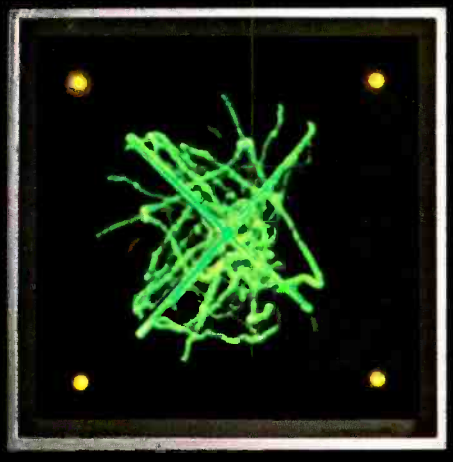
A GERNSBACK PUBLICATION

Do you know what 4-channel sound looks like?

If you don't know, then you're probably missing something. Because it's easier to adjust your 4-channel system when you see where all that sound is coming from. That's why Panasonic has made a 4-channel audio scope. Model SH-3433. With it you'll be able to see if you're getting the most out of your music. Whether it happens to be stereo. Matrix. Or discrete 4-channel. In either 8-track tapes or Compatible Discrete 4-channel (CD-4) records. Like RCA Quadradiscs.

The SH-3433 lets you see the strength and phase relationship of all 4 channels, at one time. You can look at two channels, if you're listening to stereo. Or one. Turn the Wave Form selector to the one channel you want to see. The screen will show it.

The audio scope has controls for position, balance, focus and brightness. A gain control to



change the size of the wave form. Plus a Scope Mode switch for either matrix or discrete sound.

The back panel has jacks for most accessories. Stereo or 4-channel. Including two for an FM tuner. So you can monitor FM stereo wave forms and detect possible FM multipath problems. And if you're using 2 stereo amplifiers to get 4-channel sound, you can see if the front signals and back signals are in phase. With our special Rear Phase switch.

Of course, you need more than an audio scope to get 4-channel sound. So look, and listen, to our other discrete 4-channel equipment. Like our Model SA-6800X receiver. It has Acoustic Field Dimension, so you can adjust the speaker separation electronically. You move the sound to fit the size of the room. Without physically moving the speakers. It also has a phase shifter for the various matrix systems. 300 watts of power (IHF). Plus a remote balance control.

You can see our 4-channel audio scope, receivers and other components at your franchised Panasonic Hi-Fi dealer. But before you settle back and listen, take a look. Because in 4-channel sound, seeing is believing.

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Take advantage of this U.S. Government booklet and get started in a big-income career.

"...you no longer need four years of college to start out on a scientific or technical career.

"You can break into any field – from medicine to computers to engineering to the space program – with only a year or two of education. Just become a technician."

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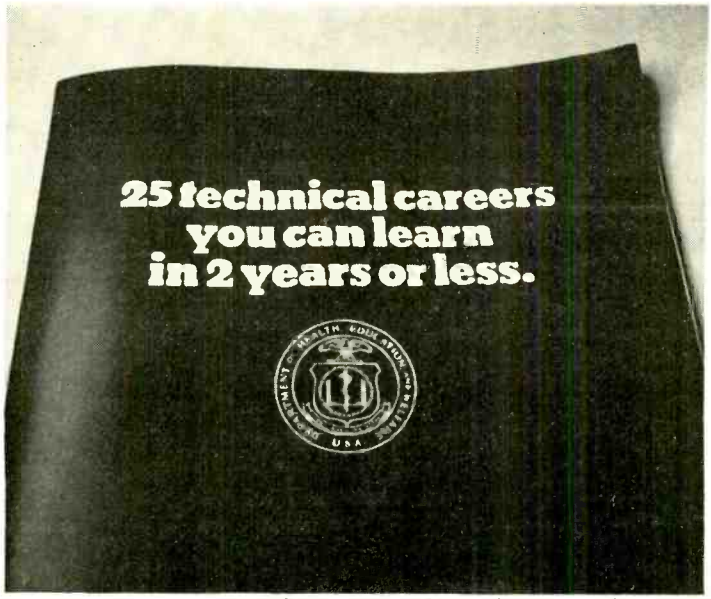

"You no longer need four years of college to start out on a scientific or technical career.

"You can break into any field – from medicine to computers to engineering to the space program – with only a year or two of education. Just become a technician."

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To help you select the technical career field that's right for you, we've listed opportunities in the special coupon, at right. And you can find out what you should know about the field you like best by simply checking off your choice and mailing the coupon today.

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- ☐ Communications, Broadcasting Technician
- ☐ Diesel, Gas Mechanic
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- ☐ Surveying & Mapping
- ☐ CATV Techn.
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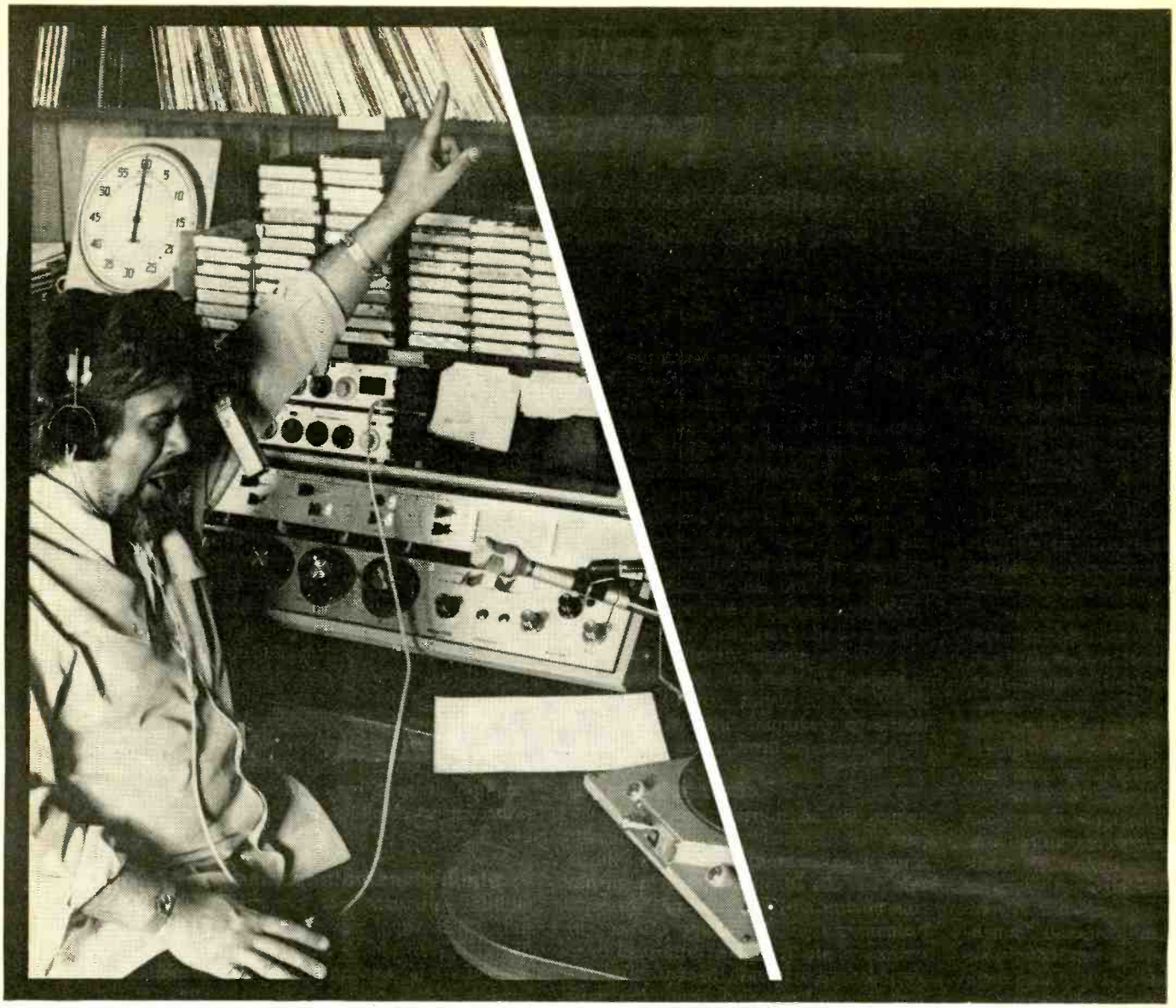
Circle 1 on reader service card



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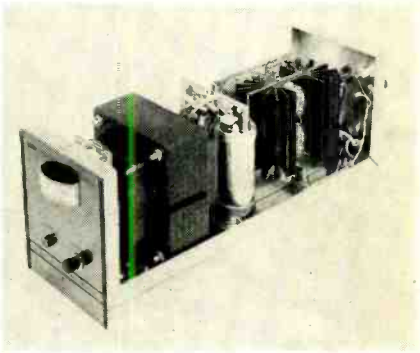
Circle 2 on reader service card

SHURE

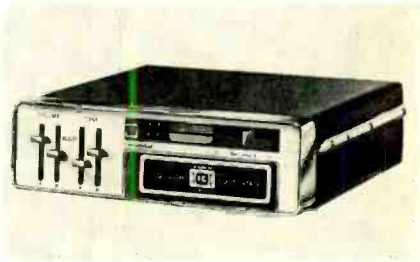
Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

MARCH 1973



4-CHANNEL POWER AMPLIFIER delivers 60 watts per channel, at insignificant distortion levels. **see page 39**



4-CHANNEL IN YOUR CAR. There's a lot of new equipment available now. Here are the details. **see page 54**

Radio-Electronics is indexed in *Applied Science & Technology Index and Readers Guide to Periodical Literature.*

Radio-Electronics, February 1973, Vol. 44, No. 2. Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York City 10003. Second-class postage paid at New York, N. Y. and additional mailing office. One-year subscription rate: U.S.A., U.S. possessions and Canada, $7. Pan-American countries, $8. Other countries, $8.50. Single copies 60¢.

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editorial

CET—three important letters

Certified Electronic Technician! These three words symbolized by the three letters, CET, identify a new kind of electronic technician. They signify the technician who has taken the time, effort and interest in proving to himself, his customers and his peers that he has established a bonafide level of knowledge; much the same as the lawyer who passes the state bar exam or the accountant who gets his CPA certificate.

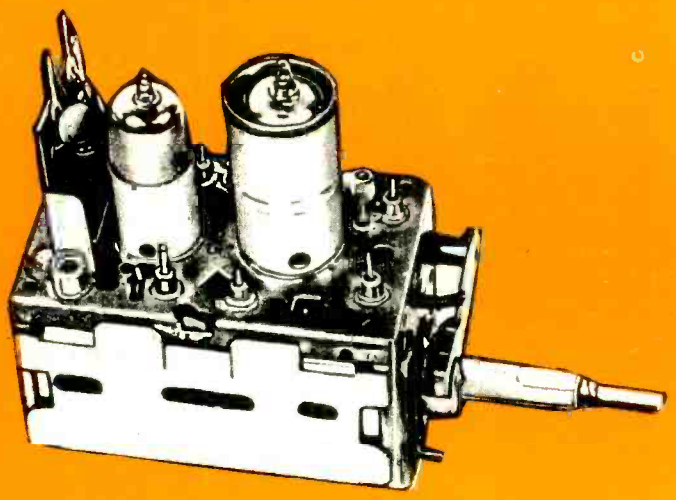
Obtaining the right to use CET after your name is not easy. The test is a difficult one—carefully prepared so that a large proportion of those who take it fail it. The prerequisites for the test also require a level of experience in the field. In some states, where licensing laws currently exist, the CET certificate is required before the technician can be licensed to repair electronic equipment.

The number of technicians who display the CET certificate are growing rapidly as more and more technicians come to understand the reason for the certification program and what it does for them. The technician who holds a CET certificate should display it proudly as it represents an authoritative evidence of his skills and abilities.

Radio-Electronics strongly supports this program and, in fact, our editorial staff acts as monitors for the CET examinations given in the metropolitan New York area.

We urge that all technicians find out what the program is and what it offers. We would like to see every qualified technician become a Certified Electronic Technician and an active member of ISCET (The International Society Of Certified Electronic Technicians). If you require further information on the CET program or ISCET, please write to us. We will forward your inquiry to the proper organization for reply.

There is still room in many states to become a CET with a certificate number that is lower than 100. Take advantage of this opportunity now, and become one of the first Certified Electronic Technicians in your state. **—Larry Steckler,** CET, Editor



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WATCH US GROW

Circle 3 on reader service card

looking ahead

Enter Disco-Vision

Discomania seems to be overtaking the television set manufacturers as they search for a new generation of video products. Most of them are also very closely researching the possibility of cartridge video-tape recorders for the home—some are already selling them. But the concept of the disc appears to have captured their imagination as a potential new entertainment medium that could provide pre-recorded visual information at a cost far below that of magnetic tape.

So far, three basic principles have been used in video discs: **(1)** The mechanical pressure-transducer system developed by German Telefunken, British Decca and their joint subsidiary Teldec. Zenith has also demonstrated its own system, based on Teldec principles. **(2)** An electrostatic-capacitance system developed by RCA, that had not been publicly demonstrated at press time. **(3)** The laser-optical system shown by Philips.

The third system, which Philips calls VLP (see **Radio-Electronics** December, 1972), was warmly received by those engineers who witnessed its first demonstration. Now, suddenly, a new system has entered the race—but one that so strongly resembles VLP that there is open discussion as to whether the two could eventually become compatible. The new system is Disco-Vision, developed by a subsidiary of MCA Inc., the entertainment collossus that owns Universal Pictures, several record labels and a TV program syndication company.

Although demonstrated with only seven minutes of program material, Disco-Vision's backers say that up to 40 minutes of color pictures and stereo sound can be pressed into a single-sided plastic 12-inch disc with a reflective coating. The disc revolves at 1,800 rpm (or 30 revolutions per second, in synchronization with TV's frame rate) and is scanned by a 1-milliwatt helium-neon laser. The master disc may be made from film, video tape or a live television picture and is laser-etched in real time. Pressings are made in a manner similar to the replication of an audio phonograph disc. Although MCA demonstrated only a single-play Disco-Vision attachment for home TV sets (the signal is fed in through the antenna terminals), it showed a mockup of a proposed changer, which could accommodate up to 10 discs, which could provide up to six hours and 40 minutes of continuous visual material, interrupted only by a 4-second disc-changing cycle.

MCA believes the single-play attachment could sell for less than $400, the changer for under $500, and record albums for $2 to $10, depending on the length and content of the material. Although MCA hasn't yet decided whether to manufacture the hardware itself or farm it out to others, its officials say they are shooting at a late-1974 production target—which happens to be the target date for virtually all of the competitive systems. MCA also promises it will release movie albums from "the world's largest collection of feature films" in Universal Pictures' vaults.

Videoplayer rules

A new FCC ruling should result in stronger, clearer pictures from those videodiscs as well as VTR's and other devices designed to be attached to the antenna terminals of home TV sets. Since July 1961, when the FCC ruled it had jurisdiction over videoplayers under its authority to control radio-frequency interference, manufacturers of such "Class I TV devices"—which include most videoplayers as well as Magnavox's Odyssey TV game—have been operating under legal restrictions that some said guaranteed a noisy picture.

The most odious part of the rules was the provision limiting signal strength to a maximum of 2,000 μV rms across a 300-ohm antenna terminal, or 1,000 μV across 75 ohms (see **Radio-Electronics,** December, 1971). Last-minute modifications were made in various video devices to meet this restriction, but their makers didn't like it.

Now the final rules are out. As a result of the near-unanimous view of the industry that the earlier limit was too low to produce a good, clean picture, the FCC raised the limit to 6,000 μV across 300 ohms and 2,000 μV across 75 ohms. As a safeguard against video-players feeding out through antennas or CATV systems, the Commission added the requirement that these devices must be equipped with a 60-dB antenna-transfer switch to disconnect the receiving antenna when the videoplayer or other gadget is in use. The increase in signal strength permitted by the FCC is on the order of 10 dB and should help melt the snow that has often been a characteristic of videoplayers sold to date.

CATV receivers

With cable TV now serving more than 10% of America's television receivers, and with all future cable systems required to carry at least 20 channels, FCC-backed industry studies are now under way with a view toward standardizing CATV channels.

A large number of proposals for new channeling have been made. Some envision 24 to 34 extra cable channels not duplicating the present broadcast channels. Others involve the use of standard vhf channels, plus some extra new ones, as is now being done with converters. Still others foresee the use of multiple cables and the existing channels. In the latter case, a two-cable system would permit the transmission of two programs per vhf channel, the viewer merely turning a switch to change from Channel 2A to Channel 2B, switching from one cable to the others. A two-cable system would permit the use of 24 vhf channels, a four-cable system 48 channels.

How would these various plans affect receiver design and costs? Sylvania's Advanced Development Manager C. Bailey Neal has analyzed the various plans and concluded that the first two would unduly penalize viewers who are not connected to the cable, and add to the cost and bulk of television sets. The first plan, with the completely separate set of cable channels, his study indicated, would require an extra tuner twice the cost of the standard vhf tuner (which would also be in the set for off-the-air reception) and increase the cabinet size by three to four inches, expanding a 17-inch color set to the bulk of today's 19-inchers. The multi-cable approach was found to be the most practical from the standpoint of receiver design, requiring only the addition of a simple A-B (or A-B-C-D) switch to change channel inputs. **R-E**

by **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

SONY® 1055 and 5055
One good Sony deserves another

Sony offers you eleven individual choices in tuners, amplifiers and preamps, plus an infinite variety of combinations. For every listening requirement in every price range. We're going to tell you about two new low-priced models that offer all the traditional Sony performance and value.

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The deserving tuner for the TA-1055 is Sony's ST-5055. Its sensitivity is 2.2μV IHF, moderate by today's standards, but when you combine it with a capture ratio of 1 dB, performance is outstanding. There's a high blend switch for quiet stereo reception of weak signals, built in AFC, signal-strength meter and switchable muting. The price, including walnut finish cabinet, $159.50.

Each is the lowest priced tuner and amplifier offered by Sony. Imagine the performance and value offered by the nine other models. Sony's wide selection of deserving amplifiers and tuners goes right on up to the ultimate combination of the super-powered 3200F, deluxe 2000F preamp, and 5130 tuner at $1238. Visit your dealer and audition these Sonys. You deserve it. Sony Corporation of America, 47-47 Van Dam St., L. I. City, N.Y. 11101.

All prices suggested retail.

Sony Tuners and Amplifiers now start at $149.50.

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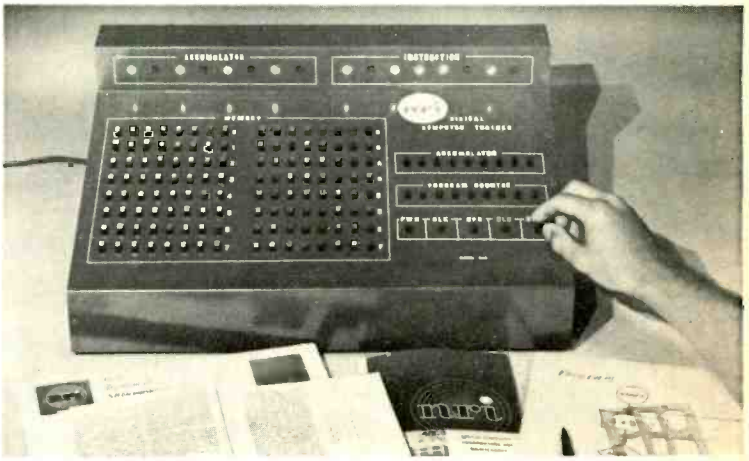

first to give solid state 25″ color TV, 5″ wide band oscilloscope, color bar generator and other professional equipment engineered specifically for education. You work directly on the receiver as you build it, discovering the practical aspects of TV servicing as you create a handsome new color console. Only NRI includes an attractive woodgrain cabinet without extra charge.

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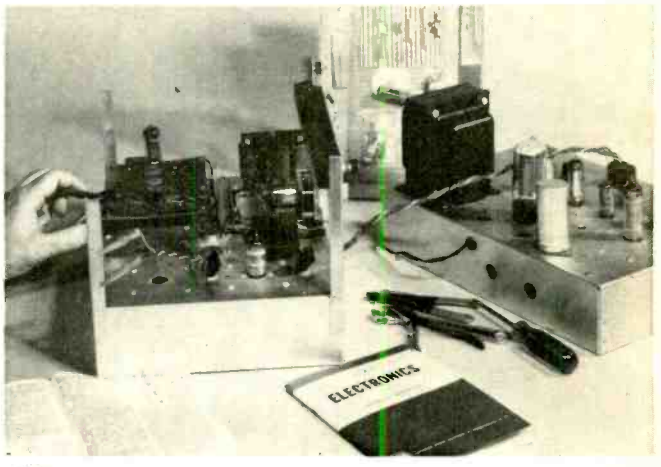


first to give you completely specialized training kits engineered for business, industrial and military Electronics. Shown above is your own training center in solid state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, and problem-solving digital computer circuits are also included in your course.

new & timely

Beeping traffic signals help blind cross streets

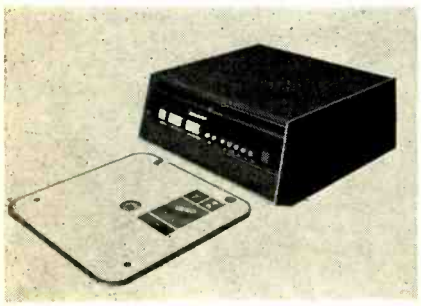
An electronic traffic signal that combines the traditional red and green lights with a loud beeping during the first 5 seconds of the green light period has been installed at a Vienna street crossing adjacent to a school for the blind. It has had such excellent results that Viennese authorities are promising more.

A blind American electronics instructor points out that the blind are especially helpless at a street crossing. "You just listen till you hear no sound from either direction, then run like hell and trust to luck." With the beep signal, the blind pedestrian knows that there are 12 seconds to cross after the 5-second beeping stops.

"But," says one student, there is another advantage—the driver respects the sound-and-light signal more than a conventional light. "When we had normal lights," he said, "drivers used to roar away on the green as if they were on a racetrack, regardless whether a pedestrian—blind or not—was in the way. Now they have more respect."

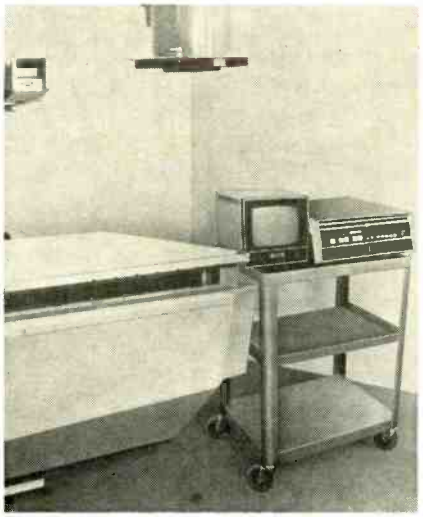
"Floppy-disc" video recorder can make X-rays safer

Reduction of doctor and patient exposure to X-rays by as much as one-half in such examinations as barium swallows, and even more in other procedures, is promised with a new magnetic video disc recorder, which can record and play back up to 600 pictures from a single disc cartridge.



THE DICASSETTE, with its cartridge disc.

In a barium swallow, for example, the patient swallows a barium solution to make his upper digestive system visible. The doctor watches the TV monitor carefully to discover problems. If he sees something interesting, he presses a foot switch that takes a photograph. The X-ray procedure goes on while the doctor is waiting for the film to be developed, and only after the full X-ray session is the doctor in possession of the photos that may solve his problem for him.



TYPICAL X-RAY SET-UP, including the examination table, TV monitor and Dicassette.

With the *Dicassette* recorder, the doctor presses a foot switch that gives him an instant video snapshot. The recorder freezes the scene, giving the doctor a still picture he can study as long as desirable. In many cases, the X-ray examination can be terminated immediately, as soon as the doctor is sure he has found the trouble, thus saving the patient unneeded exposure to the rays.

The new recorder, made by Arvin Industries, has two advantages over equipment now in use. It takes an absolutely stable picture, something that cannot be accomplished with the standard helical-scan tape recorder, and it uses a low-cost, easily interchangeable flexible disc, in contrast to the expensive and critical plated aluminum discs of existing recorders with equal picture stability. Listing for $4,000, with a cartridge disc selling for $25, its manufacturer calls it a breakthrough in reliability, simplicity and price.

Each *Dicassette* cartridge contains 600 stable full-revolution still frames. Cassettes can be changed rapidly—less than 20 seconds from lock-up to lock-up. Pictures can be played back at 1, 3, 6 or 15 frames a second, giving stop motion, slow motion or full motion. A stack of disc cartridges four inches high can hold as many as 10,000 pictures. Any one is immediately accessible, and any one can be updated or replaced without disturbing the other images.

Aside from the medical field, the recorder has many applications in training, industrial applications, security, banks, educational TV and CATV. Animation offers a particularly promising field.

New upgraded program planned for unified service training

A two-day pilot session of a new program designed to overcome some of the service technician's problems of receiving information on new design features and circuitry in TV-electronics equipment, and in participating in advanced service training will be conducted in Indianapolis March 19th and 20th. It is being launched by a group including the organized service technicians (NEA), the manufacturers and the Electronic Industries Association (EIA).

The main weaknesses in present-day training methods, which the new program is intended to correct or ameliorate, are:

1. Manufacturers' service training sessions easily available to service technicians usually cover only the most popular brands.

2. It is estimated that to keep up with current information on even the popular brands, a technician would have to spend at least two evenings a week attending training sessions. Many technicians, realizing that they cannot attend all the sessions, attend none.

3. Considerable material at the various service meetings is—necessarily—duplicated for each brand of receivers.

The new approach has been named JESUP—Joint Electronics Service Upgrading Program. The first two-day pilot training program will be broken down into general sessions of an hour each, in which authorities discuss such subjects as feedback circuits (agc, aft, acc) TV alignment, solid-state troubleshooting techniques, for example, and into special sessions of two hours, in which students break down into 20-man teams to work actively on electronic equipment under the direction of manufacturer training directors.

It is expected that the lessons learned in the JESUP two-day pilot program in March will be used to debug, modify and form the permanent program,

(continued on page 14)

new & timely

(continued from page 12)

which will probably be expanded to cover the country within the year. Program publicity and promotion are handled by Joe Groves, manager of Photo-Facts at Howard W. Sams Co.

Hugo Gernsback scholarship winner

Donald O'Rourke, 27, Brooklyn, N.Y., is the winner of the last of the second Hugo Gernsback Annual Scholarship Awards. These awards are in the form of $125 grants made to home-study students of electronics. Eight are made each year, to outstanding students in each of eight home-study schools.

Donald O'Rourke joined the U.S. Navy in 1962, immediately after leaving high school. He served aboard the aircraft carrier U.S.S. Constellation as Aviation Jet Mechanic until 1965. Separating from the Navy, he joined the New York Police Department as Patrolman, and is now working in the Medical Section of the Police Academy in New York City.

He became interested in electronics, he says, because of "the many opportunities in this field," which, he points out, has now expanded to encompass areas as far apart as space technology and the needs of everyday living, and almost everything in between. He enrolled in a Master Television Service course with the RCA Institutes, without any previous electronics experience. "I have found the course very interesting," he says, "not only learning basic electronic theory, but attaining practical experience in building test equipment and television receivers."

After completing his studies Mr. O'Rourke expects to work part-time in TV servicing, with the eventual prospect of having his own business.

Mr. O'Rourke has a wife, Elaine, and one son, Patrick, age 2.

Second-year guarantee offered on 25-inch TV's

A free second-year parts and labor warranty—said to be the first ever made by an American manufacturer—is being offered by Philco-Ford on three new 25-inch diagonal solid-state console color receivers during its annual "One Idea Better" sale, which began in late December and runs through March. The second-year warranty has an estimated value of up to $100, according to a survey of major TV service organizations.

The warranty is standard on the new consoles during the sale only, and is optional on all other 25-inch diagonal modular solid-state sets.

NEA-NATESA move toward unity

Presidents of the two national service organizations, at a meeting of members of their merger committees and boards in Nashville, Ind., November 30 last, agreed that the two associations might be able to merge in a matter of months. Members of both organizations, they indicated, were still unclear in their understanding of the proposed details of the anticipated consolidation, and time will be required to make all points clear and to solve all vital issues before the merger.

Meanwhile the two organizations are cooperating closely on several mutual projects, including the joint annual convention in Kansas City, August 1973, and their joint effort to improve the design of products by manufacturers to bring about better serviceability.

FCC authorizes new type of common-carrier service

By the authorization of a new type of microwave common-carrier service, the FCC has created a new communications medium that may make possible hundreds of low-cost private television networks for business, institutional, government or entertainment use. The new *Multipoint Distribution Service* (MDS) is a common-carrier telecommunications system on which anyone may purchase time. MDS stations, as common carriers, will not be permitted to produce or con-

(continued on page 16)

new & timely

(continued from page 14)

trol the programs they transmit, but will make their services available to anyone on a first-come-first-served basis.

MDS operates in the 2150-MHz (2.15 GHz) band and is designed to transmit encoded signals to any number of locations within a 25-mile radius. Receiving locations are equipped with parabolic antennas and equipment to decode the signals and convert them down to regular television channels, when they may be displayed on an ordinary television receiver.

Since program transmissions are address-encoded for a pre-determined set of reception points, purchasers of time on the system are assured of security. A company, for instance, may buy time to telecast a confidential sales meeting to ten locations within a metropolitan area. Only those ten locations can receive the program. At the end of that company's time, another user may transmit, say, a training session to 50 other locations in the area. None of the signals can be picked up by receivers of the first group, or by other MDS users in the network.

Possible uses for the new system approach the infinite and are limited practically only by the imagination of the potential users. That this imagination may be lively appears from the fact that more than 300 license applications had been filed for more than 160 cities by the middle of last November.

SPECIAL RECOGNITION CERTIFICATE is awarded to Radio-Electronics magazine by the National Electronics Associations, Inc. for "much appreciated assistance on the Certified Electronics Technicians examination program 1972." The award was presented on behalf of NEA by Lew Edwards (right) and accepted by Larry Steckler, Editor. R-E

Radio-Electronics is published by Gernsback Publications, Inc. 200 Park Ave. S. New York, N.Y. 10003 (212) 777-6400
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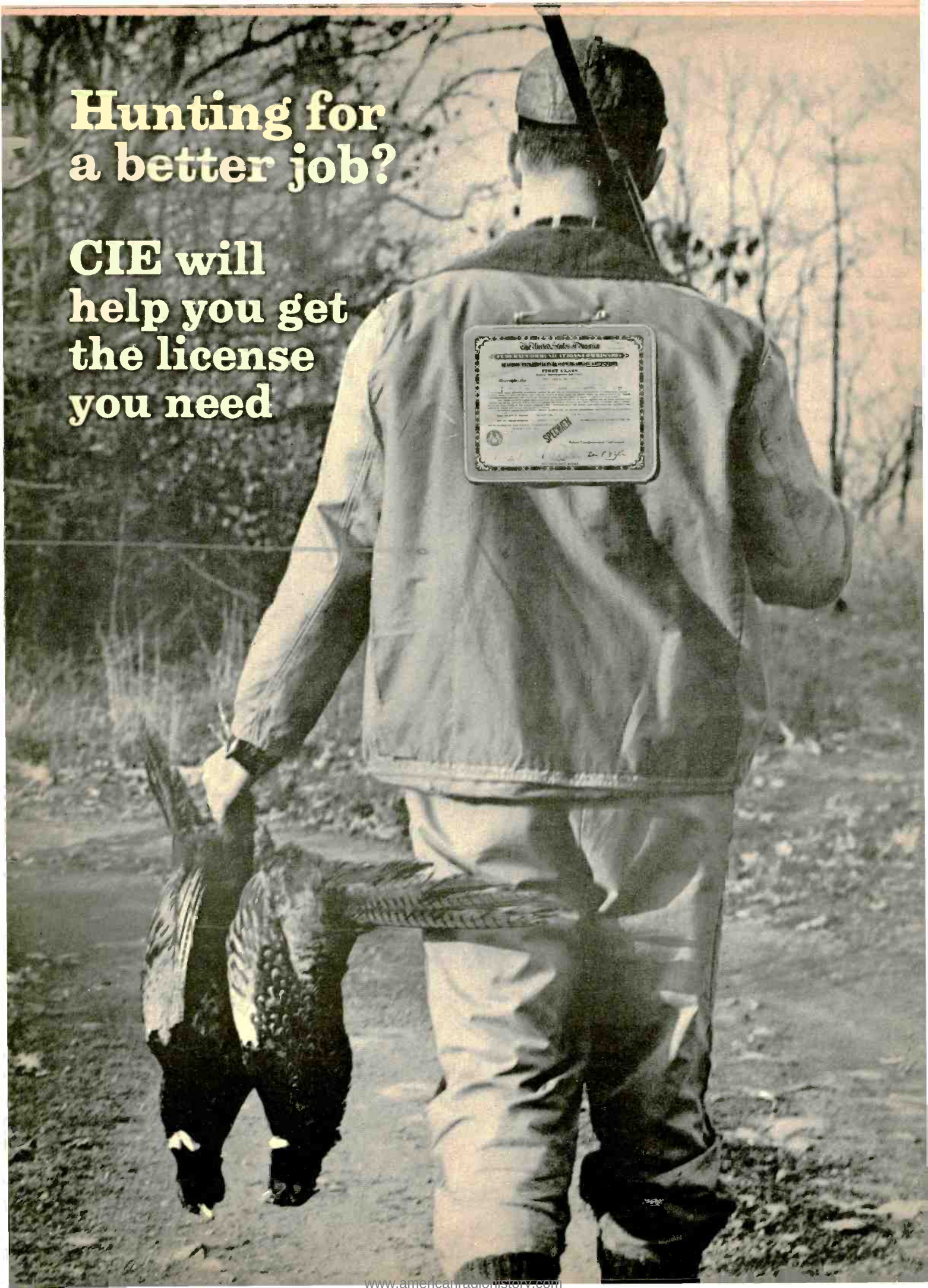


letters

DIGITAL CLOCK CORRECTION

Mr. Larry Sullivan has called our attention to an error in the schematic in his article "Inside the IC Digital Clock" in the February issue. In Fig. 2, page 37, the line connecting the common side of resistors R6 through R18 is shown going to ground. This connection is wrong. The line joining these resistors should go to −35 volts as the collector of the 2N3906; and to ground only through potentiometer R5.

PREDICTIONS

Reading some of Bob Gerson's predictions for TV in the annual TV issue brings back memories of many earlier annual TV issues, and I note that TV hasn't really changed much in 20 years.

Bob makes many predictions of things to come. We shall wait and see. In the meantime, I will have to go along with "old timer" Jack Darr on the modular sets. Chances of any module standardization are very remote and there won't be any drugstore module testers for that reason.

Designing and marketing a module tester to test all present and future modules are formidable engineering and sales tasks. Economical testing of modules in the field will come about only when sales competition forces it, just as sales competition forced *all* other changes.

Today, sales competition on modular sets is very slight. They are high-cost top-of-the-line sets. I'm sure that manufacturers build in the replacement cost of defective modules during the warranty period. So why would they add a module-tester plug to each chassis and provide a plug-in module tester?

DAVID R. MCKNIGHT
Norwalk, Conn.

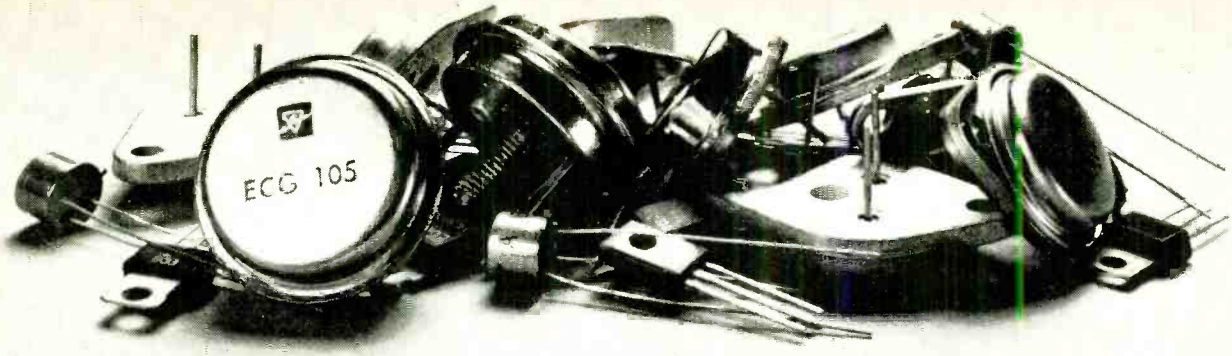
Certainly, the manufacturer has built in a cost factor to allow for warrantee repairs, but he does that on every product he manufacturers, as does every other manufacturer—it isn't done only for modular color TV's.

Why would he build in a module-test jack? Serviceability! The more serviceable the set, the less expensive the repair, the more likely the set owner is to buy that brand again.—Editor

ENGINE TIMING WITH A VOM

After reading through the method presented by Radio-Electronics for set-

(continued on page 24)



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AD149	104	OP-8-1	130
AD149-01	121	OP-8-F	130
AD149-02	121	OP-10	179
AD149B	121	OP-11	130
AD150	121	OP-12	130
AD152	131	OP-13	185
AD155	131	OP-14	184
AD156	131	OP8-6623N	105
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GTE SYLVANIA

LETTERS

(continued from page 22)

ting the timing of an automobile engine with a vom or vtvm (August 1971, page 75) I've come up with an alternate method that I feel is superior to the earlier method because:

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2. Engine can be timed to its specifications and not just top dead center.
3. Depending on the condition of the distributor, I think the above method is as accurate as a timing light.

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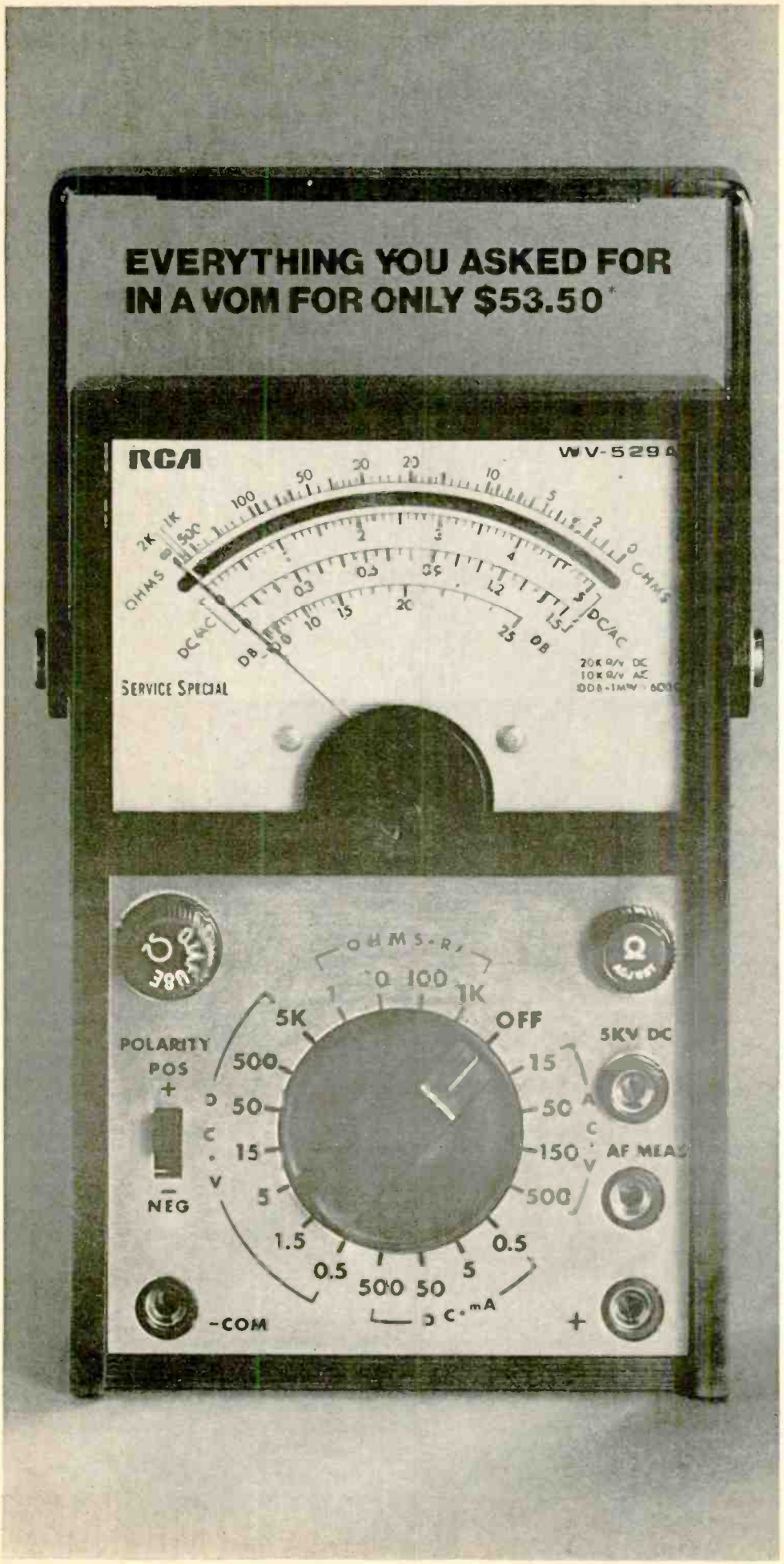
2. With the vom/vtvm set to read the battery voltage, connect it between the point connection to the coil and ground.
3. Turn the ignition key on but do not start the engine.
4. Adjust the distributor to the point where a meter reading occurs. At this time the points have just opened and the meter will read the battery voltage. The engine is now timed.

J. KENNETH BERTRAM
Asbury, N.J. **R-E**



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Circle 14 on reader service card

equipment report

Radatron Auto Sentry Educational Burglar Alarm Kit

Circle 30 on reader service card

RADATRON CORPORATION PRODUCES AN automobile burglar alarm aptly tagged the Auto Sentry Educational Kit. It intermittently blows the horn when triggered by operating any of the car's electrical equipment. In the past we have warned that some kits are definitely not for beginners due to inadequate instructions or the high degree of skill required. This one is specifically recommended for beginners because of its ease of construction and instructive nature. It does give protection but should not be expected to foil a professional car thief familiar with this type of alarm.

Guided by a well-prepared 52-page booklet, the builder is given background information about electronic components and soldering techniques. It is complete with a "What did you learn?" quiz at the end. The manual is amply illustrated with numerous views of the printed-circuit board and the rear panel with its power transistor relay driver. Radatron points out that some vehicles do not use a horn relay and offers one as an option. Horn circuit color coding for popular car models is included. There are five push buttons, the single printed-circuit board and the power transistor to be assembled, and construction time is only 2 to 3 hours. Resistors are preformed and wires cut to length with connectors eventually used to attach to the car's wiring without any cutting.

There is a troubleshooting list limited mostly to suggesting incorrect component insertion. One omission in the booklet is the marking of component values on the schematic. The information, however, is readily available in the parts list and can be filled in. A neat small cast-aluminum enclosure houses the project. It can be easily mounted out of sight for further security. The five coded push buttons are mounted in die formation on the front panel along with a green hold indicator lamp.

The kit worked on completion but instead of the specified alternating 15 second on, 15 second off horn blast, the timing was 5 seconds on with 20 seconds off. The discrepancy is probably due to the wide electrolytic capacitor tolerances.

Operation is broken down into three modes; armed, temporary hold and permanent hold. The correct button choice puts the alarm into the temporary hold mode after turning on the ignition. Pressing the wrong button blows the horn. Turning off the ignition terminates this mode automatically arming the alarm. A 25-second delay gives time to leave the car. While armed, any voltage transient on the auto's 12-volt battery bus caused by operating any electrical equipment including the door light or brake light switches, triggers an SCR into conduction. The alarm is delayed for 15 seconds to give the owner time to open the door and key-in the temporary hold sequence. A different button combination selects the permanent-hold mode disabling the alarm until further programmed, allowing a parking lot attendant to drive the car without alarm activation.

The armed standby current drain was measured at 12-mA while the permanent-hold mode drain was 130-mA. A 24-hour "permanent" hold should be considered a maximum since this represents 0.13 x 24 or a 3.12 ampere-hour battery drain.

The Auto Sentry is a simple kit to construct well suited for the beginner, with the finished product offering a modicum of protection. Any gal who services her own Maverick will find this kit a cinch. R-E

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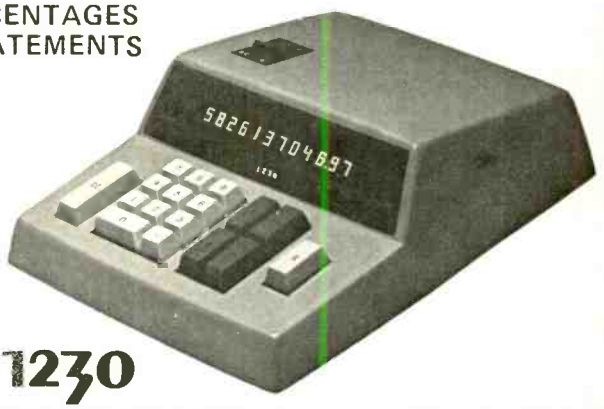

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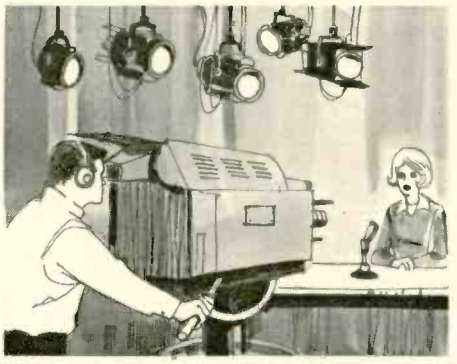

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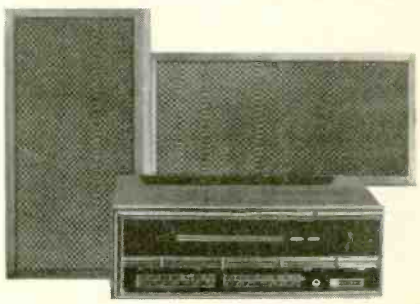

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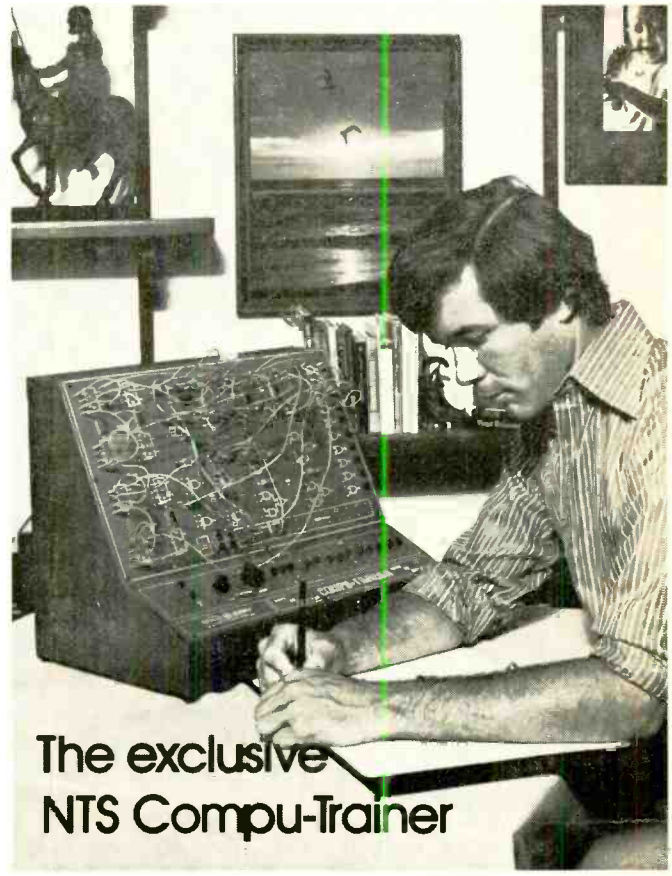

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ALL ABOUT TIMERS

by JACK DARR
SERVICE EDITOR

THE "CONTROL-CENTER" OF ANY AUTOmatic electrical appliance that offers multiple functions is the timer. Each "thing" must be turned on and off at the proper point in the cycle. In an automatic washer, for instance, this would include water valves, the motor, drain pump, clutches for changing speed from wash to spin, and even the timer driving motor itself. When it reaches the end of the cycle, it turns itself off.

If you have troubles in any machine like this, the first thing to do is to isolate the function that *isn't* working. For example, the hot-water valve. A symptom here would be cold water in the tub after the timer has gone through the WASH position. If the machine has a TEMPERATURE selector switch, HOT and WARM, this would be set to WARM for the cold-water-in-the-tub symptom. If the selector switch was set to HOT, the symptom would probably be "no-water-at all" since only the HOT valve opens then. (First step; check to make *sure* that the hot water faucet is turned on.)

Check the wiring diagram on the back of the machine, and locate the hot-water solenoid. (Follow the hoses.) There are several ways of checking this. Pull the ac plug, and pull one wire from the solenoid. Most of these have push-on connectors. Check the coil for continuity with an ohmmeter. If this is good, follow the wiring up to the timer. It may go through the HOT-WARM selector switch; some of these control only the cold water solenoid, however.

Most machines have very plainly color-coded wiring. Follow the hot-water valve lead to the contacts on the timer. Be sure that all of the push-on connectors are firmly seated. Wiring troubles are comparatively rare, but check for them just the same.

Next you can turn the timer knob to the beginning of the WASH portion of the cycle. The hot-water valve should be open, filling the tub. Check across the timer contacts with the ohmmeter.

A better test for contacts is to clip the ac voltmeter across them (insulated clips *please!*), and then plug the machine in. With the contacts open, you will normally read the full line voltage across them, (unless another switch somewhere in the circuit is open). However, when the contacts should be closed, there should be absolutely *no* voltage drop across them. If you see a low ac voltage reading, this indicates that the contacts are dirty. You're reading the drop across the resistance of the "dirt".

This means trouble. The resistance of the poor contact generates heat, the heat burns the contacts even more, and you're in a vicious circle. In a great many of these timers, the contacts are easy to get at. Fig. 1 shows a typical timer assembly. You can clean up the contacts with a "point-file", fine sandpaper or even an emery-board. Smooth them off to a high polish, for best contact.

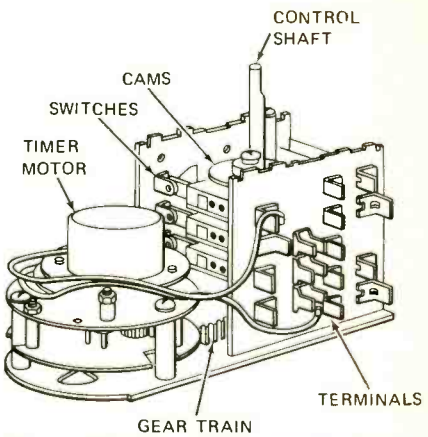

FIG. 1—TYPICAL TIMER ASSEMBLY, with motor and contacts.

Turn the timer knob by hand, to open and close the contacts. Check to make sure that the contacts meet absolutely flat, or parallel, for maximum contact area. If necessary, bend the contacts arms very slightly so that they do meet properly. Contact closure should be "firm", so that the arm bends just a tiny bit, to jam the contacts tightly together. Fig. 2 shows how this type of cam and lever actuator works. As you can see here, some of them use spdt switches. Be sure

(continued on page 102)

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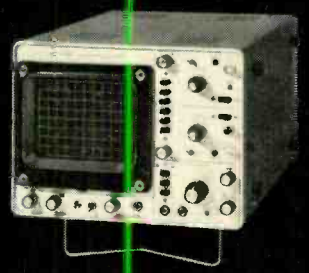

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Zero tracking error may be the most dramatic aspect of Zero 100, but it has other features of genuine value and significance. Variable speed control; illuminated strobe; magnetic anti-skating; viscous-damped cueing; 15° vertical tracking adjustment; the patented Garrard Synchro-Lab synchronous motor; and exclusive two-point record support in automatic play.

The reviewers have done exhaustive reports on Zero 100. We believe they are worth reading, so we'd be happy to send them to you along with a 12-page brochure on the Zero 100. Write to us at: British Industries Co., Dept. C243 Westbury, N.Y. 11590.

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4-CHANNEL MATRIX How Good Is It?

It sounds better than 2-channel stereo and appears to be getting better all the time

by EUGENE WALTERS

YOU DON'T HAVE TO ASK THE EXPERTS any more; ask anyone at all who's heard four-channel stereo and you'll find that he agrees with the experts' consensus—4-channel sound is in, and it's already here in a big way.

Just take a quick look at the incredible equipment lineup. Everyone who makes any kind of stereo equipment at all has at least one quadraphonic product in the line; more likely, it's three or four items or more. These products can run from the simple kit-type matrix decoders for $19.95 on up to a super combination AM/FM Stereo/4-Channel Receiver/Amplifier with every bell and whistle you can think of and a few that may not have occurred to you yet.

But the all-important question is, "What's in that little decoder box or behind the decoder selector switch on the big rig?" There has been a variety of equipment designs, announcements, pronouncements, technical papers purported to prove something or other, and massive confusion for everyone. There are two basic formats for 4-channel sound today: discrete 4-channel tape, and 4-channel records. The records can be further broken down into the so-called "discrete" discs (the RCA/JVC system) and the various matrix types.

Let's take a look at the RCA/JVC disc first. While we won't offer any kind of final judgment here, the "discrete disc" just might not end up as the industry standard, even though it does produce an exceptional four-channel effect with the right equipment and under the right conditions. But that's precisely the rub with the carrier-type disc; it requires too much in equipment modifications, special pickups, styli, and cannot be broadcast on FM without some special ruling by the FCC—which may be hard to come by.

So if we rule out the carrier-type disc, we are left with matrix, and the one thing we can say for sure about matrix 4-channel is that it's getting better all the time. The beauty of the matrix is its operational simplicity. No special pickups are needed; no fancy detecting circuitry; and any FM stereo broadcaster can convert to quadraphonic by simply playing an encoded record on the air!

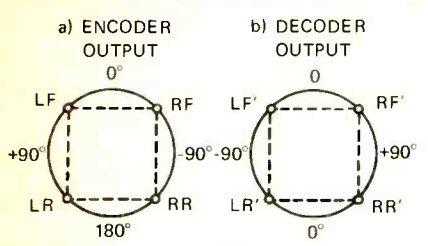
For a while, there was a field of three different competing matrix systems: Columbia/Sony's SQ; Sansui's QS; and the Electro-Voice System. There were also various schemes advanced by some manufacturers for "recovering" the ambience information that is believed to be present in most recent two-channel stereo recordings. This is done by extracting certain phase differences and feeding these

on the cover

Discrete 4-channel records are not only possible, but they *are* being made today. One of the current group of discrete 4-channel systems is shown on this month's cover. It consists of a JVC model 4DD-5 Disc Demodulator, a special high-frequency-response JVC phono cartridge (its got a conical stylus and frequency response out to 38,000 Hz); and of course, the records to play using this system. The record shown is an RCA Quadradisc. Others are available now, as are a variety of records from JVC. These recordings are not compatible with matrix records. Other 4-channel discrete disc equipment is being produced by JVC, and also by Panasonic. There are more demodulators, as well as preamp-amplifiers and receivers with the discrete 4-channel demodulator built in.

How good is discrete 4-channel? We don't know at this time, but tests are being performed now to enable us to give you some basis of comparison between 4-channel matrix and 4-channel discrete. **R-E**

signals, mixed with some of the up-front signal, to one or two rear speakers. To be sure, this technique very markedly enhances the overall sound



PHASE RELATIONSHIPS between the four channels in both encoding and decoding.

quality and listening experience for two-channel stereo recordings—much the same way that a mono recording can be enhanced by playing it through a stereo system.

But even here, the sound improvement is markedly better for one very important reason: we have transposed the reproducing system from a "wall of sound" to a "room full of sound"—creating the "sound field" which has come to be synonymous with four-channel.

In the process of creating such a sound field, some front-to-back crosstalk is inevitable. For that matter, isn't such "crosstalk" inevitable in the live concert-hall situation? We don't sit at a concert and try to measure the reverberation time of a particular pillar or balustrade; instead we are immersed in the total sound field, and if the hall acoustics are as good as they should be, our attention is focused on the source of the sound—up front, on the stage.

What all this boils down to is a new study and approach to the *psychoacoustic* aspects of sound reproduction—how we listen to and hear live sounds and their recorded versions. Increasingly, matrix researchers have come to rely on these psychoacoustic phenomena in an effort to squeeze more separation out of their respective systems.

We know how good a matrix can sound. The reason why it has been so difficult to get the matrix systems to provide discrete effects can be seen in this basic encoding formula:

$$L = (LF + LR)\cos\theta + (RF - RR)\sin\theta$$
$$R = (RF + RR)\cos\theta + (LF - LR)\sin\theta$$

These two equations represent the output of a typical matrix encoder—the actual signals that will go into the disc-cutting head.

But what has happened here? We have taken four "unknowns"—the four signal channels, LF, LR, RF and RR and reduced them to two equations so they can be cut in the disc as simply L and R. When it comes time to recover these four individual signals, we still have just two equations, and no amount of algebraic or electronic processing will extract more than two unknowns from two equations.

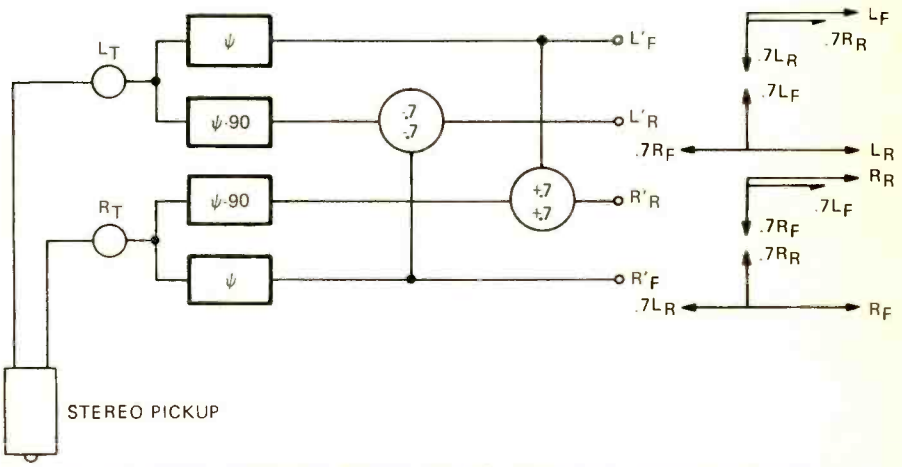
Yet *something* is extracted by the decoder working on the signal from that record. The decoder output in a basic matrix system looks something like this:

$$LF' = L\cos\theta + R\sin\theta = LF + 2RF\sin\theta\cos\theta + LR\cos2\theta$$
$$RF' = R\cos\theta + L\sin\theta = RF + 2LF\sin\theta\cos\theta + RR\cos2\theta$$
$$RR' = R\cos\theta - L\sin\theta = RR - 2LR\sin\theta\cos\theta + RF\cos2\theta$$
$$LR' = L\cos\theta - R\sin\theta = LR - 2RR\sin\theta\cos\theta + LF\cos2\theta$$

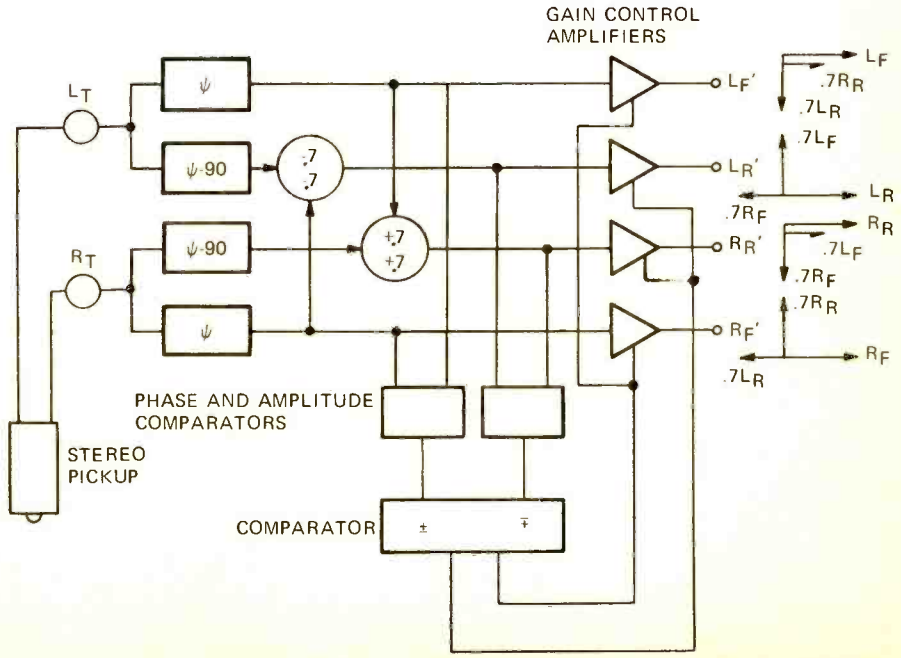
So it is possible to end up with some usable signal. What has happened is that the front-to-back separation has been reduced—diluted in the process of condensing and then recovering the four channels. Instead of decoding into LF, RF, RR and LR, the decoder output is something slightly different: LF′, RF′, RR′ and LR′. Yet even these diluted channels can provide a degree of listening satisfaction unobtainable with conventional two-channel stereo.

But from the vantage point of ever-improving technology, it's quite reasonable for us to be a little unsatisfied with this sort of compromise. Something better was needed. In the past year, several important developments have made the matrix record look more and more attractive. For one thing, Electro-Voice combined its system with the not-dissimilar SQ matrix. That left two major matrix contenders: CBS SQ and Sansui QS.

The principal differences between these two systems in their basic form



FOLLOW THE SIGNAL FROM THE STEREO PHONO CARTRIDGE, through the decoder to the decoder output and this is the relationship between signals using an SQ decoder.



SQ MATRIX DECODER WITH LOGIC is shown here in block diagram form. Signal vectors produced when matrix signal is processed by this circuit are on the right.

involve the method of phase-shifting the rear channels before recording. Sansui points out a major problem with the rear channels as processed in the SQ system: the 180° phase shift used in SQ can cause severe rear-channel cancellation when the actual disc is cut. This is caused by the mechanical lineup of various vectors in the groove walls.

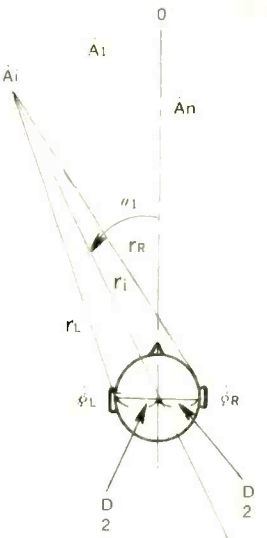
To get around this problem, the QS system phase shifts the left-rear channel by +90° and the right-rear channel by -90°. The total effect is 180° of separation between LR and RR but apparently without the phase cancellation that plagued other matrix systems.

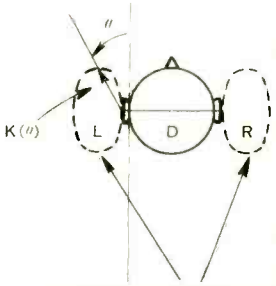
This was fine as far as it went, but it soon became obvious to everyone that something had to be done to improve channel separation. As long as there were just two equations and four unknowns, accurate recovery and a high degree of separation seemed impossible.

Back to psychoacoustics. If this word has left a bad taste in your mouth because of some of the early attempts to make quadraphonic records, it's certainly understandable. After all, the Scheiber psychoacoustic system looked good on the blackboard, but sounded barely like 2½ channels of stereo. Then many experts swung over to discrete, while others decided to try different types of matrix encoding. Now the experts are saying that maybe Scheiber had something after all.

The basic matrix methods went about as far as they could a year or so ago. To obtain the added separation, something else was needed. If we go back to the basic definition of "high fidelity," we find that it is not a close or precise reproduction of the original sound at all. Instead it is a method of creating an acceptable *illusion* of the original sound or a kind of sound that will be agreeable to the listener—with little or no pretense of being faithful to the original. True, refinements in reproducing technology have brought us ever closer to the original, but stereo and quadraphonics are still just an *illusion*.

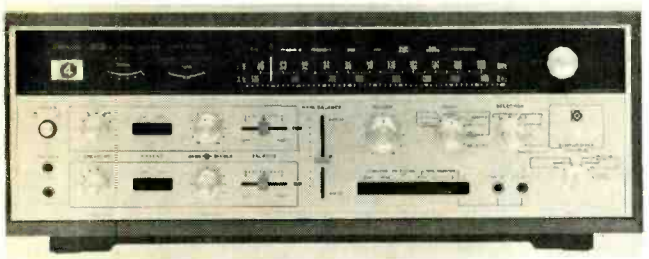
Psychoacoustics tells us this about directional perception in a sound field: directionality is perceived by phase, precedence and relative amplitude. A simple experiment will show that the ears hear differences of intensity (amplitude) as differences in



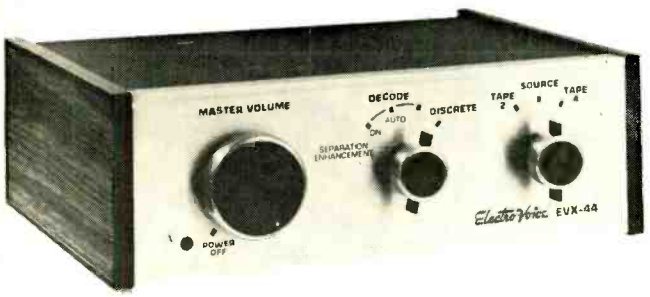


Directional Sensitivity of Ears

DIRECTIONALITY of a reproduced sound image is determined using calculations of this type.

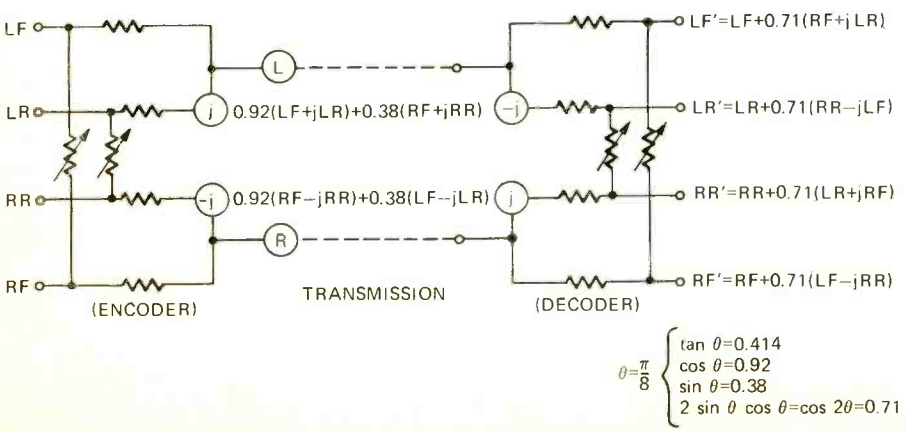


SANSUI 4-channel receiver is their model QRX-6500. Has several matrix decoding systems built in.



ELECTRO-VOICE EVX-44 Universal Decoder is said to decode any matrix recording.

BLOCK DIAGRAM OF THE SANSUI QS CODING SYSTEM

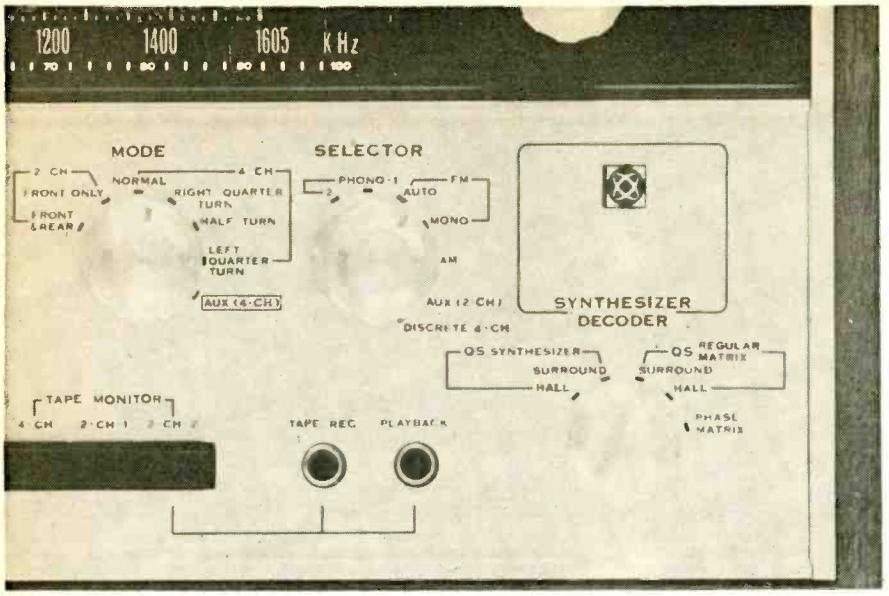


$$\theta=\frac{\pi}{8}\begin{cases}\tan\theta=0.414\\ \cos\theta=0.92\\ \sin\theta=0.38\\ 2\sin\theta\cos\theta=\cos 2\theta=0.71\end{cases}$$

SANSUI QS CODING SYSTEM is shown in block diagram form. Mathematics of the system are written in as they apply.

phase and that actual differences in phase are perceived as differences in amplitude. But then differences in amplitude are still translated by our ears as phase differences, so the end result is the same—our ears,—the ultimate phase detectors, pinpoint directionality by phase differences.

But something else important was discovered both by CBS Labs and by Sansui researchers. Given any two identical sound sources, the one that is louder will mask directionality from the other. We perceive the louder source at the instant that it is louder than other sources. There is also the precedence effect—sound waves that arrive at the listener's ears first provide the needed phase relationship for directional perception. If, a few microseconds later, another sound source provides a louder signal, then directionality will shift toward *that* source. In effect, even though we may be using four sound sources in the quadraphonic listening room, our own perception of instantaneous directionality can accommodate only one of these speakers at a time—as long as one of these speakers is louder than the others. When amplitude is equal for all



WHAT THE USER SEES OF THE QS MATRIX is this portion of the receiver controls. The MODE, SELECTOR, and SYNTHESIZER DECODER knobs.

four speakers, then a total immersion in the sound field occurs, but this happens in theory or with a tone generator only—certainly not with real music.

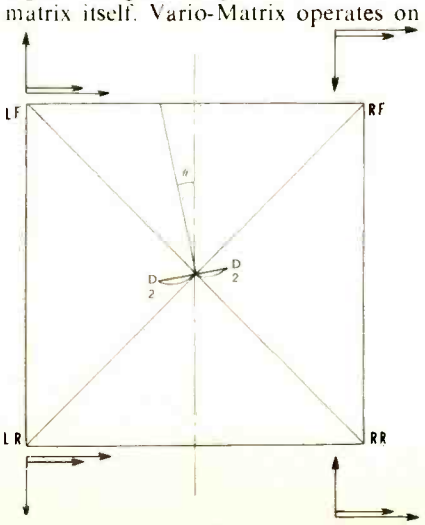
To capitalize on this effect, CBS developed its gain-riding logic—a method of deceiving the ears into believing that they are hearing true directionality, when such directionality without the logic may be only minimal. The SQ logic is modulated by low-frequency signals, with logic gates in effect providing instantaneous switching of major audio signals among the four loudspeakers. The entire sonic system in effect picks up a particular kind of rhythm of its own. The gates provide essentially an infinite number of states from full on to full off, and by detecting small variations in the directional characteristics of the decoded signal, modulate volume level settings for a given speaker at any given time. The SQ logic will turn one speaker on at a higher level, while knocking the other three down.

The total effect is one of enhanced directionality. Certainly minute differences in level have given way to much greater differences, so the directionality practically hits the listener over the head. Gain-riding logic works very well with one predominant direction of sound source. When there is more than one predominant source, the system tends to get confused, and become less and less effective. It is "fooled" into doing some things that it wouldn't ordinarily do. It can create images with sound coming from the sides or from the front, side and back simultaneously. The logic operates so fast that the listener can't hear it actually operating. This is a desirable feature, but the false images created by gain-riding logic can leave something to be desired in the listening experience. To be sure, gain-riding logic possesses a high degree of directionality, and from the standpoint of creating an *illusion*, can be very effective.

Hardware can be a problem, especially without any across-the-board controls. Lafayette Radio, for example, with its LRA-6000, has attempted to operate the SQ logic effectively. As compared with the Sony SQD-2000, the Lafayette unit has fewer components, and uses a simpler way of handling wave-comparative logic. Yet the specifications for this unit are impressive, and it does its intended job, up to a point.

But even the Sony unit is substantially different from the decoder designed by CBS Labs. Here, we find basic differences in time constants—how fast the logic works, and its total effect.

The Sansui *Vario-Matrix*, instead of using the go, no-go operation of logic, changes the parameters of the matrix itself. Vario-Matrix operates on changes in the phases and amplitude relationships of the matrix to provide the appearance of various sounds coming out of various places; it doesn't change the level, but it does change the phase/time relationships noticeably.



OUTPUT IN EACH CHANNEL as delivered by a rotationally symmetrical phase-amplitude matrix system for 4-channel sound.

Since amplitude changes give the effect of phase changes, the Vario-Matrix sidesteps the level-juggling act entirely, and operates directly on the apparent phase relationships as they occur at the listener's ears. If, for example, a 1-kHz signal is fed to just the LF encoder input, there will be a separation of more than 20 dB among the four channels. As a signal is fed to another channel—such as a 3-kHz signal to the LR channel—and is increased in level to gradually acquire greater separation, it gradually begins to mask the directionality of the 1-kHz LF signal. As this happens, the need for great separation between the LF channel and the other three channels decreases, so the matrix in effect reduces the separation of the LF signal. When the LR signal finally reaches the same level as the LF, there is still a separation of about 10 dB front-to-back.

As the 3-kHz signal continues to increase in level, the LF separation becomes less needed and decreases while the LR separation continues to increase. While all this is going on, the low-level signal (LF) retains its total energy; it's not artificially decreased the way it would be with logic. In a logic matrix, the lower-level signal in the LF channel would no longer be reproduced at all, and only its crosstalk components would be carried in the other channels. This separation effect continues in force, even when two simultaneous signals are fed into the system.

Unfortunately, a lot of spade work still has to be done in our understanding of just how psychoacoustics operate in a real listening environment. Still, what little has been learned about the mechanics of how we perceive sound has already contributed toward vastly improved quadraphonic reproduction systems. The coming few months will see a major shaking-out of the matrix and discrete systems, and the industry may well settle down with a psychoacoustically viable system that works as well as discrete. In the meantime, eardrum tests have borne out the reality of enhanced matrices. The Sansui QS system, when A-B'd with discrete sources, showed little if any *apparent* differences between matrix and discrete. The best-trained ears in the industry came away from last Fall's AES convinced that this was the way to go. But as with all major developments, time (and phase) will tell. **R-E**

BUILD 4-CHANNEL POWER AMPLIFIER

Unbelievably low distortion is a feature of this four-channel amplifier for quadraphonic applications. Each channel drives an 8-ohm load at up to 60 watts rms.

by DANIEL MEYER

TIGER .01 IS MY LATEST EFFORT TO PRODUCE A BETTER audio power amplifier. With this design, distortion is reduced to a level of less than .01% at any power level up to rated output. With distortion products pushed down to a level more than 80 dB below the program material, it is very tempting to announce that this is the ultimate and that no further improvement in amplifiers will ever again be necessary.

Since the same thing was said when amplifier distortion was reduced to 5%, then 1% and finally to 0.1% and each time has been proven false, we will simply have to await improvements in other components to a comparable level of distortion before we can know for sure, but don't take any bets. The ear has proven to be considerably more sensitive to such things than anyone imagined ten or twenty years ago.

Like most things, the *Tiger .01* circuit has evolved slowly over a number of years with small, but steady improvements. It is usually possible to consider a power amplifier as consisting of two parts; the input, or voltage amplifier portion and the output, or matching portion. The point of division is obvious in most circuits, since the portion following the bias system is the output portion.

Except for car radios and a few other low/power special cases almost all development effort has been toward perfecting the class AB, or B type circuits. Class-A circuits are only practical for power outputs up to approximately 10 or 12 watts. Beyond this point the high quiescent power dissipation caused by low efficiency of class A-circuit discourages serious attempts at more powerful circuits.

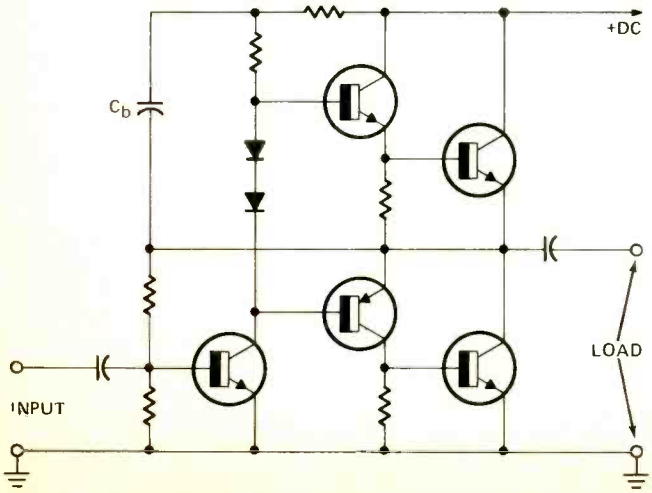


FIG. 1—QUASI-COMPLEMENTARY OUTPUT TRANSISTORS are driven by driver in complementary configuration.

The advantages of complementary class-AB and class-B amplifiers have been known for at least twenty years.[1] Most of the complementary circuits in use today are described in this paper. High-power complementary transistors were not available at this time though, and the few germanium npn types that could be obtained were terribly expensive. This led to wide use of quasi-complementary circuits in which only one polarity of output transistor is used with a complementary driver pair as in Fig. 1.

This type circuit presents a number of problems. First, the output stage must operate at unity gain, since (in the form shown here) the positive half cycle of the signal passes through a pair of emitter followers that cannot provide any gain. In addition, the circuit inherently has greater distortion than a complementary circuit due to the different number of junctions in the signal path on positive and negative half cycles and the difference in input impedance of the upper and lower pairs. Despite all of this, the quasi-complementary output circuit delivers reasonably good performance and is still widely used today.

Fully complementary output circuits became popular in the late '60's when reasonably priced complementary silicon transistors became available. Some of the best of these were the Marrantz 15 and the JBL "T" circuits. In 1967 the first of the present series, *Lil Tiger* was introduced. Although not designed to be the worlds lowest distortion amplifier, this circuit gave quite respectable performance at minimum cost, due to the use of complementary plastic output transistors. In October 1970 the *Universal Tiger*[2] introduced a new variation in output circuits, an output stage with gain; see Fig. 2. You will note that that type circuit is completely complementary and also cannot be built without complementary transistors in the output stage. Using this type of output circuit reduces the drive voltage needed for the output section of the amplifier and also makes it possible to control the response of the output section very neatly by proper choice of capacitor C in the schematic.

The *Tiger .01* uses a similar output circuit, but with a

1. G. C. Sziklai, "Symmetrical Properties of Transistors and Their Applications" Proceedings of the IRE. 41, 717-724 (1953)
2. "The Indestructible 125 Watt Power Amplifier." *Popular Electronics*, October, 1970

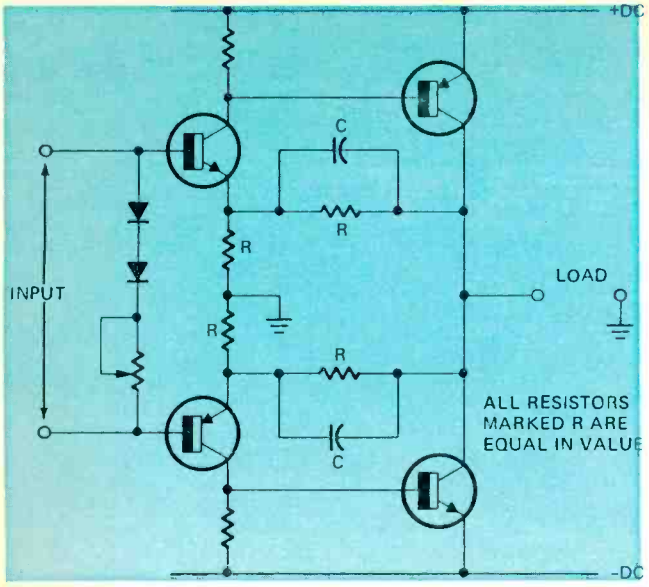


FIG. 2—OUTPUT STAGE WITH GAIN uses complementary transistors in circuit requiring relatively low drive voltage.

Darlington output; thereby making the output section of the circuit a triple. Doing this increases the current gain of the output section of the amplifier and further reduces the amount of drive current needed from the amplifier portion of the circuit. From this we get greatly reduced gain variation with signal output and can almost eliminate any need for matching of the complementary transistors.

The only problem with a triple is that temperature tracking of the bias and output stage is far more critical now. Feedback from current sensing resistors R37 and R38 to the first stage of the triple, Q10 and Q11, along with thermal compensation diode D4 takes care of this problem. Output feedback resistors R28 through R31 set the gain of the output triples at approximately three, so we have a very linear output section for our amplifier that only requires around 8 volts rms and a few milliamps to drive it to full output.

With the output section of the amplifier taken care of, the voltage amplifier portion can be considered. Most early power amplifiers and even a few current ones, used single-stage voltage amplifier and driver systems with a bootstrap collector load of the type shown in Fig. 1. Sometimes an additional impedance matching stage was added at the input to allow matching to tube preamps. Capacitor C_b allowed the amplifier to produce full positive supply output on signal peaks by adding the output voltage to the supply voltage at the junction of the two collector resistors. This type voltage amplifier does not lend itself to use with split power supplies and it is generally used with a single-ended power supply. Due to the half-supply voltage offset at the output the speaker must be coupled through a large capacitor.

This system normally has 20 some odd dB of negative feedback and will produce an amplifier with less than 1% distortion. The circuit can be improved and the amplifier can be used with a split supply, if the input stage is made a differential amplifier. This allows the input and feedback points at the two bases both to be referenced to ground and keeps the output point at dc ground. This is a considerable improvement since there are now two stages of gain, which allows more feedback to be used to lower distortion and the speaker now has no reactive components between it and the output of the amplifier. The entire amplifier may now be dc coupled if desired.

Another improvement is the use of a current source as the driver collector load instead of the bootstrap capacitor, split resistor system. This considerably reduces any cross-

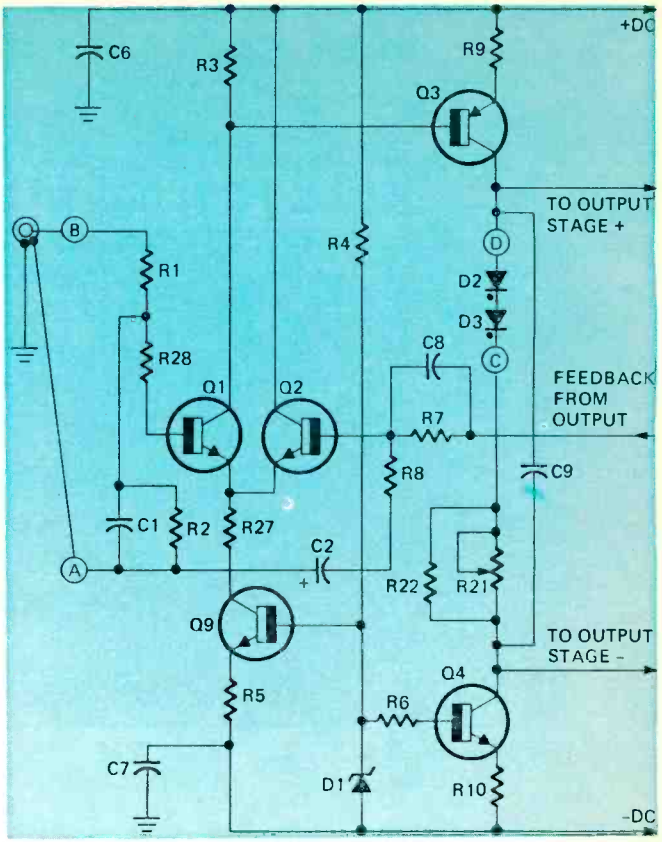


FIG. 3—CROSSOVER DISTORTION IS INHERENTLY LOW when current source replaces the driver bootstrap capacitor.

SPECIFICATIONS

Power Output—60 watts sine wave continuous; 8-ohm load.

Frequency Response—5.0 to 100,000 Hz at -1.0 dB points.

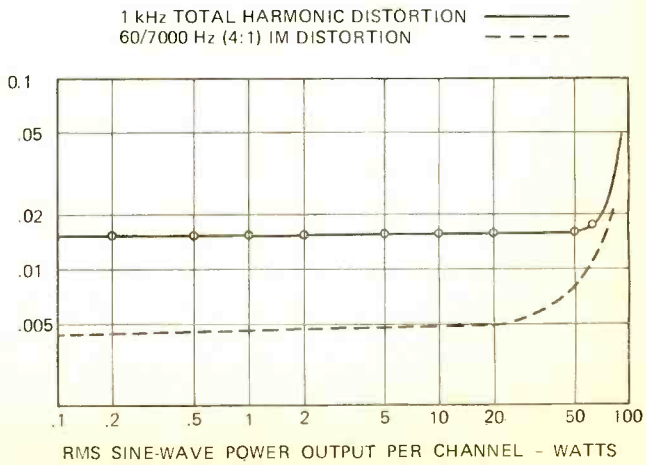
Distortion—Less than .01% IM distortion up to rated output. See graphs for complete distortion information.

Output Impedance—Less than 0.1-ohm 20 to 20,000 Hz.

Hum and Noise—More than 80 dB below full output.

Input Sensitivity—0.8 volts rms maximum for full rated output. Level control provided to reduce sensitivity if needed.

Stability—Completely stable with any type load. Volt-Amp limiting provided to protect output stage from effects of very reactive load.



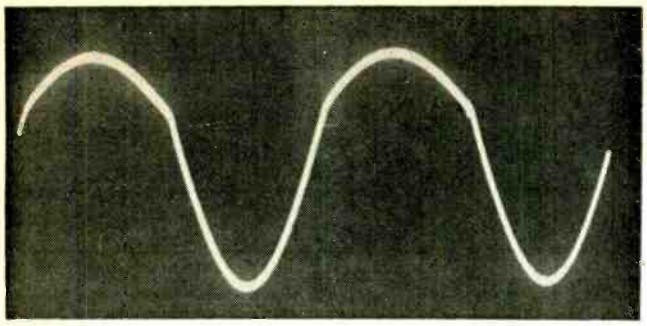
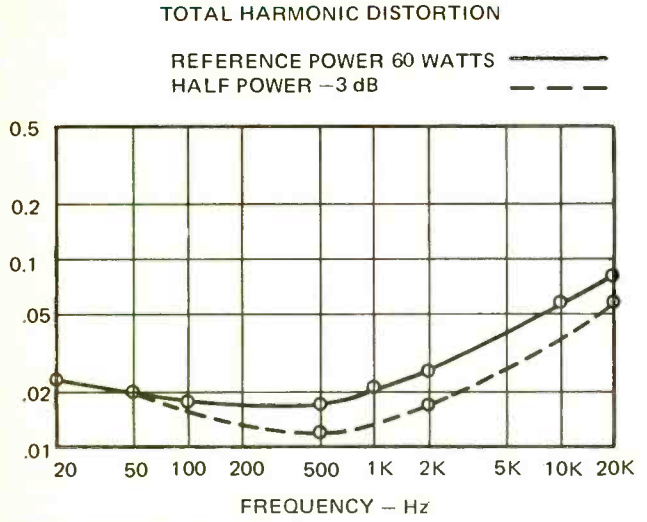


FIG. 4—DISTORTED WAVEFORM fed from collector of Q1 to the base of Q3. Effect of distortion is reduced by push-pull driver.

over notch distortion that may be present due to less than optimum bias conditions. This type driver causes the driving voltage to switch very quickly through any voltage levels where the driving current requirements drop or disappear. Although this type driver does not eliminate the need for bias in a quality amplifier, it makes the amount of bias used much less critical. In lower quality applications, such as PA work, the bias system may be removed and the amplifier run class B, generally without any noticeable effect on the quality. Amplifiers with these improvements can be expected to have distortion levels in the 0.1% range, and there should be no distortion peaks in the low power levels at the crossover point. Figure 3 is typical.

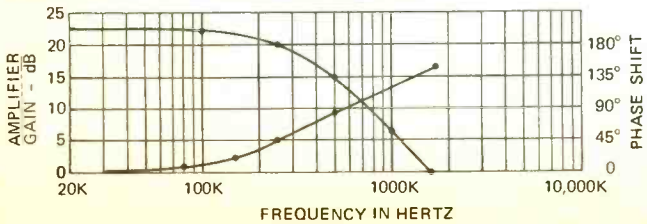
So at this point we have a pretty sophisticated amplifier with about all the gain we can handle without running into phase margin problems, or the necessity of reducing bandwidth drastically to keep the system stable. How do you improve on this circuit. A look at the oscilloscope photograph of Fig. 4 should give you a good idea. This is a photograph of the waveform at the collector of Q1 as seen at base of Q3 point in the circuit of Fig. 3.



TOTAL HARMONIC DISTORTION is very low at all frequencies (curves above) and is less than 0.1% at full- and half-power levels.

DISTORTION VARIATIONS WITH POWER are illustrated by curves at left. Typically, IM distortion is below THD up to rated power output.

GAIN-PHASE PLOT (below) shows how little phase shift there is in the audio range. Phase shift is only 10° at 80 kHz.



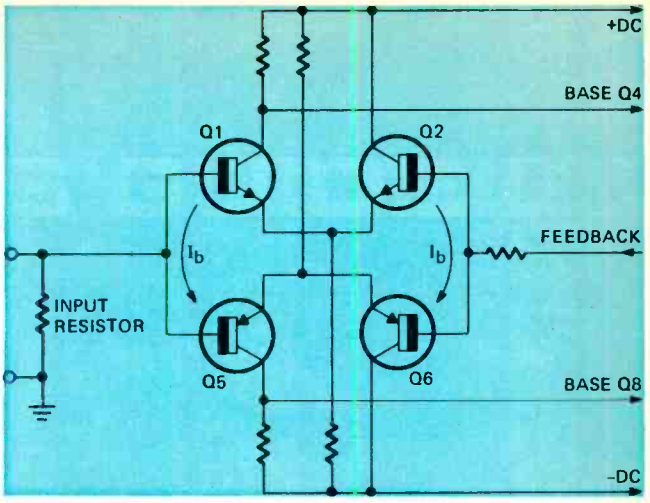


FIG. 5—COMPLEMENTARY DIFFERENTIAL INPUT STAGE. Several of its characteristics can be used to good advantage.

Why is this waveform so highly unsymmetrical you ask? Well the reason is quite simple. Q1 is supplying the current at this point to drive stage Q3. On positive half-cycles of the signal swing, Q3 must supply current to the driver in the upper half of the output section and also must supply the constant amount of current being soaked up by stage Q4. On negative half-cycles, however, the output requires no current from Q3 and most of the current from the current source Q4 is used to drive the lower portion of the output section. Thus on positive half-cycles, Q3 supplies output *plus* current source and on negative half cycles current source *less* output drive. Obviously the driving signal at the base is going to be very unsymmetrical under these conditions.

So what can be done to improve on this situation? Obviously a push-pull driver would be a good solution. Then we would have two signal swings on opposite ends of the circuit that would still be unsymmetrical, but which would be of opposite polarity. Thus the distortion would be reduced as in any push-pull arrangement. There are several possible ways to drive such a system, but the most elegant is to use a complementary, cross-coupled input system. This makes the whole amplifier symmetrical and push-pull from the very input.

The complementary differential input stage also provides us with some additional advantages. With this type circuit the base current for the input pair does not all have to flow through the input resistor from ground and through the feedback resistor from the output as in a normal single ended differential pair. Referring to Fig. 5, the base current path is from Q1 into the base of Q5 provided that the base currents of the two transistors are equal. This results in *no* offset voltage across the input resistor.

Exact matching is impossible, but even if the matching is not perfect, we still have only the difference between the two base currents flowing through the input resistor to produce an offset rather than the entire base current of one transistor as in a single-ended situation. Since the differential current is so small through this resistor we can either make the resistor quite large and have a very high input impedance on the amplifier, or we can use a smaller resistor and get away with a rather large difference in base resistors without getting the considerable offset at the output of the amplifier that this would normally cause. Since input impedances over 50,000 ohms are of little value the later course was followed on *Tiger .01.*

The only thing remaining is to choose a bias system for the output stage. The input amplifier pretty well dictates the use of a transistor for this purpose. The dual dif-

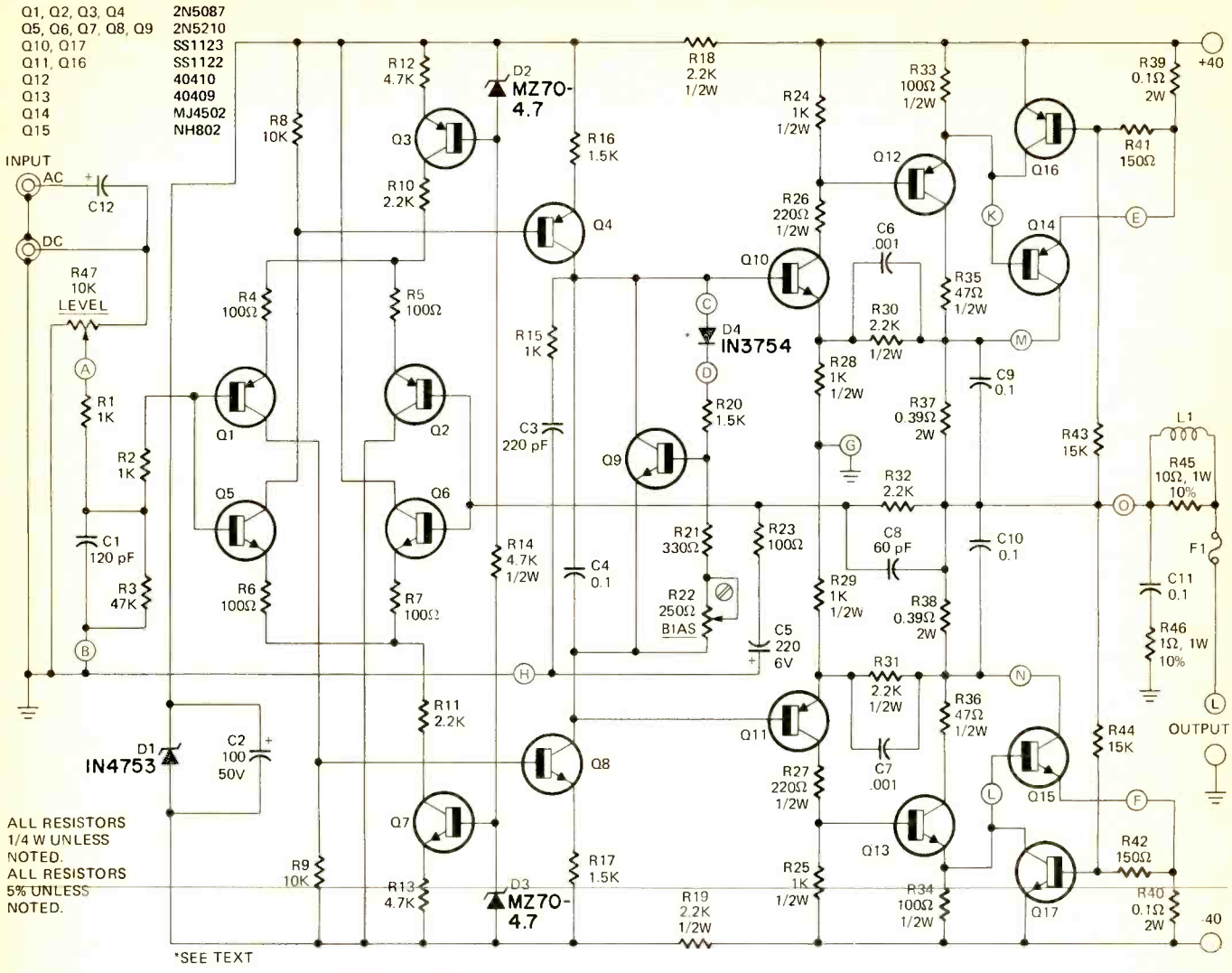


FIG. 6—COMPLETE CIRCUIT OF ONE OF THE FOUR CHANNELS. PC board patterns and complete construction details next month.

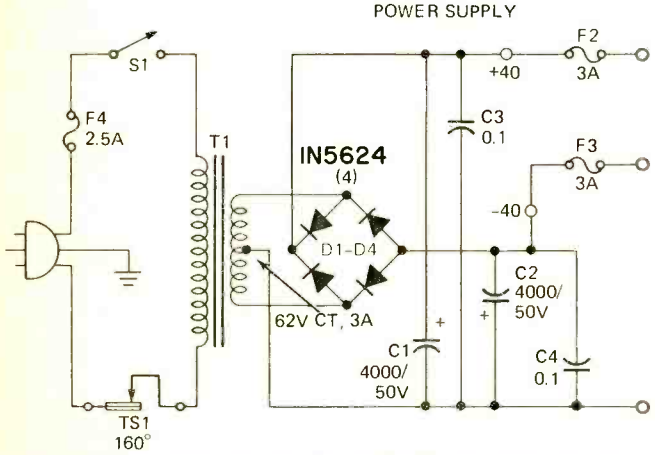


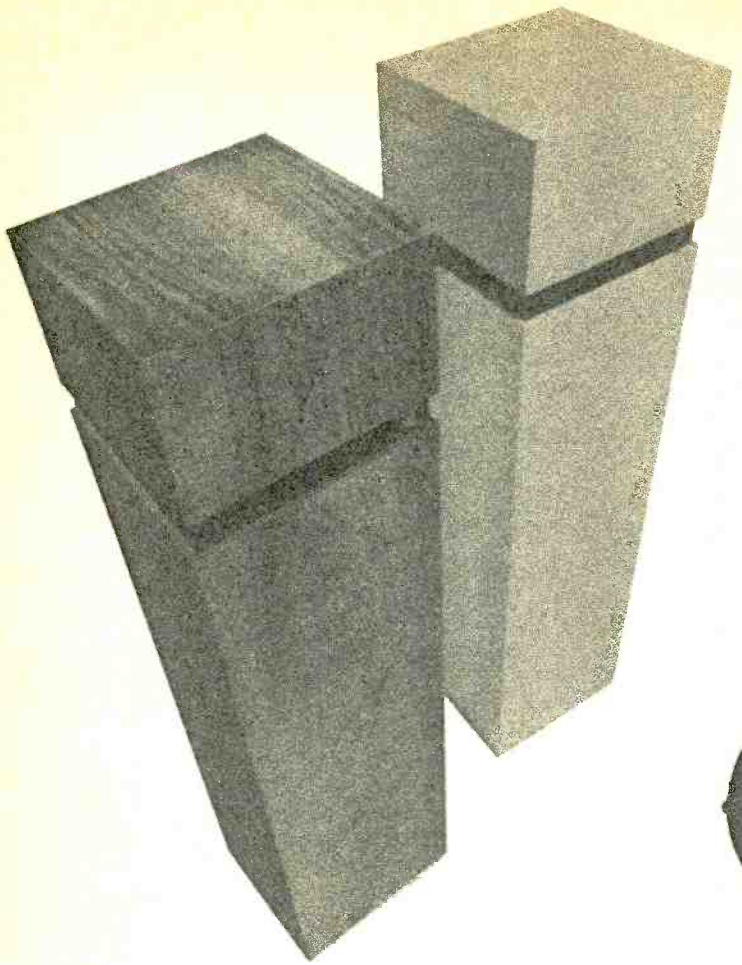
FIG. 7—POWER SUPPLY FOR ONE CHANNEL. The bridge rectifier supplies the dual-polarity voltages needed for the amplifier.

ferential input stage cannot be perfectly temperature compensated easily. As a result the idle current in the driver stage varies with temperature to some extent. If we attempted to use diodes for bias, this current variation would result in bias voltage changes. This is highly undesirable, and besides this it would take a bunch of diodes to get the 3 to 4 volts of bias that we need with this circuit (Fig. 6).

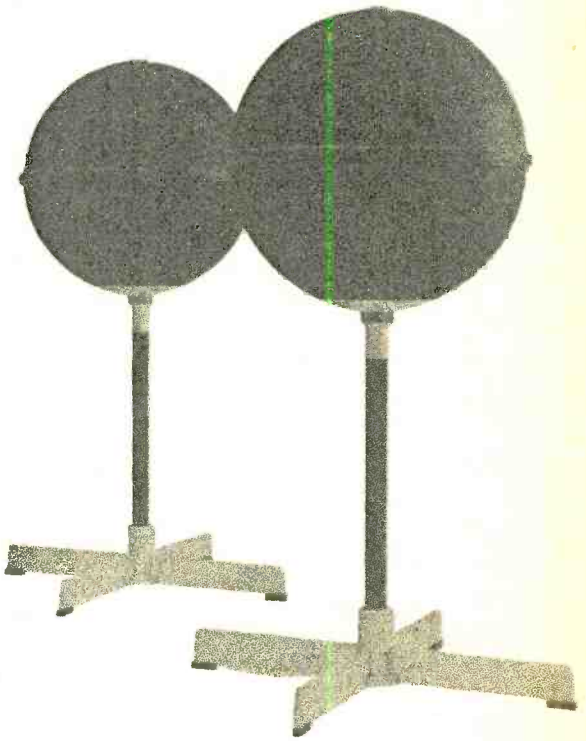
The bias voltage is set by the emitter-to-collector voltage drop across Q9. This voltage tracks quite well with the base-emitter voltage changes of Q10 and Q11 when ambient temperature changes occur. The temperature of the output transistors however is more dependent on the power output at any given time and Q9 needs some feedback information on this temperature rise if anything is to be done about stabilizing the output current with these temperature changes. This information is provided by D4. The diode's forward voltage drop changes with temperature and changes the bias on Q9 to reduce the bias voltage slightly as the output transistors warm up. All this keeps the amplifier's idle current under control under all power output and ambient temperature conditions it is likely to be subjected to.

The power supply is a simple bridge rectifier system with capacitor-input filters. Due to the large amount of isolation from supply ripple and hum in the voltage amplifier stages, excellent noise figures are obtained without any complicated regulated supplies. It is doubtful that any measurable improvement would be obtained if such a supply was used. The output transistors are protected from highly reactive loads by Q16 and Q17. These transistors monitor the output transistor current and voltage drop. If either of these, or a combination of the two occur that could cause operation of the output transistor outside it's rated safe operating area the protection transistors will turn on and bypass enough drive current to keep the output device from going into secondary breakdown.

That's all we have room for this month. Next issue we'll present full construction information; along with parts lists, full-size circuit-board patterns, and parts layout diagrams. We'll also have additional photos of the unit. **R-E**

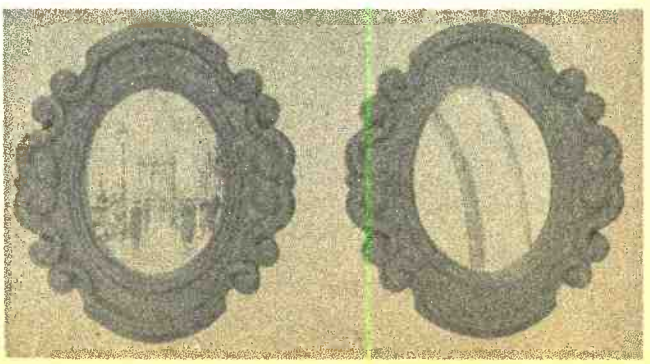


off-beat 4-channel speaker systems



In 4-channel stereo, the question of speaker type and placement arises early. Here are some answers

by FRED PETRAS



ALTHOUGH THE WOMEN'S LIBERATION MOVEMENT IS CONSIDered a recent phenomenon, any fellow interested in good sound knows that it's been around for something like 15 years—since the advent of stereo. The average married guy may be considered "Man of the House" in most respects, but just as often he is NOT when it comes to the "furniture side" of running a household. This is the province of the "Lady of the House," and woe be to anyone trying to tamper with it . . . like adding "those boxes" that are an integral part of stereo.

Fortunately, several years ago the acoustic-suspension speaker system was developed, and manufacturers used them as aid to beleagured husbands wanting to move from mono to stereo sound. The compact speaker systems they had conceived could readily and unobtrusively be incorporated into Ye Lady of the House's province. In one swoop the manufacturers saved thousands of threatened marriages, and virtually assured the future of two-channel stereo sound.

And all was well for several years. Until four-channel sound evolved. Many a stereo buff has been sitting on the sidelines for the past four years, reluctant to go through the hassle of convincing his wife that sound has advanced another stage, and that to attain the benefits of "The New Order" some concessions to home decor are required. And so he sits, only sporadically listening to his OLD two-channel rig and chomping at his innards with frustration because his wife won't let him add *two more* boxes—attractive as the current ones may be—to louse up her decorating scheme.

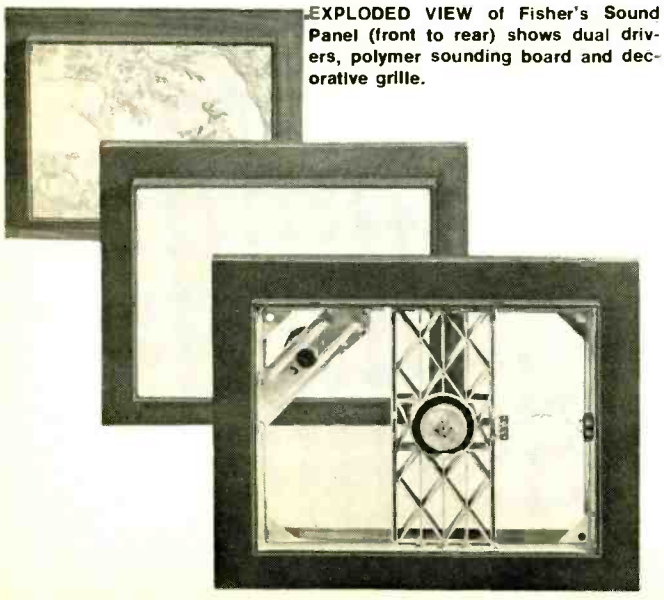
Enter a few speaker manufacturers who have obviously been on top of the situation, and are foxy enough to know that if you can't fight 'em, join 'em. They have come up with several intriguing approaches to "How To Get

Around The Woman Of The House Relative To Quadraphonic Sound." Some of the approaches are actually variations on existing themes, while others are advances in concepts that the industry has been toying with for some time. Any one of these approaches might appeal to *your* particular Guardian of the Living Room and thus enable you to enjoy surround sound.

Before we go on to describe these new "lifesavers," a bit of background relative to their creation. One of the many unresolved aspects of 4-channel sound is, just what is the RIGHT approach to it? That is evident in the variety of basic systems—discrete tape, discrete disc, several matrix disc systems, and even proposals of a combination discrete/matrixed disc.

Within the framework of each of these is another unresolved aspect of 4-channel sound, namely, Should the conductor and engineers strive for a mirror image of the bandstand or concert hall, or should they get as far away as possible from mirroring reality and explore the potential of quad for some *new* sound ideas? Where companies have adopted the mirror approach, each has come up with his special way of handling it; where they have decided to generate a "new sound," they have also expressed themselves according to how they feel about the matter. The end result is that each new quad tape or disc, in whatever the basic system/approach, is actually a unique experience, further offering *several ways* to savor it.

Which leads us to the final link in the chain—the speaker system. Talk to 10 different owners of quadraphonic stereo rigs and you'll probably get nine different expressions on how to play 4-channel discs and tapes. But within these expressions you'll find two *basic* schools of thought. One holds that all four speaker systems should be of a traditional design and the same general type, size, quality and efficiency, and should be placed according to rather precise guidelines. The second holds that your speakers need not all be near-comparable; that you need first-rate speakers for the front channels, but that the rear channel models can be entirely different in basic design, size, quality, efficiency, etc., because you can compensate for the differences with various controls. It also holds that since every quad disc or tape is unique unto itself in terms of recording, so too, can speaker placement be unique unto itself in terms of playback. This school includes manufacturers of the speakers we'll discuss. While these manufacturers as a group are anxious to aid 4-channel-hungry chaps in getting around Ye Keeper of the Decor, some point out that their decor-oriented products are not necessarily compromises in the way of quality sound. (We'll clue you on those particular models as we go along.)

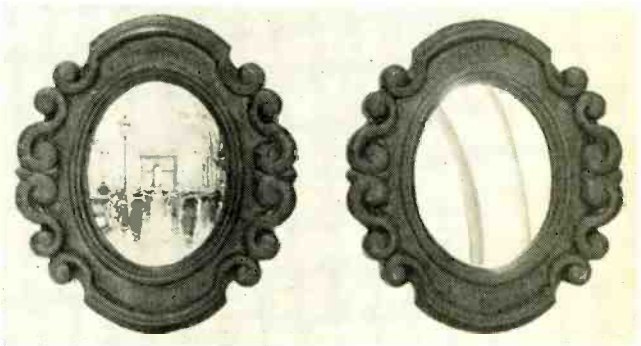


EXPLODED VIEW of Fisher's Sound Panel (front to rear) shows dual drivers, polymer sounding board and decorative grille.

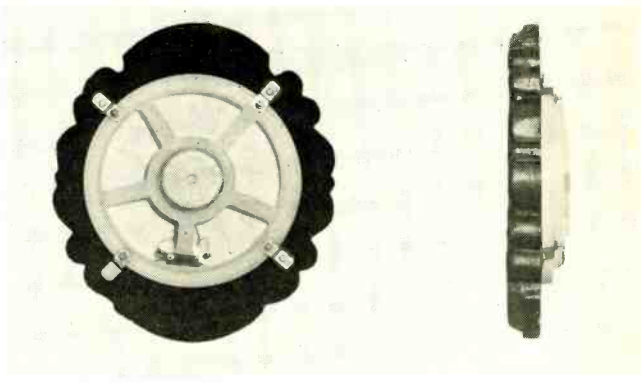
Wall models in profusion

Slim-line speaker systems with traditional "guts" have been around for a number of years. They have not been a great success in the two-channel field since they are regarded as a hybrid. They have enjoyed more success in commercial applications where top-notch sound is less a factor than efficient use of space. But now there is a new crop of slim-line speaker systems on the scene, utilizing different "innards" than the old slim-lines. This new crop consists of two price ranges—low, and high, with sound fidelity being low/medium for the first group and truly high for the second.

The first group—"Poly-Planar"—utilizes thin panels of expanded polystyrene in a compacted bead structure instead of cone loudspeakers. This permits them to be incorporated in systems that are less than two inches thick. Developer of the concept, patent holder, and manufacturer of Poly-Planar systems is Magitran Co., Moonachie, N.J. Magitran offers such speaker systems in the form of framed



MAGITRAN MODELS DS8P and DS8M (above) picture and mirror speakers, respectively. REAR AND SIDE VIEWS (below) show construction based on the maker's Poly-Planar concept where panel replaces the speaker cone.



mirrors and framed pictures in rectangular and oval shapes for living room wall use, at $17.95 and $24.95. While the bass response of the units—when used by themselves—could not be called hi-fi in the generally accepted sense of the word, and claimed specifications notwithstanding, their sound is first rate when they are used *in conjunction with* true hi-fi front-channel speaker systems. What happens is that the bass response of the rear-channel Poly-Planar units is reinforced by that of the front-channel units and the end results is an illusion of solid bass emanating from the wall area where the thin speakers operate. (This same phenomenon is apparent with some of the other systems.)

Fisher Radio recently came out with its version of "picture" speaker systems. They use high-density acoustical polymer diaphragms and twin drivers—for low-frequency and high-frequency sounds. Their dispersion is fully omnidirectional—360 degrees. Called "Sound Panels," the new models are true hi-fi speaker systems. Four of them can be

used for the total speaker complement of a 4-channel system in place of traditionally designed systems, or two can be used for front-channel operation combined with traditional speakers for rear-channel use, or vice versa. Their bass sound needs no reinforcement. The units—a shade thinner than three inches—can also be used in special floor mountings to function as decorative screens, as for example flanking a fireplace. The Lady of the House may also incorporate them into room dividers, or work them into a hanging wall—such as a beaded screen type.

The Magitran picture speakers permit removing the existing picture and substituting another. The visual designs of the Sound Panels cannot be changed since they are "welded" to the polymer diaphragms.

Conversion units

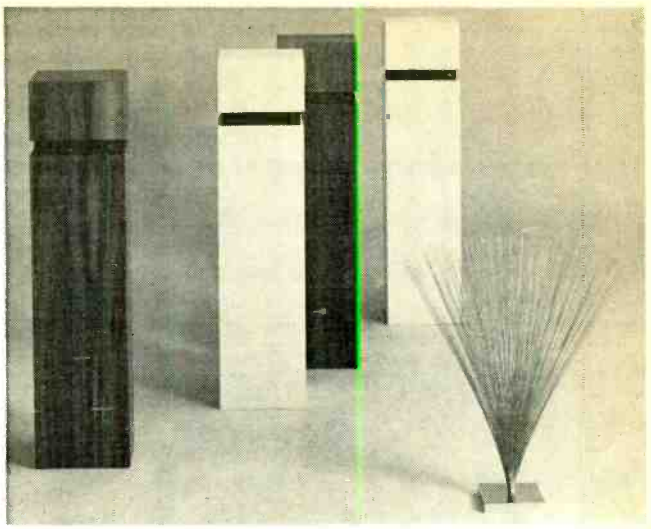
Since the advent of two-channel stereo, there have been sporadic attempts to put across speaker converters—units that change a flat surface into a speaker system. The most widely acclaimed appears to be the Poly-Planar concept as offered in Magitran's mirror and picture speakers described earlier. In addition to finished decorative speakers, Poly-Planar speakers come as panels in a variety of configurations, permitting you to get around The Lady of the House by "turning on" tables, doors, walls, wall panels, and other objects of decor and furniture to function as speaker systems for rear-channel use. They are priced from $8 to $19.

Another conversion approach is in the form of a round 3½-inch diameter by 1½-inch thick driver unit from Hi-Vi Systems, San Clemente, Calif. Priced at $19.95 each, the units convert many resonant objects into speaker systems. We heard them installed on 4 by 8-foot sheets of ⅜th-inch thick decorative plywood and found their sound to be comparable to many of the simpler, more basic compact speaker systems, with an openness and solid bass that some of the latter did not possess.

Unlike earlier lighter weight devices of this type, the Hi-Vi models have excellent transient response. Note: The Hi-Vi units are strongly dependent on the objects to which they are attached; hence, their performance will equate to how well those objects disperse sound vibrations. The company mentions that they work well on the following surfaces: Fiberglass, plastic, glass, dry wall, metal, plaster board, and Celotex. An executive of the firm also writes as follows: "We have found that when these units are installed aboard a boat that has a clean hull, and when they are played continually with either music or through a low-cycle oscillator that no barnacles or other marine infestation will occur. The same holds true in homes where termites or other wood boring pests are a problem. We are doing further development, and will shortly have data with facts and figures to substantiate our claim."

Columnar systems

At least three companies have come up with double-duty columnar speaker systems that may be just the thing to solve your wife's hangup about adding two more speaker systems to "her" living room. All three products are attractive in their own individual ways, and each takes up a minimum of floor space—14 inches square at most. All three can serve as pedestals on which to place appropriate objects of art, vases of flowers, etc., to *enhance* Ye Little Lady's living room. Additionally, these models can be used effectively in corners of a room. Each provides first class sound of a quality that would permit four to be used as a total quad speaker system complement, or in conjunction with existing speaker systems either up front or for rear channel sound. The most widely distributed of the units is the JBL "Aquarius 4" priced at $186. It comes in oiled walnut or satin white finish. It is 40 inches tall and is 10 by 10 inches at its base. In somewhat limited distribution is EPI Model 400, "The Minitower," a 38-inch-high column whose base is 14 by 14 inches. Its appearance is both subtle and striking; black grille cloth is framed by four corner posts of solid walnut accented by a brass extrusion. The top is solid walnut. The price, $389 each. Both the above models have a dispersion of 360 degrees. The third unit, Equasound Two, priced at $219.95 in walnut or white, and $239.95 in rosewood, has a dispersion of 270 degrees. It measures 42½ inches high, and is 11½ by 11½ at its base. The systems come with three removeable side panels and matching leather top piece, in a choice of black, orange or blue grille fabrics.



AQUARIUS 4 COLUMNAR SPEAKERS by JBL are 40 inches high and 10 inches square at the base. They come in oiled walnut and satin white finishes.

Molded-plastic units

In a class by itself is JBL's "Prima 25" series, whose bright-hued housings are of a heavy molded plastic. Not only are the Primas two-way as speaker systems, they are two-way in that the housings are also available in the form of matching storage modules. Further, the housings are molded in a way that permits them to interlock when used in multiples (see illustration) as combinations of speakers and housings. The Prima 25 series is available in a dozen different colors, including green, yellow, red, grey, white and black, with various related grille fabric colors. The interior colors of the storage modules relate to the speaker grille colors. The Prima 25's can be stacked horizontally or vertically. As speakers they cost $126 each. As storage units they cost $48 apiece. The Prima 25's are bound to appeal to any Queen of the Living Room whose preference is for bold, dramatic, yet tasteful modern styling. As speaker sys-

JBL'S PRIMA 25 SERIES speakers come in decorator colors. The housings are also available as storage modules for components.

(continued on page 50)

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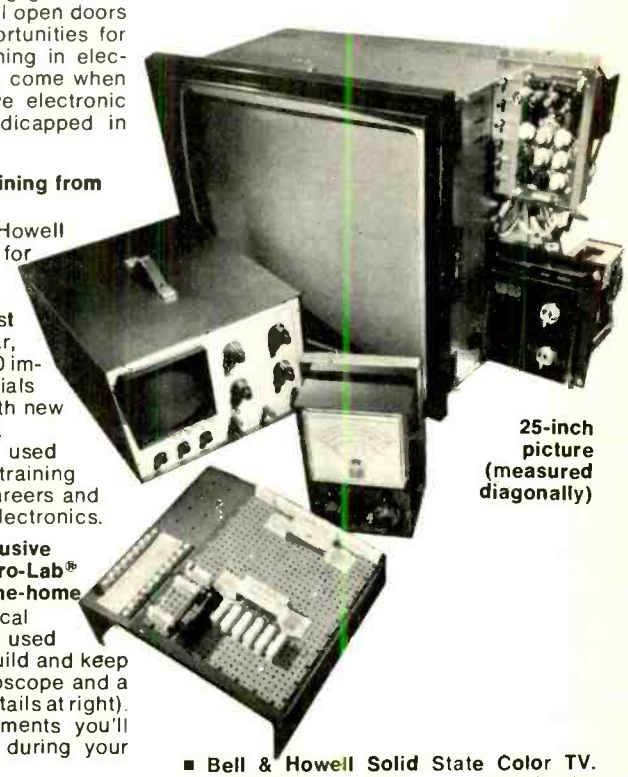

25-inch picture (measured diagonally)

■ **Bell & Howell Solid State Color TV.** Ultra-rectangular tube . . . 25-inch picture measured diagonally . . . full 315 sq. inch viewing area. Solid state modular circuitry . . . 4 advanced IC's . . . 100 transistors . . . 72 diodes . . . individual plug-in circuit boards. Special UHF/VHF tuning features . . . built-in self-service components.

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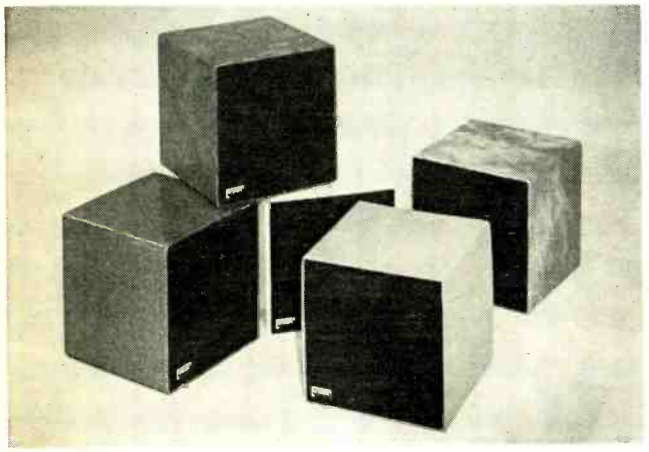
tems, they'll hold their own against most models in their price class. Four Prima 25's can serve as a full 4-channel speaker complement, or they can be used in conjunction with other speaker systems, either up front or at the rear.

The fiberboard approach

Back in the early days when hi-fi was evolving from mono to two-channel stereo, a lot of budget-strapped do-it-your-selfers embraced the cardboard box concept of speaker systems. These were usually temporary makeshift affairs, enabling a fellow with a spare raw speaker to enclose it in virtually any handy cardboard box and use it until he could afford to buy a finished unit to match his existing system, or go out and buy a new matched pair of systems for stereo.



THE KRIKET MODEL 850 SPEAKER SYSTEMS by Acoustic Fiber Systems are in tooled leather and vinyls in decorator colors.

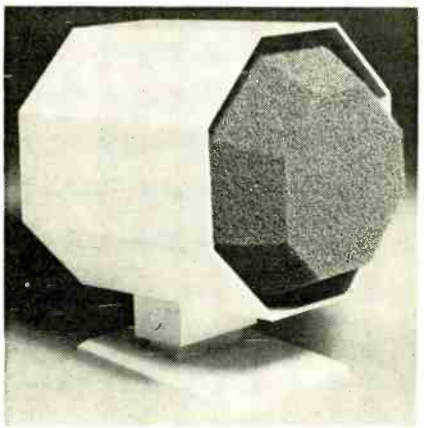
Well, this concept has returned—but in a highly sophisticated form, and one that should have broad appeal to Ye Hausfrau with a yen for bright colors and unusual textures and designs. It should also appeal to the four-channel-hungry guy who wants to meet his wife nine-tenths of the way, but also wants reasonable sound quality. The concept returns in the form of the "Kriket" and "Nirvana" lines of speaker systems from Acoustic Fiber Sound Systems, Indianapolis, Indiana. AFS touts the merits of fiberboard by describing it as "The Working Wall." A company brochure states that "The Working Wall is composed of two walls of tubes set at right angles to each other and bonded tightly together. The sound waves are absorbed into the tubes and are transformed into directional wave patterns opposing each other. This principle of polarization allows the sound waves to cancel themselves and leaves the speaker to perform unrestricted."

In checking out two different pairs of AFS systems (Nirvana 400 and Kriket 850) we were convinced that the principle is valid; the sound emanating from the units was open and uncolored and was of an overall high quality, albeit a bit shy at the bass end in the "flat" response position. But a slight turn of the bass control corrected the shortage.

But let's get on to their appeal to The Lady . . . AFS systems come in cube or rectangular form in at least eight solid colors, and a variety of smooth-surface patterns, including straight stripes, undulating tiger stripes, polka dots, and marbelized. There are also a number of textured finishes including tooled leather, suede, vinyl and cork. The systems also come in housings with Indian rag-rug fabric patterns, and—believe it or not—in fake fur coverings. AFS is also experimenting with other materials and designs, to give The Little Lady a chance to truly express herself quadraphonically. The AFS speaker systems range from $29.95 *per pair* on up to $198 *per unit,* depending on size, components and coverings. The largest system contains a 12-inch woofer, 4½-inch midrange, and two-inch tweeter.

Mini multi-mounts

Another off-beat speaker concept comes from Sound West, Inc., Van Nuys, California. Designed by Barney Rigney, well-known speaker pioneer, the units offer good sound in little space and at a relatively small price—$14.95 each. Measuring approximately 6 inches by 7 inches by 7½ inches, the round, square or octagon units are mounted on a low pedestal base that permits angling them in a fairly wide vertical arc when used atop furniture, or firing down

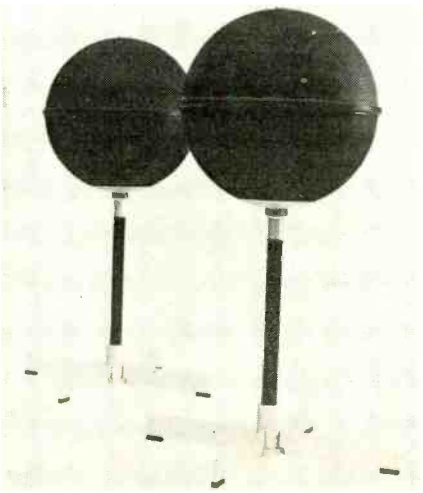


MINIATURE LOUDSPEAKERS by Sound West are available in square, round and octagonal enclosures. The foam grille lifts out for easy cleaning.

from a spot on the ceiling, or a horizontal or vertical arc when mounted on a wall. The round or octagon units in their white high-impact plastic housings are a cinch to incorporate in modern home decor. Ye Little Lady would probably consider the square models fine in a traditional furniture setting. All three types come with lift-out (for cleaning) foam grilles in rust, blue, gold, black or white. The Sound West minis can also function nicely outdoors . . . on a patio, or anywhere else you might want to hear music. In testing a pair of the devices in a four-channel setup we found their sonic attributes to be of a higher order than a four-inch speaker size would indicate. Their dispersion pattern is rather narrow.

Spherical speaker systems

Another awareness of the Little Lady of the House is apparent in a spherical speaker system from JVC that can



JVC'S MODEL VS-5313 spherical speaker system hangs or mounts on a pedestal. It has eight speakers inside its 13½-inch perforated housing.

operate as a pedestal or as a hanging model. Model VS5313, priced at $179.95 each, contains eight speakers within its 13½-inch diameter black perforated housing. Offering a claimed 20 to 20,000 Hz response, in a 360-degree

(continued on page 90)

TAPE BIAS LEVEL
key to quality recording

Only a small change in bias level can make a rather startling change in the frequency response characteristics of the recorded material

by HERB FRIEDMAN

ALL ELSE BEING EQUAL, CASSETTE recording quality is primarily determined by the bias level applied to the tape. In fact, except for the two-for-a-buck cassettes, even when things aren't equal it's still the bias level that primarily determines if the final sound playback will be acceptable to the average audiophile.

As **Radio-Electronics** showed in the March, 1972 issue, virtually no two cassette tapes have the same high-frequency performance when recorded on the same recorder with the same bias level. If the same series of tests are run on another recorder factory-set to a higher or lower bias level, the scope traces shown in the March issue would be vastly different.

Yet, with rare exception, most cassette recorders can have their bias adjusted for a "flat" response with any *quality* cassette tape. On some of the latest model recorders there is a choice of up to three bias levels, making it much easier to match tape to machine through factory-set bias levels.

Before you challenge the contention that a tape's frequency response can or should be corrected by an adjustment in bias level, keep in mind that we are not dealing with reel recorders where the playback equalization is set for "flat" response from an NAB test tape, where the bias is then adjusted for maximum midband output (or 0.5 dB down on the high side), and, finally, adjustable record high-frequency equalization is used to obtain an overall-record/play "flat" response.

Cassette recorders do not, as a general rule, have an adjustable high-frequency record equalization. Hence, we cannot adjust the bias for maximum midband output, lowest distortion or lowest noise and then hope to correct the high-frequency response losses (or gains) with record equalization. As with many things about cassettes, we must compromise, and a major compromise is that frequency response corrections must be made through a change in bias.

Before bias adjustments we should get two points out of the way, as they can lead to confusion: (1) Over a reasonable range of bias level, say +20/−10 percent of the factory-set bias level usually used for "standard tape," there will be very little change in distortion at the "0," or maximum recording, level. In most instances there will be no measurable change. (2) Similarly, there will be no, or little change, in the signal-to-noise ratio—perhaps up to 2 dB. The change in signal-to-noise ratio caused by a change in bias level will be determined by the bias change's effect on the tape's midband (400 to 1,000 Hz) output.

To illustrate the relationship between bias level and frequency response, four popular tapes were selected for use with a Kenwood KX-7010A recorder; the Kenwood was chosen because it has a "regular" and a "low-noise" bias selector, and because the bias level can be easily adjusted on this machine. (In all tests the frequency response was swept from 50 to 20,000 Hz.)

The first thing that comes to mind is what constitutes "regular" or "low-noise" tape other than the manufacturer's specification—which can often be meaningless because "low noise" is frequently a term used solely for advertising purposes. What can the user expect in the way of performance if he makes a wild guess on the proper bias selection? In some instances he'll

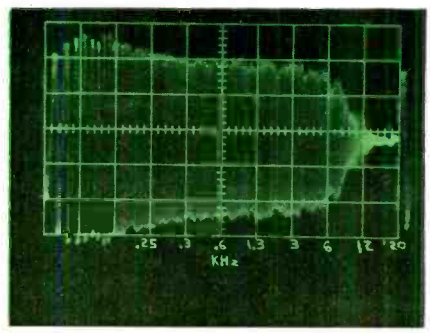


FIG. 1-a—STANDARD BIAS used to record swept audio spectrum on Scotch High-Energy.

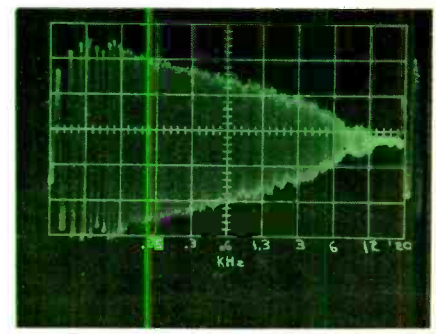


FIG. 1-b—LOW-NOISE BIAS used to record swept audio spectrum on Scotch High-Energy.

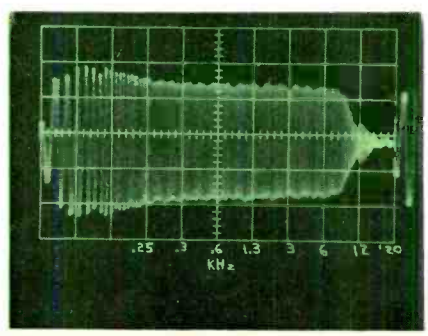


FIG. 2-a—STANDARD BIAS used to record swept audio spectrum on Norelco 100 tape.

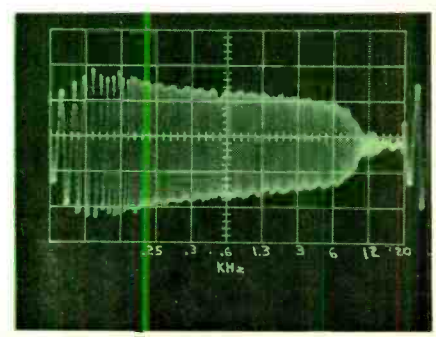


FIG. 2-b—LOW-NOISE BIAS used to record swept audio spectrum on Norelco 100 tape.

win, in others he'll lose.

Figs. 1, 2 and 3 show the performance obtained from three popular tapes using the two bias levels provided on the Kenwood recorder. Fig. 1 is Scotch High Energy tape, supposedly a low-noise tape, yet the performance obtained with "regular" bias is much better than that obtained with "low-noise" bias. Although the low-frequency performance remains the same—as it will with most other tapes—the "low-noise" bias degrades the midband 6 dB, while the high end, at 10 kHz, is degraded almost 15 dB.

Fig. 2 illustrates the same bias levels on Norelco 100 tape. Here the midband is degraded less than 1 dB while 10 kHz is attenuated about 4 dB.

Fig. 3 is Maxell UD tape. As a starter, note that the high end tends to rise with the "regular" bias; at 6 kHz the response rises +1.3 dB. With this tape the "low-noise" bias attenuates the entire frequency range output as well as degrading the high end to almost a flat response.

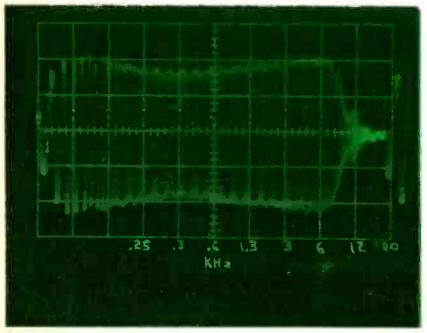


FIG. 3-a—STANDARD BIAS used to record swept audio spectrum on Maxell UD tape.

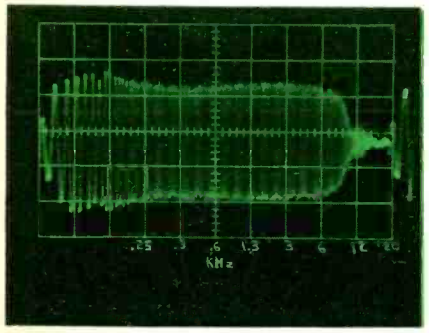


FIG. 3-b—LOW-NOISE BIAS used to record swept audio spectrum on Maxell UD tape.

In typical use any of these three tapes on a Kenwood recorder would give an acceptable performance using "regular" bias. The Scotch tape would tend towards a mellow sound, the Norelco tape would be most "normal" and the Maxell would be slightly bright. But only the most critical listener would single out the Norelco tape as being "flat." On the other hand, "low-noise" bias would deliver a "flat" response from the Maxell tape.

Because there is a considerable variation to be found in a tape's frequency response in the relatively large limits between "regular" and "low-noise" bias (about 25%), it's obvious that a small bias correction can be used to shift the overall record/play performance to a "flat" response. In fact, a careful bias adjustment can be used to tailor the high-end response to a specifically desired performance level—either slightly peaked or attenuated.

Figs. 4 and 5 illustrate the frequency response variations that can be obtained with just a small change in bias level. The two tapes used are Maxell Low-Noise and Maxell UD, selected because with "regular" bias their frequency response characteristics are almost identical. Note that the Low Noise tape is quite good. In fact, when the Kenwood's bias selector is set to "low noise" bias the Low Noise tape's performance is down 6 dB at 10 kHz, as shown in Fig. 6 This is a common problem the cassette user faces: because a tape is labeled Low Noise does not necessarily mean "low-noise" bias values should be used. The designation Low Noise can—and often does—mean only that the tape itself has inherently less noise than the manufacturer's previous product, and the bias level might have absolutely nothing to do with it.

Note in Figs. 4 and 5 that when the bias level is reduced 10% below the "regular" or "standard" bias level the effects on the two tapes are considerably different—even though they are almost identical with "regular" bias. First, the midband output of the Low-Noise tape remains essentially the same. The UD tape, however, shows an increase of 1 dB.

Second, and more important, while the Low-Noise tape shows an increase of only 1 dB at 7 kHz, the UD tape shows an increase of almost 2 dB at 7 kHz when the biased is reduced 10%. At 10 kHz the Low-Noise tape shows virtually no change; the UD tape shows an increase in output

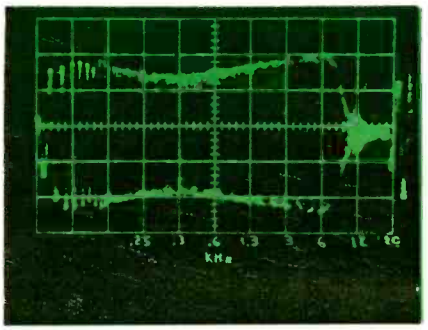


FIG. 4-a—BIAS LEVEL IS REDUCED 10% to record this pattern on Maxell low-noise tape.

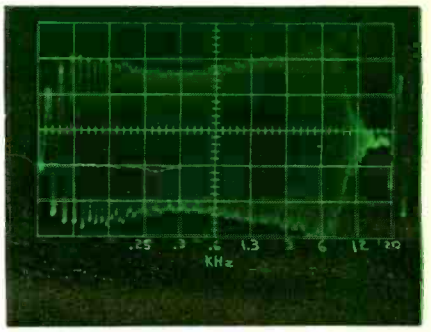


FIG. 5-a—BIAS LEVEL IS REDUCED 10% to record this pattern on Maxell UD tape.

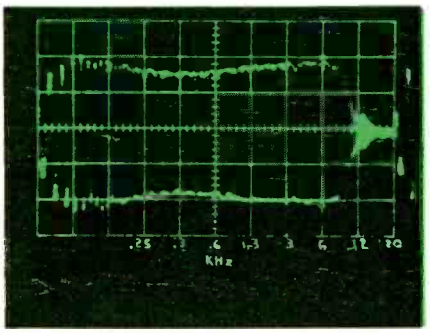


FIG. 4-b—STANDARD BIAS produced this recorded pattern.

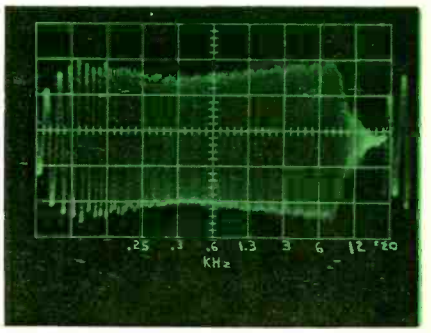


FIG. 5-b—STANDARD BIAS produced this recorded pattern.

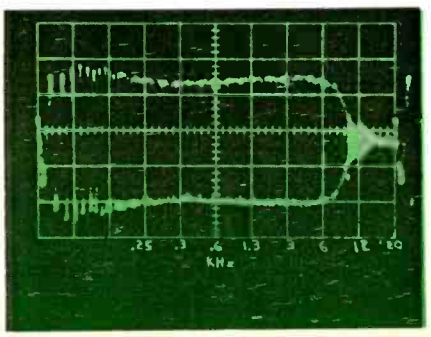


FIG. 4-c—BIAS LEVEL IS INCREASED 10% to record this pattern.

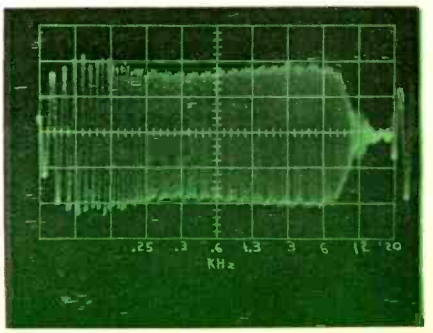


FIG. 5-c—BIAS LEVEL IS INCREASED 10% to record this pattern.

of almost 2 dB. How far the high end can be peaked is illustrated in Fig. 7, which shows the UD tape with 20% less than "regular" bias. There is little, if any, effect on the low-frequency performance.

Just as decreasing the bias will peak the high-end response, increasing the bias will attenuate the higher frequencies. But observe in Figs. 4 and 5 that while it takes a 20% increase in bias to "flatten" the Low Noise tape's response, the same degree of "flattening" with the UD tape requires only a 10% increase in bias.

Ability to control the high-frequency performance of recording tape by modifying the so-called *regular* or *standard* bias level means that just about any quality tape can be precisely matched to cassette recorder as long as the bias change isn't carried to extremes. If a tape requires more than a +20% change it's best to try a different tape. It's true that many "white box" tapes with very poor high-frequency performance can be made reasonably flat by decreasing the bias as much as 50% (to peak the high end). But this much change generally produces sharply increased distortion, poor signal-to-noise ratio, etc.

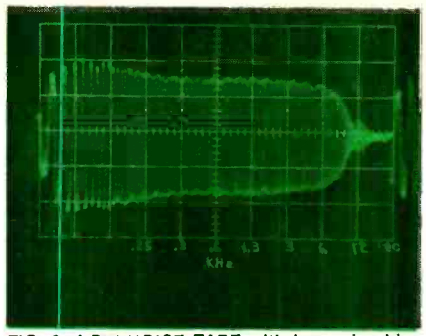


FIG. 6—LOW-NOISE TAPE with low-noise bias gives poor high-end response.

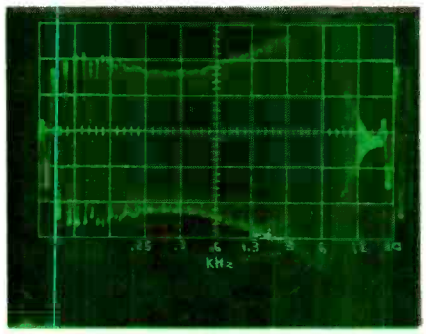


FIG. 7—HIGH-END CAN BE PEAKED by reducing bias level. Bias is decreased by 20%.

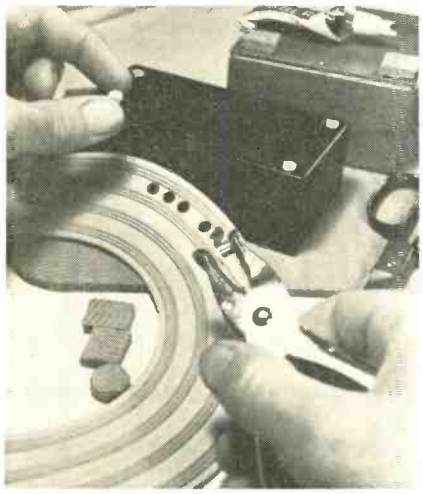
An important point to bear in mind when tailoring a cassette recorder's overall response by modifying its bias level is don't let the tape manufacturer's designation confuse the situation. Tape Brand A, designated as Low Noise, might truly require a "low noise" bias level. However, Brand B's Low Noise tape might be nothing more than "regular" or "standard" tape, or even "white box" tape. Trying to use both brands on the same recorder because they are both called Low Noise can produce two completely different levels of overall performance—one good, one downright rotten.

The match between tape and bias level is so critical in the cassette system that a 20% bias level error—which is not uncommon—can cause the best tape, used on the best recorder, to produce a final performance no better than that delivered by the cheapest quality recorder. The Rule: If you can't match the tape to the recorder, get in there with a screwdriver and do the job yourself. **R-E**

benchnotes

RUBBER FEET FOR TEST INSTRUMENTS

Miniature test instruments can be pretty unsteady when—out-weighed by their test leads—skid all over the workbench. A firm footing can be gained by cutting non-skid feet from a rubber pad such as from an old phono



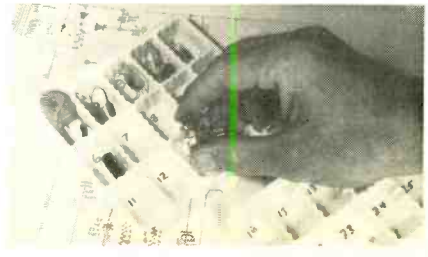
turntable. A hole-punch cuts feet for small equipment. Discarded typewriter pads make excellent shock-absorbing pads for small and large equipment. A pair of scissors can be used to cut pads of any size and shape.—*Frank Gilpin*

MARKING JUNKBOX PARTS

Junkbox parts have a tendency to lose their identity with handling and time. Felt-tip marking pens and grease pencils leave marks that just don't stand up or last for any length of time. A resist marking pen used for making etched printed circuits fills the bill beautifully. It has a fine point—great for marking small components, lasts indefinitely and, more important, it marks on any surface including shiny metal and the glass envelopes of vacuum tubes.—*Frank I. Gilpin*

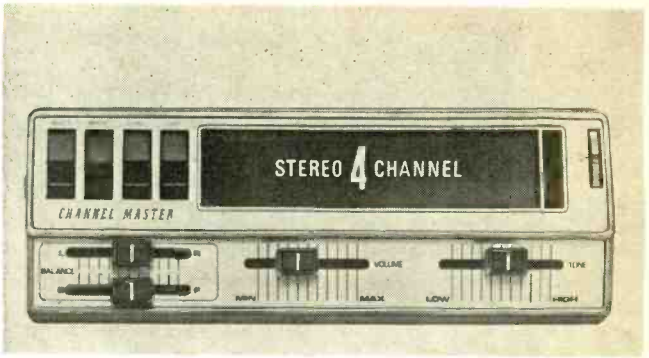
PARTS BINS EASE ASSEMBLY

Assembling a project of your own design or from a magazine article takes on the ease normally associated with a kit when you sort out components in a marked tray before connecting and soldering. Egg cartons, candy trays and similar compartmented trays marked R1, R2, D2 etc., lend themselves well and make assembly a breeze.—*Frank Gilpin*



STEREO ON THE GO—

AUDIOVOX MODEL C990 Q-8 tape player for discrete 4-channel.



MODEL 6294, BY CHANNEL MASTER is a 4-channel, 8-track player.

Following car stereo in its boundless growth is 4-channel sound on wheels. Take a look at the latest in tape players

by FRANK PETERS

IN THE PAST, COME SPRING, A YOUNG MAN'S FANCY TURNED to thoughts of love. Today, his springtime thoughts are just as likely to be about a car. Complete with cartridge tape player.

If your fancy lies in the direction of a car player this spring, you'll find that you never had it so good. The pickings are broad. The units look good. Many have more features for the dollar than ever before. The price range is wide. Quality at every price level is generally higher than in the past. Many models are vandal-proof. Many are double-duty types. And, if you're hot for four-channel sound, there's a load of quadraphonic players from which to make a choice.

Two or three years ago the car cartridge player market consisted mainly of two kinds of players—cheap basic units in the $30 to $50 bracket, and good quality models in the $90 to $120 range, with a smattering of decent sets at prices in between. Today there's a broad range, priced from $40 on up to near the $200 mark, with far more to choose from in the $60 to $80 bracket. In effect, there's a model for every budget, every taste and need.

Space limits prevent us from elaborating on all the changes that have taken place, so we'll hit just the high spots . . .

Back in 1970 and 1971, the industry lived through a deep slump, caused by a nationwide wave of auto player thefts that kept many a chap from replacing a stolen set, and kept many a fellow from buying his first add-on car player. As sales moved farther down on the charts, manufacturers began to panic. Some dropped their prices to attract lost business. Some came out with lower priced models of lesser quality, taking the approach that a player was a "disposable" on the order of a pocket transistor radio. But the more astute manufacturers took a different route; they stepped up their research and development efforts. In due time they came up with players that were virtually impossible to remove from a car . . . unless a thief had a blowtorch or the right tools, time and privacy for making a heist. As soon as these players hit the market, sales started to rise again.

This encouraged the industry to take a closer look at itself, to see what else could be done to make its products more interesting, and saleable . . .

- Like making double-duty models that operate in a car but can be removed for play in the living room.
- Like adding models with fast-forward controls to enable listeners to quickly pinpoint specific songs on a tape.
- Like coming up with models that contain a headphone jack, so a passenger can listen if the driver doesn't want to.
- Like producing models with smooth slide controls for quick visual settings.
- Like making better quality mini units for use in glove compartments . . . to lessen thievery or to accommodate cars with limited under-dash space.
- Like offering MORE models with: fine tuning to eliminate cross-talk; automatic program stop; easy, do-it-yourself installation potential; smooth, contoured lines for safety's sake; easier-to-operate characteristics; radio facilities, especially FM stereo; and, in line with being "with it," more four-channel models.

All in all, cartridge player equipment producers have done a good job to stimulate new interest in their products. If you've been hesitating about getting a new player—either a replacement or initial model—now's the time to stop doing so. As we said earlier, you never had it so good, in terms of what's viable, and available.

On the 4-channel front

Since this issue of **Radio-Electronics** centers around 4-channel sound, let's see where 4-channel stands relative to automobile use . . .

Oracles in and out of the cartridge player industry say that Q-8 (quadraphonic eight) is going to surround a lot of people in four-channel sound, and is likely to establish four-channel sound as the big business it was predicted it would be. The Word is that 4-channel sound will become big in the car, then move into the home (as did the two-channel Stereo 8 cartridge), and that Q-8 cartridges may become even more popular than 4-channel records.

The predictions are based on three points. One, a car is an excellent acoustical environment for 4-channel sound, dramatically show-casing the qualities of Q-8's discrete surround-sound in a more effective way than the average living room. Two, Q-8 tapes are generally a more viable medium for discrete 4-channel primarily because they are less susceptible to wear than discrete 4-channel discs with their ever-so-complicated groove "squiggles" that require the utmost care and attention for continued full 4-channel effect. Three, Q-8 tapes have more *use potential;* unlike 4-channel records, they can be played in both auto or home environments. This fact alone, industry observers point out, is

a round-up of tape players for your car

AUTOMATIC RADIO makes this model QME-2445. It features fine tuning.

PIONEER'S QP444 plays 2- and 4-channel cartridge tapes in your car.

likely to make Q-8 a mass-market sound medium, especially appealing to the younger generation looking for a lot for its money.

In addition to the foregoing, automobile Q-8 seemed like an ideal way for manufacturers to pump new interest into the cartridge format in the light of inroads being made by the cassette. While the cassette has been thrusting to make its way into the automobile, and has achieved some success there, it still has a long way to go. Cartridge proponents are using Q-8 as a way to block further inroads into the car field by the cassette. End result . . . a lot of new four-channel equipment for car use.

As we go to press, at least 24 companies have one or more surround-sound car players in their lines. And more companies will be entering the business as the concept catches on. Companies now in the field will expand the number of their offerings to cover more budget points, and there will be far more combinations with radio facilities. If past history of the industry is any criterion, you'll see Q-8 equipment prices moving downward, to a point where they will be only slightly higher than those of current two-channel Stereo 8 equipment. *Eventually*—just as the eight-track cartridge took over the field from the four-track cartridge—four-channel car tape players will replace today's two-channel models. This will be a "no-sweat" matter, in that Q-8 players accommodate existing two-channel Stereo 8 cartridges.

Available 4-channel auto players

There are two basic types of surround-sound auto players in the marketplace. There is the compatible Q-8 4/2-channel model that plays *Q-8* four-channel cartridges in the discrete mode through four channels of amplification and four speakers, and *Stereo-8* two-channel cartridges via four amplifier channels and four speakers for a four-channel *effect*. Such models come with and without a synthesizer circuit, which some companies call a "matrix." The second is the so-called "matrix player," which derives a four-channel effect from two-channel cartridges via two channels of amplification and four speakers. Before you lay your money on the line, make sure that you know what you're buying.

For instance, if you heard a true Q-8 four-channel *discrete* player in a friend's car and he told you his rig cost $150, don't think you'll best him with a $59.95 "four-channel" player that your local friendly dealer is advertising on a huge banner plastered across his store window. A *matrix* four-channel car player—which plays only two-channel *Stereo 8* cartridges, NOT four-channel Q-8—will cost substantially less than a discrete player, but it won't give you the precise and distinctly separate channel effect that a discrete model offers. If a dealer tries to sell you a "four-channel 8-track" cartridge player for under $70 and claims it is a discrete model, be suspicious; he may be trying to put something over on you. Or he, too, may be a victim of the misinformation and confusion rampant in the quadraphonic marketplace. We're not saying that a matrix car player won't give satisfactory surround-sound; what we're saying is, Don't expect to get discrete sound at matrix sound prices.

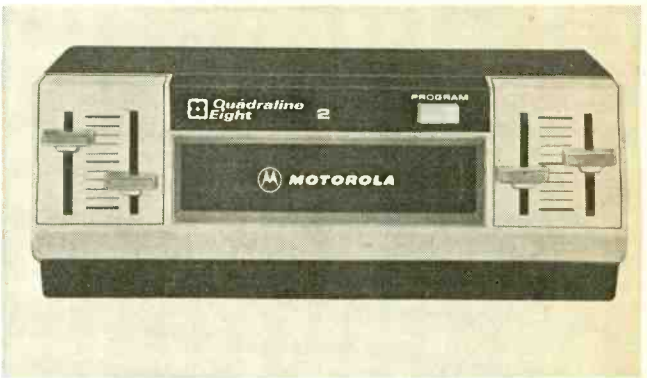
The lowest priced *2/4*-channel surround-sound players—starting at about $50—are two-channel Stereo 8 models with simple speaker phase-shift circuitry. They produce an enhanced double-stereo effect from four speakers that may satisfy many people looking for four-channel sound but not willing to pay a higher price. Such units will *not* play Q-8 tapes, unlike compatible *4/2*-channel Q-8 models which additionally play two-channel cartridges. Again, check before you buy to know what you'll get in the way of compatibility/surround-sound.

Most Q-8 discrete players have the same basic features as regular two-channel players: volume and balance controls; track selector and indicator lights; and dust-proof cartridge openings. Some have additional features such as tone controls, fine tuning, fast-forward, repeat play, slide-in/slide-out anti-theft brackets, and one (in the Dyn line) even has a remote control. They all have a sensing device for four-channel/two-channel play determination. When a Q-8 tape is inserted, the device is activated to, in effect, direct the sound information from each track to a separate amplifier channel, for four distinct and different channels of sound. When a two-channel tape is inserted, the device triggers the unit to, in effect, divide the right-channel signal into right front and right back, and left-channel signal into left front and left back, for what could best be called double-stereo. If the model contains a synthesizer/matrix circuit, another effect is created—something that to a degree approximates discrete sound in terms of distinct, individual channel information. The degree depends on the amount of ambient sound information "hidden" in a particular cartridge.

At this point in time a certain amount of confusion about Q-8 is prevalent even at the manufacturer level. It is manifest in confused product descriptions in catalogues, brochures, and spec sheets. For example, one catalogue description of a Q-8 player says "four amplifiers give double power with regular cartridges," whereas in fact, two-channel tapes played on it play at the same total amplifier power as Q-8's, but through four speakers, rather than two as in conventional stereo. Some literature dilutes its selling

add one of these

TWO- AND FOUR-CHANNEL PLAYER. Lafayette's 99 P 16065W.



QUADRALINE MODEL TM920S is 4-channel player by Motorola.

message by failing to indicate that a Q-8 unit also plays two-channel stereo cartridges.

You will also find product literature rather vague about certain details of quad operation. Most companies fail to indicate whether two-channel material is merely split between front and back, or if it is given a synthesizing/matrixing treatment in playback. In checking out a few of the vague descriptions, we found that some distributors and sales representatives handling auto players were also confused—unable to say with certainty that, for example, matrix models described as "2/4-channel 8-track" or as "Matrix 4-channel 8-track" could or could not play Q-8 cartridges in synthesized form rather than in discrete form. Some were not sure if their matrix units—as the term might suggest—actually decoded tapes, or synthesized their sound information for a derived four-channel effect. (In a way, this is a moot point since there are no matrixed four-channel cartridge tapes in the marketplace at this writing. A two-channel, non-matrixed tape played through a matrix model or through one with synthesizing circuitry, would sound virtually the same. Even a trained listener might not be able to hear a significant difference.)

Before you actually go out to buy a four-channel car player, we urge you to determine which store in your area handling such products has truly well-informed sales people. In checking sales literature, catalogue pages, or store ads before you go out to buy, do so with a lawyer's eye, to make sure the product descriptions don't create the impression that you're buying a Q-8 discrete player when in fact the "four-channel" cartridge player is actually a two-channel model that produces quasi-four-channel sound via four speakers.

The following companies produce Q-8 players that offer true discrete four-channel sound: Audiovox, Model C990; Automatic Radio, Model QME2445; Car Tapes Inc., Model CT18877; Channel Master, Model 6294: Craig, Model 3129; Dyn, Model DS905; Fulmer, Model (n.a.); Hammond Model HD585; Hitachi, Model CS4000; JVC, Models 1350, 1352, 1353; Lafayette, Model 99P16065W; Lear Jet, Model A245; Medallion, Model 65-540; Metro, Model MS9000; Mikado, Model Quad 8/4; Motorola, Model TM920S; Panasonic, Model CX601; Pioneer, Model QP444; RCA, Model 12R800; Realistic (Allied/Radio Shack) Model 12-1834; Sanyo, Model FT864; Sony, Model TC84; and Toyo, Models 721 and 722. The above sets also provide four-speaker surround-sound from two-channel cartridge tapes.

The following have matrix models that play regular two-channel cartridges in surround-sound through four speakers: Audio Vox Model C910; Boman (div. of California Auto Radio), Models BM911, BM950, and BM1950 (with FM stereo radio); Hammond, Models HD525, and HD575 (with FM stereo radio); Hitachi, Model CS1440; Realistic (Allied/Radio Shack) Model 12-2024; and Sanyo, Models FT888, FT828, and FT867 (with AM/FM stereo).

One of the appeals of true quadraphonic car players is their relatively low cost vis a vis most home models. You can get a Q-8 discrete compatible 4/2-channel model for as little as $89.95 in the Lafayette brand, for example, with a set of four speakers for an additional $8.95, making your total investment just under $100 exclusive of installation. Not bad for a complete system.

On the other hand, you can pay as much as $169.95 for a Sony TC84, less speakers and installation. As we said earlier, there's a model for every budget, taste and need; no matter how large or how small.

If you still have reservations about 4-channel and currently have a two-channel player in your car, you can check out your feelings about the *concept* of four-channel sound before going "whole hog", for under $20.

Just as the home cartridge equipment field has its conversion units and quad adaptors, so too, does the auto player field. Several companies and mail-order catalogue houses offer four-channel simulators or synthesizers that enable you to hook into an existing two-channel cartridge unit to convert it to play (with the addition of two more speakers) surround-sound. These adaptors are priced from $6.95. Some brands to check: Olson, Robins, Lafayette, Boman Astrosonix, Magnadyne, Allied/Radio Shack, and Sound Systems International.

What happens to the fellow who goes this route is that he is usually pleased with the 4-channel concept. When it comes time to plunk down his dough for a new all-in-one four-channel player, he is more likely to opt for a deluxe discrete model because he is sure that the benefits of 4-channel sound are well worth the extra investment in equipment.

Installing the tape deck in a car

Auto player manufacturers have done their best to accommodate the do-it-yourselfer who prefers to handle his own player installation—to save money, or for the satisfaction of working with his hands. They have worked out detailed, fool-proof, step-by-step instructions on how to install a player that are easy enough for even a novice to follow to successful completion. In fact, some auto player suppliers say that 90 out of 100 fellows who can handle an electric drill and can tape wires can do a hang-on installa-

tape players to your car

RADIO SHACK's Realistic model 12-1834.

RCA MODEL 12-R-800 Q-EIGHT tape player.

tion with ease, and that 75 out of 100 can do an in-dash installation in the space usually allotted for a car radio.

Further, the do-it-yourselfer is aided by the concept itself; since four speakers are used in a 4-channel ensemble and the space in which the units operate is relatively small, speaker placement is less critical than in a two-channel rig where two speakers are called on to fill the same space with a full, rich, open sound. Thus, you can utilize the many available hang-on and under-seat/above-deck speaker systems to make this aspect of a quad installation a cinch. Unless you're a sound "nut" or nth-degree perfectionist, you can get by nicely without having to cut out large holes in metal door panels for top quality sound in your car.

If you insist on built-in speakers for the front channels you still need not cut out door panels; instead, install them in the "kick" panels flanking the area under the dash. These panels are usually of an easy-to-cut material and are relatively easy to work with. Should you object to above-deck wedge speakers for rear channel use because they clutter the deck, you might investigate the use of built-ins—again, without worrying about cutting into steel. Some 90 per cent of today's cars have precut speaker openings in the metal framework of the rear deck; it's just a matter of sawing through the covering material, usually fibreboard, to install the speakers. Before you go out to buy a four-channel car player, check your car trunk to see what sort of rear deck openings your particular car has; many were made to accommodate six by nine-inch oval speakers. Make your selection accordingly.

A word of advice about speaker quality comes from Ira Lash, sales manager for Audiovox, a major player producer. "If you use surface-mount speakers, go for the heavier magnet models. Try to match the quality of speakers, front with rear. If you have to compromise, install better speakers at the rear."

If doing-it-yourself is not your style, you can have a four-channel ensemble installed in your car economically—if you ask for the budget surface-mount approach as opposed to the "full treatment" of built-in speaker systems. The best place to go for an installation is to a specialist, rather than the fellow who handles car installations as an accommodation, or as an adjunct to a radio/TV/audio service setup. The specialist is likely to do the best job. Because he has the know-how and should know all the ins and outs of the trade, he'll probably do the job for less. Further, he won't foul up an installation, as the non-specialist might, when it comes to cutting into metalwork for built-in speakers. **R-E**

LIST OF MANUFACTURERS

Audiovox Corp., 150 Marcus Blvd., Hauppauge, N.Y.
Automatic Radio, 2 Main Street, Melrose, Mass. 02176
Boman Astrosonix, 225 West Commercial Ave., Moonachie, N.J. 07074
Car Tapes Inc., 9180 Kelvin Ave., Chatsworth, Calif. 91311 and 333 East Ontario St., Chicago 60610
Channel Master Div. of Avnet, Inc., Ellenville, N.Y.
Craig Corp. 921 W. Artesia Blvd., Compton, Calif. 90220 and 50-52 Joseph St., Moonachie, N.J.
Dyn Electronics, Inc. 3095 N.W. 77th Ave., Miami, Fla. 33122 and 1111 East 14th St., Los Angeles, 90021
Arthur Fulmer, 260 Monroe Ave., Memphis, Tenn.
Hammond Sound Products, 9300 Hall Road, Downey, Calif.
Hitachi Sales Corp., 48-50 34th Street, Long Island City, N.Y.
JVC America, Inc., 50-35 56th Road, Maspeth, N.Y.
Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, N.Y. 11791
Lear Jet Stereo, Inc., 6868 South Plumer Ave., Tucson, Arizona 85706
Magnadyne Corp., 9261 W. 3rd St., Beverly Hills, Calif.
Medallion Automotive Products Co., P.O. Box 19043, Kansas City, Missouri 64141
Metro Sound, 11144 Weddington St., N. Hollywood, Calif.
Mikado Electronics, 1072 Bryant St., San Francisco, Calif. 94103
Motorola, Inc., 9401 West Grand Ave., Franklin Park, Illinois 60131
Olson Electronics, 260 S. Forge St., Akron, Ohio 44327
Panasonic, 200 Park Ave., N.Y.C. 10017
Pioneer Electronics of America, 1555 East Del Amo Blvd., Carson, Calif. 90746
RCA/Parts and Accessories, 2000 Clements Bridge Rd., Deptford, N.J. 08096
Realistic (Allied/Radio Shack), 100 N. Western Ave., Chicago 60680
Robins Industries Corp., 15-58 127th St., College Point, N.Y. 11356
Sanyo Electric Inc., 1200 West Walnut Street, Compton, Calif. 90220
Sony (Superscope), 8150 Vineland Ave., Sun Valley, Calif. 91352
Sound Systems International, 53 E. Oakland Ave., Salt Lake City, Utah 84115
Toyo Radio Co. of America, Inc., 1611 Anderson Ave., Compton, Calif. 90220

step-by-step

TV TROUBLE

Good sync is all-important sync-separator action is

by ART MARGOLIS

THE SECRET TO SOLVING A SYNC trouble is in the approach. If confusion does occur, it's often because the technician has attacked the problem from the wrong angle. The sync-separator circuit is relatively simple, there are relatively few components. But what the circuit does is not simple at all. Understanding what happens to the sync signals in the sync separator helps turn a puzzling sync trouble situation into a quick repair.

The sync separator is fed a sample of the composite video signal taken off the video amplifier stages. The separator then snips the entire sync pedestal off the composite video, keeps the pedestal and discards the other parts of the signal.

The next horizontal and vertical sync pulses are separated from each other and fed to the horizontal and vertical oscillators.

Typical transistor sync separator

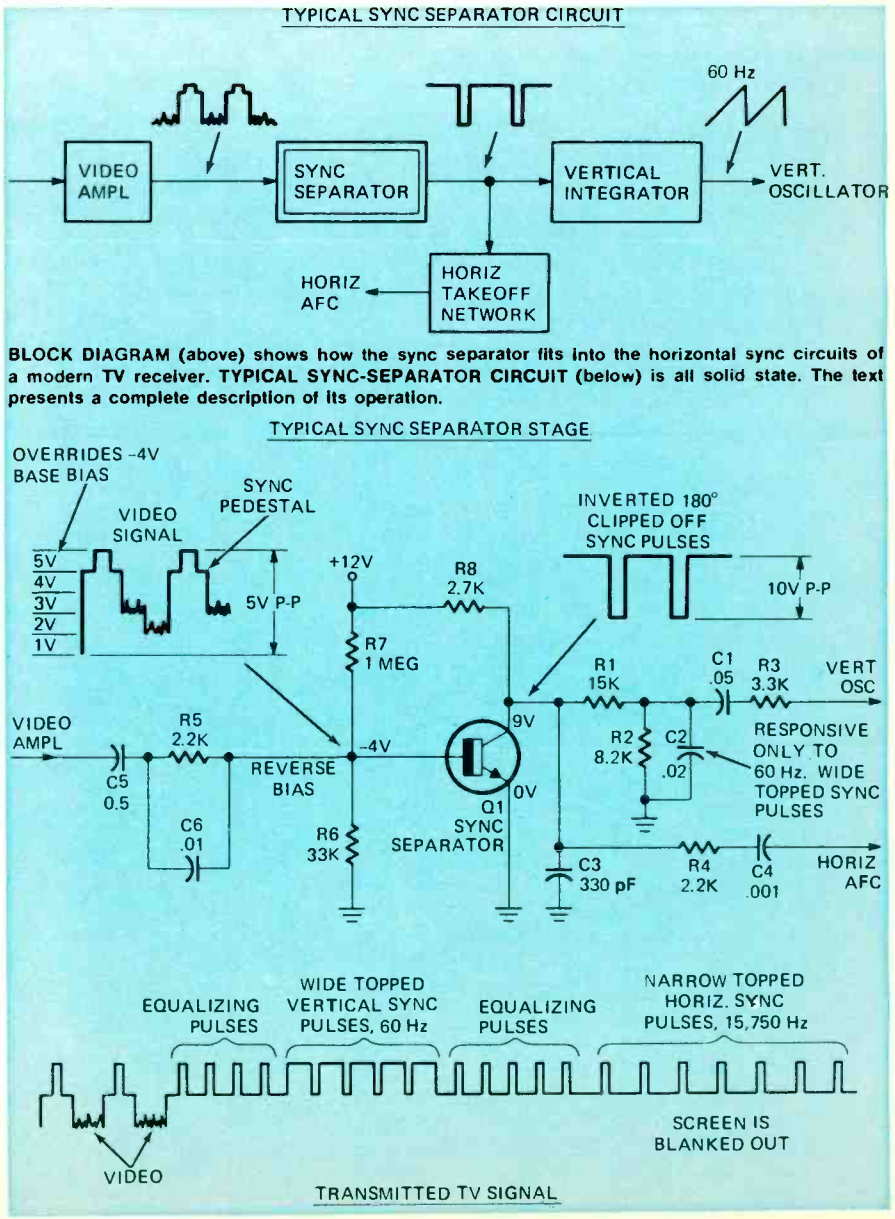
Dc setup—The composite video signal applied to the base of the sync separator causes pulsing direct current flow through base resistor R6 due to rectifying action in the base-emitter junction. Current flow makes the base negative—or reverse-biased—with respect to the emitter. Capacitor C5 charges and tends to maintain the negative base bias.

The collector goes to +12 volts through R8 (2700 ohms). In normal operation, the drop across this resistor places the collector at +9 volts. A small stabilizing base bias is provided by R7 and R6. The collector feeds a pair of takeoff lines to the horizontal and vertical oscillator circuits. One is an integrator that extracts and shapes the vertical pulse. The other has an R-C network that shapes the horizontal pulses.

Ac setup—During the interval the video appears, the reverse bias prevents any conduction through the transistor. However the sync pedestals are considerably more positive in voltage than the video. They have enough amplitude to override the reverse bias and turn on the transistor for the duration of the period.

Collector current flows during the sync-pedestal interval so the sync pedestal is reproduced in the collector circuit where it appears amplified and inverted 180 degrees. The incoming composite video signal can be about 6 volts peak-to-peak. The sync pulse in the collector circuit is about 10 volts peak-to-peak.

The clipped pulses on the collector are the square, narrow horizontal pulses occurring at a 15,750-hertz rate and the square wide vertical pulses oc-



BLOCK DIAGRAM (above) shows how the sync separator fits into the horizontal sync circuits of a modern TV receiver. TYPICAL SYNC-SEPARATOR CIRCUIT (below) is all solid state. The text presents a complete description of its operation.

SHOOTER'S GUIDE

in black-and-white and color television. Proper essential. Here's how to make sure it works right

curring at a 60-hertz rate. The horizontal takeoff line responds to the horizontal pulses and sends them on to the horizontal oscillator.

The vertical integrator has a .02-μF capacitor (C2) that can only charge up during the wide topped pulses. The wide pulses occur at a 60-hertz rate. The C2's discharge becomes the properly shaped vertical sync pulse and is fed to the vertical oscillator.

INSIDE THE SYNC SEPARATOR

QUICK CHECK

ATTACH VOLTMETER

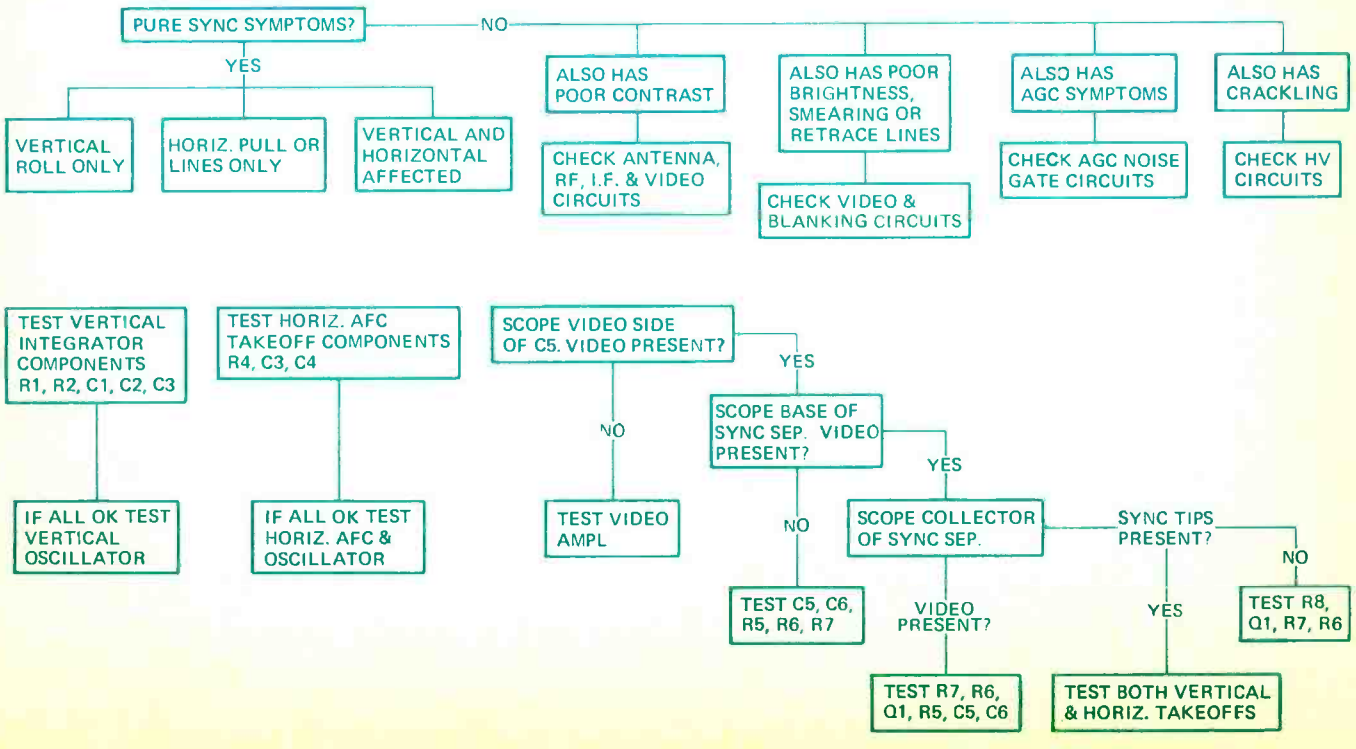
NORMAL VOLTAGES

TRY 4 CHANNEL SETTINGS	BIAS	COLLECTOR VOLTAGE
1 - COCK SELECTOR BETWEEN CHANNELS	SLIGHT POSITIVE	UNDER 5 VOLTS
2 - SET ON OFF CHANNEL	MINUS 2 VOLTS	ABOUT 6 VOLTS
3 - SET ON WEAK CHANNEL	APPROACHES MINUS 4 VOLTS	ABOUT 9 VOLTS
4 - SET ON STRONG CHANNEL	PRESCRIBED VOLTAGE	PRESCRIBED VOLTAGE

NORMAL VOLTAGES? → SYNC SEPARATOR Q1 & COMPONENTS OKAY

NOT NORMAL? → SYNC SEPARATOR HAS TROUBLE

TROUBLESHOOTING CHARTS help locate troubles fast. (above) Quick-check chart for use with voltmeter. (below) Detailed step-by-step troubleshooting procedure.



Sync separator trouble shooting

When the picture rolls, pulls or goes off into horizontal lines it is out of sync. The suspect circuits are many. Any circuit from the antenna, through the rf, i.f., video, sync to the sweep oscillators can contain the troublemaker. A closer analysis must be made to narrow the choice.

Even though the sync symptom is prominent, are there any other secondary symptoms? If there is also poor contrast, poor brightness, visible retrace, a smeared picture, age symptoms, incorrect lock in on a hold control, crackling, humming or buzzing, the trouble is probably not a sync problem. The trouble will probably be in the circuit the secondary symptom points out.

When there are no other symptoms, just sync, then the trouble will

probably be found in the sync circuit. If the sync is running both ways, horizontally and vertically then the separator itself or the surrounding components are prime suspects. Should the trouble be only vertical sync the vertical takeoff line is indicated. When the trouble is just horizontal, the horizontal takeoff line usually contains the defective component.

Once all the preceding conclusions are drawn the pinpointing of the actual component is simplified. With a scope follow the video from the video amplifier to the collector of the sync separator. As soon as you lose the correct pattern you have passed over the bad part.

Quick check—While the scope is the best approach in the sync stages, some quick checks are also handy to help isolate the section of the circuit.

The sync separator base bias and collector voltage are direct functions of the signal strength. Even though Q1 is reverse biased, some conduction is taking place in the transistor. This is proved by the difference between the 12-volt supply and the 9 volts on the collector. There is a 3-volt drop across the 2700-ohm collector resistor.

Therefore if the reverse bias should fall to minus 1 the transistor will conduct more heavily and the collector voltage will drop below the 9 volts, due to the larger voltage drop across R8. If the bias should increase to minus 6 volts the transistor will conduct less and the collector voltage will rise toward the supply voltage.

Since the bias is a direct function of the signal strength, the transistor can be quick checked by changing the bias and noting if the transistor is acting normally or not.

Attach the voltmeter and try four different channel selector settings. One, cock the selector between channels. This is a relatively noise-free setting. The total lack of signal, not even any noise, does not let C5 charge up at all and the -4 volts bias disappears. The base goes slightly positive and Q1 conducts heavily. The collector voltage drops way down, under 5 volts.

Two, set the selector on any unused channel. There is no signal, but there is plenty of snow or noise. The noise will charge up C5 a bit and could provide a bias of about -2 volts. As a result, collector voltage rises as transistor conduction is reduced. It could rise to about 6 or 7 volts.

Three, set the selector on a weak channel. The weak signal will charge C5 almost normally. The reverse bias approaches -4 volts and the collector rises, to 8 or 9 volts.

Lastly, set the selector to a strong local channel. Normal voltages should now appear.

This test takes much less time than reading about it. If normal voltages are present, Q5 and its components are operative. Should the sequence produce other than normal, attach the scope and pinpoint the defective leg. **R-E**

solid-state news

The Signetics Corporation (811 East Arques Ave., Sunnyvale, Calif. 94086) has introduced a new fully decoded 256 × 1 static random access memory (RAM), the type 25L01. Employing enhancement mode P-channel MOS devices integrated on a single monolithic chip, the new device is optimized for operation on +5 and -12 volt DC supplies, but also can be used on +5 and -9 volt sources. It has a guaranteed access time of only 1.0 μs. With a standby power dissipation of just 100 μW/BIT, its access power dissipation is but 1.7 mW/BIT.

The 25L01 can be driven directly by standard TTL and DTL bipolar IC's, while its data output buffer is capable of sinking a minimum of 2.0 mA, sufficient to drive a standard TTL load. The new IC's internal block diagram is illustrated in Fig. 1-a, its pin connections given in Fig. 1-b. Packaged in a 16-pin silicone DIP, the 25L01 nets for only $6.00 each.

With interest in digital displays reaching boom levels, inexpensive new readout devices have been introduced by two major manufacturers: Fairchild's Semiconductor/Microwave and Optoelectronics Division (4001 Miranda Ave., Palo Alto, Calif. 94304), and Sperry Rand's Sperry Information Displays group (P. O. Box 3579, Scottsdale, Ariz. 85257).

Fairchild's new display is a ¼" high LED digit which utilizes a new and unique construction technique. Only one LED is used per display segment, with a molded plastic light pipe converting the spot of light into a uniform bar segment. A "fly's eye" lens consisting of multiple convex lenses on the display surface diffuses the light to provide bright displays with a viewing angle of 140°.

Sperry's new displays, Fig. 2, are seven-segment planar gas discharge devices designed specifically for interfacing with MOS/LSI circuits. Recommended for use in all dc or multiplexed applications, with or without suppressed zeros, the units are offered in two sizes, the SP-330 Series (⅓") and SP-350 Series (½"). **R-E**

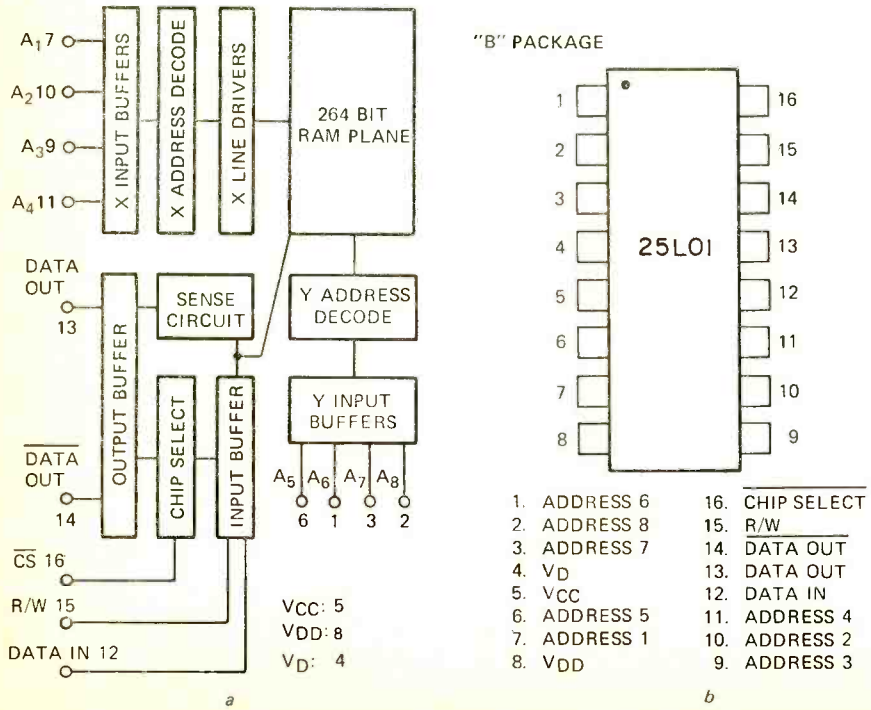


FIG. 1—BLOCK DIAGRAM (a) and pin connections (b) of Signetics' 25L01 RAM.

FIG. 2—SPERRY'S MOS/LSI compatible digital displays.

the state of SOLID STATE

This month's glimpse into the world of semiconductors takes off with a glossary of terms so you too, can talk-that-talk.

by LOU GARNER
SEMICONDUCTOR EDITOR

SPECIALISTS LIKE TO USE TERMS AND expressions peculiar to their field. Frequently, these are acronyms of oft-repeated phrases or common, but longish, technical names. Sometimes they are coined words, adopted because there is no completely suitable term in the English language. In other cases, they are slang expressions appropriate to the equipment, process or technique described.

It follows, then, that logic circuit designers, manufacturers and engineers have their own lingo—their own stock of pet phrases and expressions. As a result, a technician, hobbyist, student, or engineer, no matter how well trained, skilled or experienced, may find himself lost in a maze of unfamiliar terms when he first starts working with digital circuits, especially if his past experience has been primarily with amplifiers, radio and TV receivers or transmitters, and similar types of equipment. At times, in fact, the novice to digital circuits may feel as if he is drowning in a vast bowl of alphabet soup or, at the very least, is a prisoner in an alphabet noodle factory.

For the benefit of those newcomers to the sometimes confusing but, nonetheless, logical field of digital logic, here is a brief review of the most common special expressions used and their basic definitions:

A/D or AD: With due respect to our own advertising department, this **AD** means *analog-to-digital.* Sometimes a third letter will be added to designate a particular circuit function. For example, the analog-to-digital converter used in a digital meter might be referred to as an **ADC** circuit.

BCD: Binary coded decimal.

Bit: A small role for actors, but, in logic technology, an abbreviation for binary digit.

Chip: Not off the old block, but a basic substrate without leads containing a single device or all the active and passive elements of a complete circuit . . . i.e., an uncased IC. Some manufacturers use transistor, diode and capacitor chips in the fabrication of hybrid circuits.

Clock: Some people watch these, but in digital work it's a pulse generator which controls the timing of counting, switching and memory circuits. Often, a simple multivibrator or relaxation oscillator.

CML: Current mode logic; logic circuits which operate in an unsaturated mode in contrast to types which operate in a saturated mode.

CMOS: Complementary (or complementary-symmetry) metal-oxide semiconductor. Used to identify devices manufactured of MOS materials and using complementary circuit configurations.

COS/MOS: See **CMOS.** Expression used primarily by RCA for its CMOS devices.

D/A or DA: Not "district attorney," but *digital-to-analog.* As in **A/D,** which we see, a third letter may be added to identify a specific circuit function. **DAC's** (digital-to-analog converters) are used in many control system designs.

DCTL: Direct-coupled transistor logic.

DI/CMOS: Expression used by Harris Semiconductor to identify its dielectrically isolated **CMOS** devices.

DIP: Slang expression for a pickpocket or a *dual in-line package.* If it's smaller than a breadbox and has metallic leads, it's the latter.

D-MOS or D-MOST: Designation used by the Signetics Corporation for a proprietary semiconductor manufacturing process and/or devices produced using the process; also, obsolete expression for "the greatest."

DTL: Diode-transistor logic.

ECL: Would you believe *emitter-coupled logic?*

FEB: If you were born in this month, your birthstone is the amethyst, but it's also an abbreviation for *functional electronic block,* a less common name for a monolithic integrated circuit.

Gate: Not to swing on, but the basic electronic switch used in digital logic; a circuit having two or more inputs and a single output, in which the output depends on the combination of input signals. Four basic types are used, identified according to the relationship between the input and output signals as . . . AND, OR, NAND and NOR gates.

GIGO: The expression sometimes used to describe poor digital equipment operation. It is an acronym for "Garbage In, Garbage Out." *Really!*

Hybrid: A type of corn as well as in-

tegrated circuits manufactured using a combination of discrete chips and thin film wiring.

IC: The common abbreviation for integrated circuit. *IC, do UC?*

LSI: Acronym for "large scale integration." Integrated circuits which may contain the equivalent of thousands of devices.

McMOS: Not a Scotsman, but the expression used by Motorola for its **CMOS** devices. See **CMOS.**

MECL: See **ECL.** Term used primarily by Motorola for its **ECL** devices.

Memory: A device or system into which digital information can be inserted and held for use at a later time. *Don't forget!*

Monolithic: Literally, "single stone." Could be one member of a rock group, but it's really used to identify complete integrated circuits formed on a single semiconductor chip.

MOS: Metal-oxide semiconductor. Often used in combination with other letters and/or acronyms to designate special devices as, for example, **MOSFET**—metal oxide semiconductor field effect transistor. See **CMOS, D-MOS, NMOS, PMOS.**

MSI: Acronym for "medium scale integration." Integrated circuits which may contain the equivalent of scores or hundreds of devices. Without the "I," used by Women's Lib.

NMOS: Designation for n-channel **MOS** devices.

PMOS: Guess? You're right—designation for p-channel MOS devices.

PRAM: If you're British, a baby buggy; in digital logic, a *programmable random access memory.*

PROM: Could be a dance if junior or senior, but used alone it's an acronym for *programmable read only memory.*

RAM: For our drinking friends, the symbol for bock beer . . . for Californians, a football player . . . and, in digital land, a *random access memory* (bet you figured that one out yourself).

RCTL: Resistor-capacitor-transistor logic; circuit in which logic functions are performed by resistors, with capacitors used to improve switching speed; a transistor serves as a buffer/inverter amplifier.

ROM: *Read only memory;* with an "E," a city in sunny Italy.

RTL: Resistor-transistor logic; similar to **RCTL,** but without the capacitors.

TSL: Acronym abbreviation for National Semiconductor's *Tri-State* logic devices.

TTL, T²L or T2L: Transistor-transistor logic. Not a stutter, but the designation used for certain logic devices employing multiple-emitter transistors.

WHEW: Not a digital term at all—just my reaction to finishing this list.

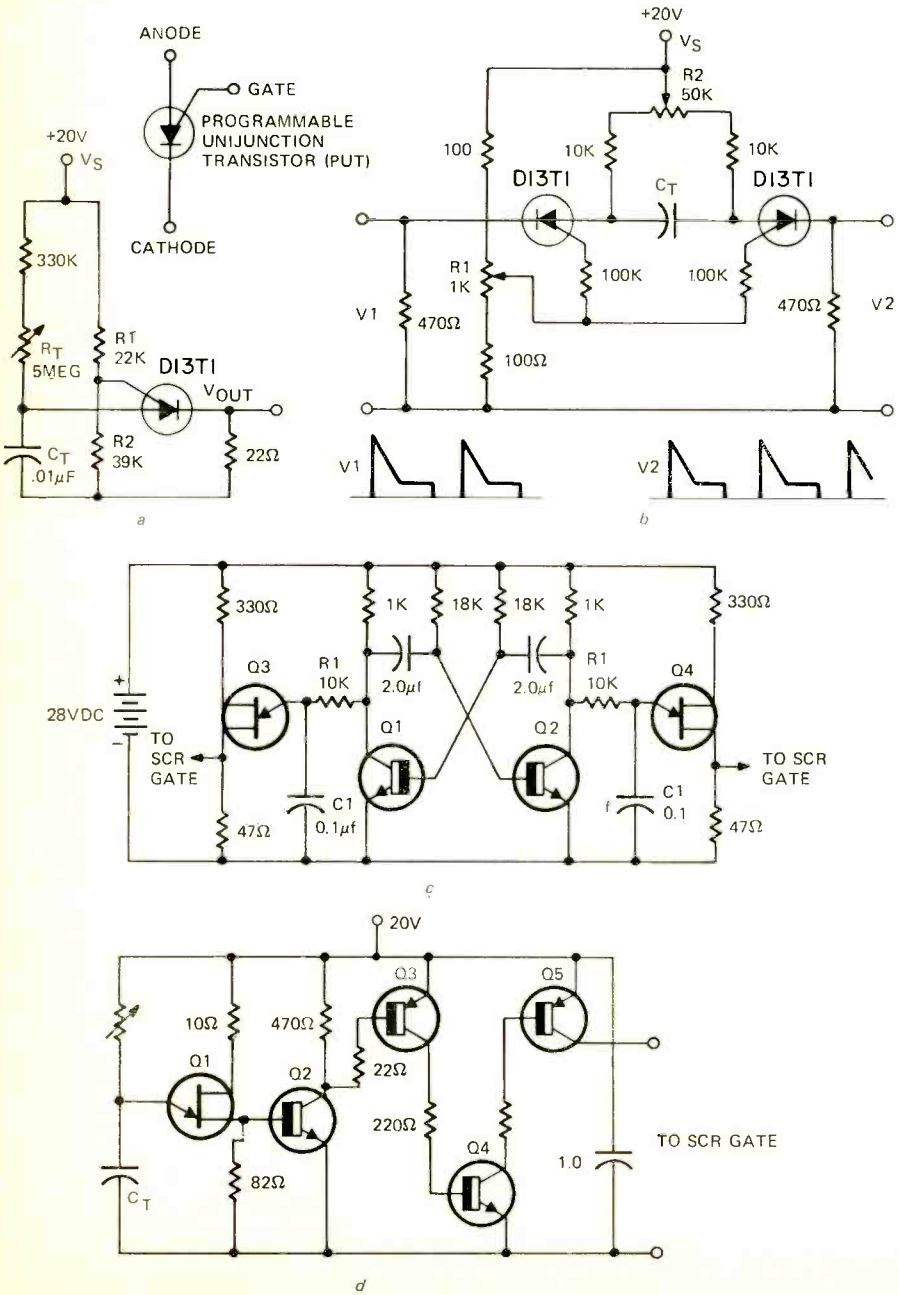


FIG. 1—PULSE GENERATOR CIRCUITS SUGGESTED by General Electric. A—PUT relaxation oscillator; b—Flip-flop trigger circuit; c—Pulse train circuit; d—High speed circuit.

SCR trigger circuits

Semiconductor manufacturers generally recommend that pulse signals be used to trigger SCR's for optimum performance in light dimmers, motor speed controls, power inverters, solenoid drivers and similar applications. Four suitable pulse generator circuits are illustrated in Fig. 1. All four were abstracted from GE application notes.

Perhaps the most popular pulse generator is the basic relaxation oscillator. A simple and inexpensive, but reliable, relaxation oscillator using a programmable unijunction transistor (PUT) is shown in Fig. 1-a. In operation, its repetition rate is established by timing control R_T in conjunction with timing range capacitor C_T. The output pulse is developed across a 22-ohm load resistor. A type 2N6027 may be used for the type D13T1 PUT specified.

The circuit in Fig. 1-b may be used when it is necessary to trigger two SCR's on alternate half-cycles as, for example, in a full-wave power inverter. Here, a pair of PUT's are used. The repetition rate is set by R2 in conjunction with timing range capacitor C_T.

In higher power applications, it is often desirable to drive the SCR's with a train of narrow pulses rather than a single broad pulse to reduce gate dissipation. This can be done with the circuit in Fig. 1-c. In operation, a collector-coupled transistor multivibrator, Q1-Q2, serves to gate a pair of UJT relaxation oscillators, Q3 and Q4, on alternate half-cycles. With the component values specified, this circuit delivers 1200-Hz pulse trains at a 50-Hz repetition rate.

Q1 and Q2 are 2N3416's. Q3 and Q4 are 2N2647's. If the circuit is used on dc source voltages of less than 25 volts, use 2N3414's for Q1 and Q2.

Where high-speed operation is needed, the circuit in Fig. 1-d may be used. Featuring a UJT relaxation oscillator, Q1, followed by a four-stage direct-coupled transistor amplifier, Q2 to Q5, this circuit can generate rectangular pulses of 10-μs width at repetition rates of up to 20 kHz, depending on the values of the UJT's timing resistor and capacitor. Q1 is a 2N2647, Q2 and Q4 are 2N3414's, Q3 is a 2N5365, and Q5 is a D43.

Product/device news

Interdesign, Inc. (1190 Elko Drive, Sunnyvale, Calif. 94086) has announced a third addition to their series of general-purpose IC chips. Designated Monochip C, the new chip, Fig. 2, contains 110 integrated com-

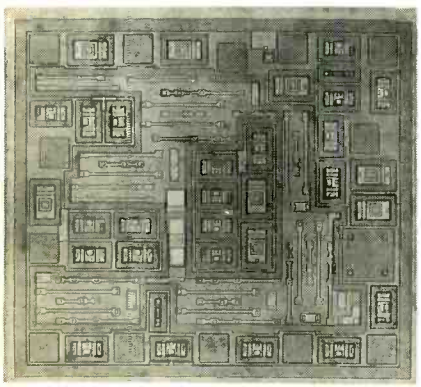


FIG. 2—INTERDESIGN'S MONOCHIP C general-purpose IC chip.

ponents and 14 bonding pads, comprising 23 npn transistors, 8 pnp transistors, 6 Schottky diodes, and 73 resistors. Used in conjunction with the firm's model MO-K Design Kit, which nets for $39.00, the Monochip devices permit an engineer or skilled technician to design his own custom IC's.

A series of glass passivated thin-film resistors suitable for use in hybrid circuits has been announced by the new Hybrex Division of the Burr-Brown Research Corporation (6730 S. Tucson Blvd., Tucson, Ariz. 85706). Named the "S" series, the new units, illustrated in Fig. 3, offer standard

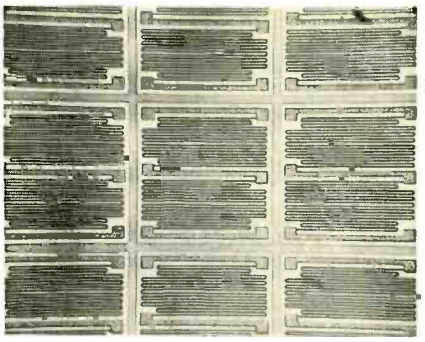


FIG. 3—HYBREX'S "S" SERIES thin-film resistors for hybrid circuits.

temperature coefficients of less than ± 50 ppm/°C. Standard resistance values are available from 10 ohms to 511,000 ohms with 1% tolerance; from 10 ohms to 510,000 ohms with 5% tolerance; from 10 ohms with 10% tolerance.

All have a power dissipation rating of 250 mW. Tighter tolerances and higher resistance values are available in custom types. Offered in both chip and wafer form, the "S" series resistors are priced at 59 cents each for 10% tolerance types in medium quantities.

Another interesting hybrid circuit component has been introduced by the San Fernando Electric Manufacturing Co. (1501 First St., San Fernando, Calif. 91341)—*would you believe a monolithic ceramic chip inductor?* It's true! Dubbed *Magnachip*, the device is manufactured from a proprietary ferrite formulation that is dispersed in plastic, cast to a uniform film, and then printed with conductive ink. A process of stacking, interconnection, lamination, and firing is used to produce the final devices, which are small, solid, dense, multilayer inductances. Standard inductance ranges are from 0.2 to 5 μH with a minimum Q of 20. The units have a series resistance of 0.5 ohms maximum, a power rating of 0.3 watt, and a current rating of 1.0 amperes.

"Not *another* function generator IC," was my initial reaction when I first learned of Intersil's (10900 No. Tantau Ave., Cupertino, Calif. 95014) new 8038 Voltage-Controlled Oscillator. Upon closer examination, however, I found that the new device has a lot to offer. It works with any 10 to 30-volt or ± 5 to ± 15-volt dc supply. It can furnish high-level sine, triangular and square waves simultaneously (Fig. 4) from 0.001 Hz to 1.5 MHz, and its output can be swept or

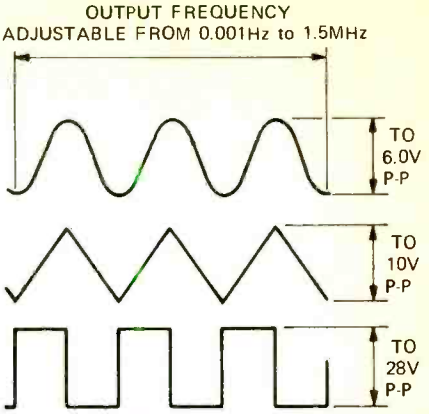


FIG. 4—WAVEFORMS AVAILABLE from intersil's 8038 IC voltage controlled oscillator.

FM'd up to 100 kHz. Its square-wave duty cycle is adjustable from 2% to 98% and it has a typical stability of 50 ppm/°C. But its best "spec" is its price—packaged in a plastic DIP, the 8038CC nets for only $3.75 each in unit quantities!

Intended for use in miniature, battery-powered equipment, such as hand-held calculators and portable test instruments where power and space are limited, HP's new displays are 7-segment monolithic units 0.11 inch high. The devices are available in 3, 4 and 5-digit clusters with either the standard right-hand decimal point or a centered decimal, as illustrated in Fig. 5. End-stackable, the units feature built-in magnification which increases the apparent luminous intensity, thus reducing power requirements.

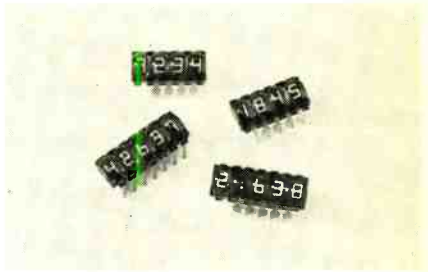


FIG. 5—HEWLETT-PACKARD'S new LED displays.

Identified as the Model 5082-7400 series, the new HP displays are packaged in standard 12 (3 and 4 digits) or 14 (5 digits) pin DIPs which can be plugged into conventional sockets or soldered directly into PC boards. The shoulders of the lead frame pins are intensionally raised above the bottom of the packages so the displays can be tilt-mounted up to 20° from PC boards. A red dye is incorporated in the plastic lens to filter out visible light other than red and thus to improve contrast.

Unit prices for the 5082-7400 devices range from a mere $12.75 for a 3-digit cluster to $21.25 for a 5-digit cluster. Quantity prices are lower, of course. **R-E**

RCA Institutes introduces the CASSETTE SYSTEM

It's almost like having an instructor in your own home.

Now, another breakthrough from the company that brought you AUTOTEXT, RCA's step-by-step home learning method! It's the new RCA Institutes' CASSETTE SYSTEM, an innovative learning-by-hearing approach designed to get you started more quickly and easily towards an electronics career. The CASSETTE SYSTEM adds an extra dimension to AUTOTEXT, RCA's step-by-step planned instruction which simplifies the mechanics of learning. As you play the cassette tapes, you'll have an instructor guiding you through your AUTOTEXT lessons. Explaining the material as you read it. Going over schematics with you, reinforcing the basic electricity and electronics study materials. All in an easy-to-understand conversational tone. And now the CASSETTE SYSTEM is available as an optional extra to all students enrolling in basic, fundamental, and career programs.

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NO SALESMAN WILL CALL

If you're interested in an exciting rewarding career in electronics, send the attached card or fill in the coupon. We'll send you all the information you'll need to discover which RCA course or program is for you. No salesman will call.

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hard rock's high dB's— and your hearing

Music soothes? Not if it is hard rock with amplifiers going full blast. It's dangerous and hurts. Here's how

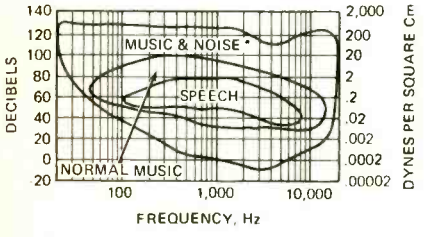
by MERINO y CORONADO

GUITARS COUPLED TO 100-WATT AMPLIFIERS, combo organs delivering 200 watts and accordions provided with pickups and high-power amplifiers are "in" on the rock scene today. Amateur and professional rock groups are engaged in a wattage war: 50-watt amplifiers are quickly replaced by monsters of 200 watts or more, and the technology of modern loudspeakers make it possible to operate them continuously at high levels.

When it was found some discotheques operate with sound levels of 90 dB and up, doctors and psychologists began to worry about the effects these music levels may produce on the delicate human inner ear. Several medical and technical publications published articles on the subject, and I decided to make some measurements myself.

Frequency and intensity limits

Textbooks say that the audible frequency range lies between 20 and 20,000 Hz. This is not the case in Mexico. Some time ago, a study with several hundred workers of the Mexican Railways System revealed that the audible range of these people goes from 35 to 15,200 Hz. These results agree closely with what I obtained with some 150 of my students in the School of Electrical Engineering.



* MUSIC AT HIGH VOL. & LOW FIDELITY

FIG. 1—STANDARD AUDIOGRAM with frequencies and intensities found in ordinary speech and normal music. Sounds with both parameters located *under* the outer line are inaudible. Sounds over some 130 dB cause discomfort or damage to the ear.

For Mexico, the normal or standard audiogram must be modified accordingly. But for the moment, let's look at a standard audiogram such as Fig. 1 (reproduced from the June 1934 *Bell Laboratories Record*). This shows the frequency and volume ranges of speech and orchestral music, as well as ordinary sound.

The outer line depicts the boundaries of "normal hearing," that is, the upper and lower limits of intensity and frequency. For example, a sound of 100 Hz becomes inaudible when its intensity falls below about 38 dB. But the same sound must have an intensity of more than 50 dB but less than 90 dB if it is to be musically useful, as shown by the first inner line. The innermost line is for speech.

Notice the threshold of hearing is 0 dB at 1,000 Hz, but is about -10 dB at 3,000 Hz, the frequency at which the human ear is most sensitive.

Sound that hurts

The upper portion of the curve, the threshold of "feeling," is practically flat for all frequencies. Sounds stronger than 120–130 dB are not "heard," but "felt" by the human ear: a "tactile sensation" is experienced and discomfort begins. Pain is experienced at 140 dB, but it is well known that prolonged exposure to sound levels of 100 dB in some instances (and even 80dB at certain frequencies) may result in permanent, irreversible damage to the inner ear.

A number of representative noise levels are shown in the table below.

REPRESENTATIVE NOISE LEVELS

Db	Source of Sound
0	Threshold of hearing
10	Whisper at one meter
20	Extremely quiet room
30	Whisper at two meters
40	Conversation, low voice
50	Ordinary office or home
60	Expressway traffic
70	Heavy street traffic
80	Pneumatic drill at 15 meters
90	Printing plant
100	AVERAGE GO-GO MUSIC
110	Piston airplane engine
120	Discomfort begins
130	Jet take-off at 60 meters
140	Threshold of pain
150	Damage to the ear
160	Destruction of the ear

Different machines produce different sound levels, as every acoustic or industrial engineer knows. But what about go-go music?

It is well known that a symphony orchestra can produce sound levels around 100 dB during certain fortissimo passages, but most of the time its ability to produce high-intensity sounds is considerably reduced. Since I knew nothing about sound intensity of go-go and rock music, I measured the levels at three or four discotheques and four or five "well-designed" go-go night clubs. To my surprise, I found *constant levels* of between 90 and 100 dB. That is more than the noise intensity found in the plant where this magazine was printed!

In some night clubs the musicians play on a stage and their amplifiers and loudspeakers are also located there. Customers can select a place to sit away from the sound sources when they're not dancing. But in "well-designed" discotheques, loudspeakers are distributed across the room. A constant and equal sound level is found in every square meter of dancing or sitting space. There is no way to escape this Niagara of sound.

Go-go audiograms

Recently I organized a go-go party with about 40 of my students

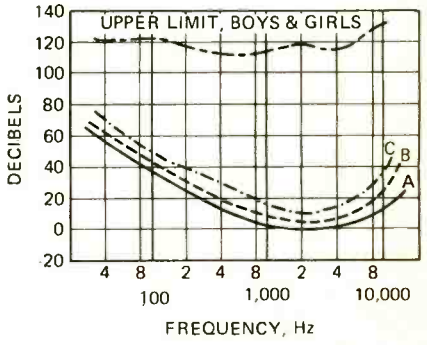


FIG. 2—HEARING LOSS after three hours of a go-go music. Line A is the *mean* audiogram for both boys and girls *before* the party. Line B shows the hearing loss for girls; Line C shows the hearing loss for boys.

under controlled conditions. An audiogram for each was made before the party, and the music was carefully se-

(continued on page 89)

R-E's Service Clinic

The "funny button"

Automatic picture control at the push of a button

by JACK DARR
SERVICE EDITOR

THE BOYS IN THE BACK ROOM HAVE come up with another "new" one for us. Nothing really new, of course, just a different application of things we've been using all along. This is showing up in more and more sets all the time, so I thought it would be a good idea to kick it around for a while. Mostly an advertising gimmick, it can be very helpful (especially with *some* of our customers!)

This is the *Magic Button.* One company's engineers call it the *Funny-Button!* Motorola calls it INSTA-MATIC, Zenith calls it CHROMATIC TUNING, and others have their own semantic tricks with it. The idea of the whole thing is to let the customer correct for accidental misadjustment of controls (kids, brothers-in-law, etc.) by simply pushing one button. The picture then comes in perfectly adjusted.

Basically, it's simple. The funny-button is just a multiple-contact switch. When it is pushed, several of the regular controls are completely disconnected, and preset controls switched into their place. The number of these varies. In some sets, this is actually nothing but the aft switch. In others, such as the Motorola TS-929 Quasar II chassis, the brightness, contrast, hue and color controls, as well as the aft, are switched.

In INSTA-MATIC position, the front panel controls are disconnected. The preset controls are mounted on the top rail of the chassis, accessible from the outside in most models. When you install one of these sets, you tune it up for the best picture, color, etc. Then, switch to INSTA-MATIC, and adjust the preset controls to get exactly the same picture quality. Check with the owner, so the picture is set to what he or she likes best.

In the Motorola chassis just mentioned, beside the controls already mentioned, an AUTOMATIC TINT CONTROL is switched in. It changes the demodulation angle, making it just a little wider than the regular 90°, to give "improved flesh tones." The red video level is slightly raised to give the picture a "warmer" tone. The acc circuit is also in on INSTA-MATIC, to help hold the color-level constant. This is a great help during commercials, etc., old movies and such things where color levels may change drastically.

In the new Zenith D-line chassis, the funny-button is called CHROMATIC TUNING. It switches in presets for color, tint, contrast, brightness, and aft. Here, the preset controls are in the form of duals, each one mounted behind the regular front-panel control for the same function. To set these up, adjust as before, for the best picture. Then pull the knobs off, and push the CHROMATIC TUNING button. The presets are adjusted with a special wrench; one of these comes with each set, in the instruction manual. (It has been recommended that the installing technician quietly snitch this wrench out of the book, to keep the customer out of them!)

The CHROMATIC TUNING switch is a square pushbutton on the front panel. In some it's a push-on, push-off switch, in others a push-pull type. In both of them, a pilot light inside the pushbutton glows a bright orange, to indicate that the set is in automatic tune position. (This could save several nuisance calls on new sets. If the owner complains that none of the front panel controls work, ask him to check and see if this pushbutton switch is lit.)

RCA uses a double-button system. Since these are side by side, anyone with a fat finger can push both at the same time, and get "one-button" control. One is the aft, and the other is the acm for AUTOMATIC COLOR MONITOR. They call the whole thing ACCU-MATIC.

Here again, the automatic controls are set up to make a good color picture, comparing it with one tuned in with the acm off. Two controls are used, for color and tint. Unlike the "full-disconnect" circuit used in others, the RCA circuit still leaves a little range of adjustment for both color

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

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

and tint, for customer preference. So if you notice that the color and tint controls do not seem to have enough range, check to be sure that the acm button is *not* pushed in. It also produces a slight shift in demodulator angle to enhance the red in flesh tones.

These things could be of quite a bit of help to us, especially in making preliminary diagnoses. If there is a picture, with any kind of trouble symptoms, just push the *Funny-Button* and see if this straightens things up. If you still have the same troubles, *then* you go dig in the chassis to find out what's going on.

There is also the possibility of *both* normal controls and funny-button being incorrectly adjusted. **R-E**

reader questions

LOW VOLUME

I've got very low volume in this GE T2NA stereo amplifier. The dc supply voltage is normal, about +15 volts, on the collectors, but I can't get any dc voltage at all at the common emitters of the output transistor pair.

Also, I broke one of the bias regulator diodes, and I can't find a number for it as a substitute. Original is EA-1405.—J.K. Wellsville, Ohio

It sounds very much as if your two "top" transistors in the output pair are both *open* ('top' transistor is the one connected to the dc supply). If this happens, they won't conduct, and you'd have no dc voltage at the midpoint of the circuit as you should. Take them out and check; you'll probably find the emitter-collector junction open. Replace both of them at once, in each pair, so that they'll be matched.

This bias diode should be of the same material as the output transistors; silicon, here. An RCA SK-3100 should work.

THE BACKWARD SCREENS

I've got no raster on this Zenith 20Y1C50. However, the high voltage reads 25 kV, and the pix tube checks good. All of the dc voltages on the pix tube are normal except the screens. They read only +300 volts. The weird part is when I turn the screen controls; turning them clockwise, the screen voltages go down!***—V.D.R. Helena, Mont.***

You've got a problem in the B++ or boost-boost rectifier circuit. In this same chassis, I have found the 68K series resistor practically open, and the B++ rectifier open at the

(continued on page 78)

R-E's Substitution Guide for replacement transistors

compiled by ROBERT & ELIZABETH SCOTT

This Universal Transistor Substitution Guide is being compiled to help those experimenters, hobbyists and service technicians who are hard-pressed to find the transistor needed to complete a project or a servicing job. It lists the interchangeability between JEDEC and EIA (standard) type numbers and the universal replacement-type solid-state devices made by eight of the leading semiconductor manufacturers. This month we list replacements for about 200 standard transistor types in numerical order, beginning with the 2N23. In following months, we'll bring you more in an easy-to-use form that you can clip and file in a notebook where it will always be handy. 2N numbers not listed are devices for which no replacements are available.

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

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

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

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

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

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

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

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

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

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

	ARCH	G-E	IR	MAL	MOT	RCA	SPR	SYL
2N23	NA	GE-52	TR-05	PTC 102	NA	SK 3004	RT-120	ECG 102
2N24	NA	GE-1	TR-14	PTC 109	NA	SK 3004	RT-120	ECG 102
2N25	NA	GE-52	TR-05	PTC 102	NA	SK 3004	RT-120	ECG 102
2N26	NA	GE-1	TR-14	PTC 102	NA	SK 3004	RT-120	ECG 102
2N27	RS276-2004	GE-1	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100
2N28	RS276-2002	NA	TR-08	NA	HEP-641	SK 3011	RT-119	ECG 101
2N29	RS276-2002	NA	TR-08	NA	HEP-641	SK 3011	RT-119	ECG 101
2N30	NA	GE-51	TR-05	PTC 107	NA	SK 3005	RT-118	ECG 100
2N31	NA	GE-51	TR-05	PTC 107	NA	SK 3005	RT-118	ECG 100
2N32	RS276-2004	GE-1	TR-14	PTC 109	HEP-253	SK 3004	RT-120	ECG 102
2N33	NA	GE-51	IRTR-89	PTC 107	HEP-2	SK 3006	NA	ECG 126
2N34	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-121	ECG 102A
2N34A	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	NA	RT-121	ECG 102A
2N35	RS276-2001	GE-8	IRTR-85	PTC 108	HEP-641	SK 3010	RT-122	ECG 103A
2N36	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3003	RT-121	ECG 102A
2N37	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3003	RT-121	ECG 102A
2N38	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3003	RT-121	ECG 102A
2N38A	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3003	RT-121	ECG 102A
2N39	RS276-2005	GE-2	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N40	RS276-2005	GE-2	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N41	RS276-2005	GE-2	TR-05	PTC 102	HEP-254	SK 3003	RT-120	ECG 102
2N42	RS276-2005	GE-2	TR-05	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N43	RS276-2005	GE-2	IRTR-85	PTC 134	HEP-254	SK 3003	RT-120	ECG 102
2N43A	RS276-2005	GE-2	IRTR-85	PTC 134	HEP-254	SK 3004	RT-120	ECG 102
2N44	RS276-2004	GE-2	IRTR-85	PTC 134	HEP-253	SK 3004	RT-120	ECG 102
2N44A	RS276-2004	GE-2	IRTR-85	PTC 134	HEP-253	SK 3004	RT-120	ECG 102
2N45	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	NA	RT-121	ECG 102A
2N46	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-120	ECG 102
2N47	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N48	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3004	RT-120	ECG 102
2N49	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N50	RS276-2005	GE-52	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N51	RS276-2005	GE-52	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N52	RS276-2004	GE-52	IRTR-85	PTC 109	HEP-253	SK 3004	RT-120	ECG 102
2N53	NA	GE-52	IRTR-85	PTC 102	NA	SK 3004	RT-120	ECG 102
2N54	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N55	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3004	RT-120	ECG 102
2N56	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3004	RT-120	ECG 102
2N57	NA	NA	TR-27	NA	NA	NA	NA	NA
2N58	NA	NA	IRTR-85	NA	NA	NA	NA	NA
2N59	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3003	RT-120	ECG 102
2N60	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3003	RT-120	ECG 102
2N61	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3003	RT-120	ECG 102
2N62	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-121	ECG 102A
2N63	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	SK 3003	RT-121	ECG 102A
2N64	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-121	ECG 102A
2N65	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-120	ECG 102
2N66	NA	NA	TR-27	NA	NA	NA	NA	NA
2N67	NA	NA	TR-27	NA	NA	NA	NA	NA
2N68	NA	NA	TR-27	NA	NA	NA	NA	NA
2N71	NA	GE-52	IRTR-85	PTC 102	NA	SK 3004	RT-120	ECG 102
2N72	NA	GE-1	IRTR-89	PTC 109	NA	SK 3006	NA	ECG 126
2N73	NA	GE-52	IRTR-85	PTC 102	NA	SK 3004	RT-120	ECG 102
2N74	NA	GE-52	IRTR-85	PTC 102	NA	SK 3004	RT-120	ECG 102
2N75	RS276-2004	GE-51	IRTR-89	PTC 107	HEP-250	SK 3006	NA	ECG 126
2N76	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-120	ECG 102
2N77	RS276-2005	GE-2	IRTR-85	PTC 107	HEP-254	SK 3004	NA	ECG 102
2N78	RS276-2001	GE-6	IRTR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N79	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N80	RS276-2005	GE-2	IRTR-85	PTC 107	HEP-254	SK 3004	RT-120	ECG 102
2N81	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	SK 3003	RT-120	ECG 102
2N82	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-120	ECG 102
2N83	RS276-2006	GE-1	IRTR-85	NA	HEP-232	SK 3003	RT-118	ECG 100
2N84	NA	NA	IRTR-85	NA	NA	NA	NA	NA
2N85	NA	NA	IRTR-89	NA	HEP-2	SK 3006	NA	ECG 126
2N86	NA	NA	IRTR-89	NA	HEP-2	SK 3006	NA	ECG 126
2N87	NA	NA	IRTR-89	NA	HEP-2	SK 3006	NA	ECG 126
2N88	NA	NA	IRTR-89	NA	HEP-2	SK 3006	NA	ECG 126
2N89	NA	NA	IRTR-89	NA	HEP-2	SK 3006	NA	ECG 126
2N90	NA	NA	IRTR-89	NA	HEP-2	SK 3006	NA	ECG 126
2N94	RS276-2002	GE-6	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N96	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3004	RT-120	ECG 102
2N97	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N98	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N99	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101

Note: NA = Not Available

	ARCH	G-E	IR	MAL	MOT	RCA	SPR	SYL
2N100	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N101	NA	NA	IRTR-84	NA	NA	NA	NA	NA
2N103	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N104	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	SK 3004	RT-121	ECG 102A
2N105	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-121	ECG 102A
2N106	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3003	RT-121	ECG 102A
2N107	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-250	SK 3003	RT-121	ECG 102A
2N108	RS276-2005	GE-2	IRTR-85	PTC 107	HEP-254	SK 3003	RT-120	ECG 102
2N109	RS276-2003	GE-2	IRTR-85	PTC 109	HEP-632	SK 3004	RT-121	ECG 102A
2N111	RS276-2007	GE-1	IRTR-85	PTC 107	HEP-631	SK 3005	RT-118	ECG 100
2N112	RS276-2005	GE-1	IRTR-85	PTC 107	HEP-638	SK 3005	RT-118	ECG 122
2N113	RS276-2005	GE-1	IRTR-85	PTC 107	HEP-638	SK 3004	RT-118	ECG 100
2N114	NA	GE-1	IRTR-85	PTC 107	HEP-2	SK 3005	RT-118	ECG 100
2N115	NA	NA	TR-01	NA	NA	NA	NA	NA
2N117	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N118	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N119	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N120	RS276-2009	GE-61	TR-21	PTC 121	HEP-53	SK 3020	RT-100	ECG 123
2N122	NA	NA	TR-23	NA	NA	NA	NA	NA
2N123	NA	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N124	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N125	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N126	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N127	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3004	RT-119	ECG 101
2N128	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3008	NA	ECG 126
2N129	RS276-2003	GE-9	IRTR-88	PTC 107	HEP-3	SK 3008	NA	ECG 129
2N130	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3003	RT-120	ECG 102
2N131	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3003	RT-120	ECG 102
2N132	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3003	RT-120	ECG 102
2N133	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3003	RT-120	ECG 102
2N134	NA	NA	IRTR-85	NA	HEP-631	NA	NA	NA
2N135	RS276-2007	GE-1	IRTR-85	PTC 107	HEP-631	SK 3005	RT-118	ECG 100
2N136	RS276-2007	GE-1	IRTR-85	PTC 107	HEP-631	SK 3005	RT-118	ECG 100
2N137	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3005	RT-118	ECG 100
2N138	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3003	RT-121	ECG 102A
2N139	RS276-2003	GE-1	IRTR-85	PTC 107	HEP-3	SK 3005	NA	ECG 126
2N140	RS276-2003	GE-1	IRTR-85	PTC 107	HEP-635	SK 3005	NA	ECG 126
2N141	NA	NA	TR-01	NA	NA	NA	NA	NA
2N143	NA	NA	TR-01	NA	NA	NA	NA	NA
2N145	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N146	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N147	RS276-2001	GE-10	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N148	RS276-2001	GE-7	TR-21	PTC 108	HEP-641	SK 3020	RT-119	ECG 123
2N149	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3020	RT-122	ECG 103A
2N150	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N151	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N155	RS276-2006	GE-3	TR-01	PTC 114	HEP-230	SK 3009	RT-127	ECG 121
2N156	RS276-2006	GE-3	TR-01	PTC 105	HEP-230	SK 3009	RT-124	ECG 104
2N157	RS276-2006	GE-3	TR-01	PTC 122	HEP-230/232	SK 3009	RT-127	ECG 121
2N158	NA	GE-3	TR-01	PTC 105	NA	SK 3009	RT-127	ECG 121
2N159	NA	GE-52	IRTR-85	PTC 102	NA	SK 3004	RT-120	ECG 102
2N160	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N161	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N162	RS276-2009	GE-20	IRTR-95	PTC 132	HEP-53	SK 3039	RT-108	ECG 107
2N163	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123

	ARCH	G-E	IR	MAL	MOT	RCA	SPR	SYL
2N164	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N165	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N166	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N167	RS276-2002	GE-6	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N168	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N169	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N170	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N171	NA	GE-7	TR-08	PTC 108	NA	NA	NA	NA
2N172	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N173	NA	GE-4	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105
2N174	NA	GE-4	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105
2N175	RS276-2005	GE-2	IRTR-85	PTC 107	HEP-254	SK 3003	RT-121	ECG 102A
2N176	RS276-2006	GE-3	TR-01	PTC 114	HEP-623	SK 3009	RT-124	ECG 104
2N178	RS276-2006	GE-3	TR-01	PTC 122	HEP-230/232	SK 3009	RT-124	ECG 104
2N179	RS276-2006	GE-3	TR-01	PTC 114	HEP-230	SK 3009	RT-124	ECG 104
2N180	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-121	ECG 102A
2N181	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A
2N182	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N183	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N184	NA	GE-6	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N185	RS276-2003	GE-2	IRTR-85	PTC 109	HEP-632	SK 3003	RT-121	ECG 102A
2N186	RS276-2007	GE-2	IRTR-85	PTC 109	HEP-631	SK 3004	RT-121	ECG 102A
2N187	RS276-2007	GE-2	IRTR-85	PTC 109	HEP-631	SK 3004	RT-121	ECG 102A
2N188	RS276-2003	GE-2	IRTR-85	PTC 109	HEP-632	SK 3004	RT-120	ECG 102
2N189	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-631	SK 3004	RT-120	ECG 102
2N190	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-120	ECG 102
2N191	RS276-2003	GE-2	IRTR-85	PTC 135	HEP-632	SK 3004	RT-120	ECG 102
2N192	RS276-2003	GE-2	IRTR-85	PTC 107	HEP-632	SK 3004	RT-120	ECG 102
2N193	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N194	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N195	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-120	ECG 102
2N195	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-120	ECG 102
2N197	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-120	ECG 102
2N198	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-120	ECG 102
2N199	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-120	ECG 102
2N200	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	SK 3004	RT-120	ECG 102
2N204	RS276-2001	GE-2	IRTR-85	PTC 109	HEP-641	SK 3004	RT-120	ECG 102
2N205	RS276-2001	GE-2	IRTR-85	PTC 109	HEP-641	SK 3004	RT-120	ECG 102
2N206	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-120	ECG 102
2N207	RS276-2003	GE-2	IRTR-85	PTC 107	HEP-632	SK 3003	RT-120	ECG 102
2N211	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N212	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N213	RS276-2002	GE-8	TR-08	PTC 134	HEP-641	SK 3010	RT-122	ECG 103A
2N214	RS276-2002	GE-8	TR-08	PTC 134	HEP-641	SK 3010	RT-122	ECG 103A
2N215	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-121	ECG 102A
2N216	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N217	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-636	SK 3004	RT-121	ECG 102A
2N218	RS276-2003	GE-1	IRTR-89	PTC 107	HEP-3	SK 3005	NA	ECG 160
2N219	RS276-2005	GE-1	IRTR-89	PTC 107	HEP-254	SK 3005	NA	ECG 160
2N220	RS276-2005	GE-2	IRTR-85	PTC 107	HEP-254	SK 3004	RT-121	ECG 102A
2N221	NA	NA	NA	NA	NA	NA	NA	NA
2N222	RS276-2004	GE-2	IRTR-85	PTC 107	HEP-253	SK 3004	RT-121	ECG 102A
2N223	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3003	RT-121	ECG 102A
2N224	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A
2N225	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A

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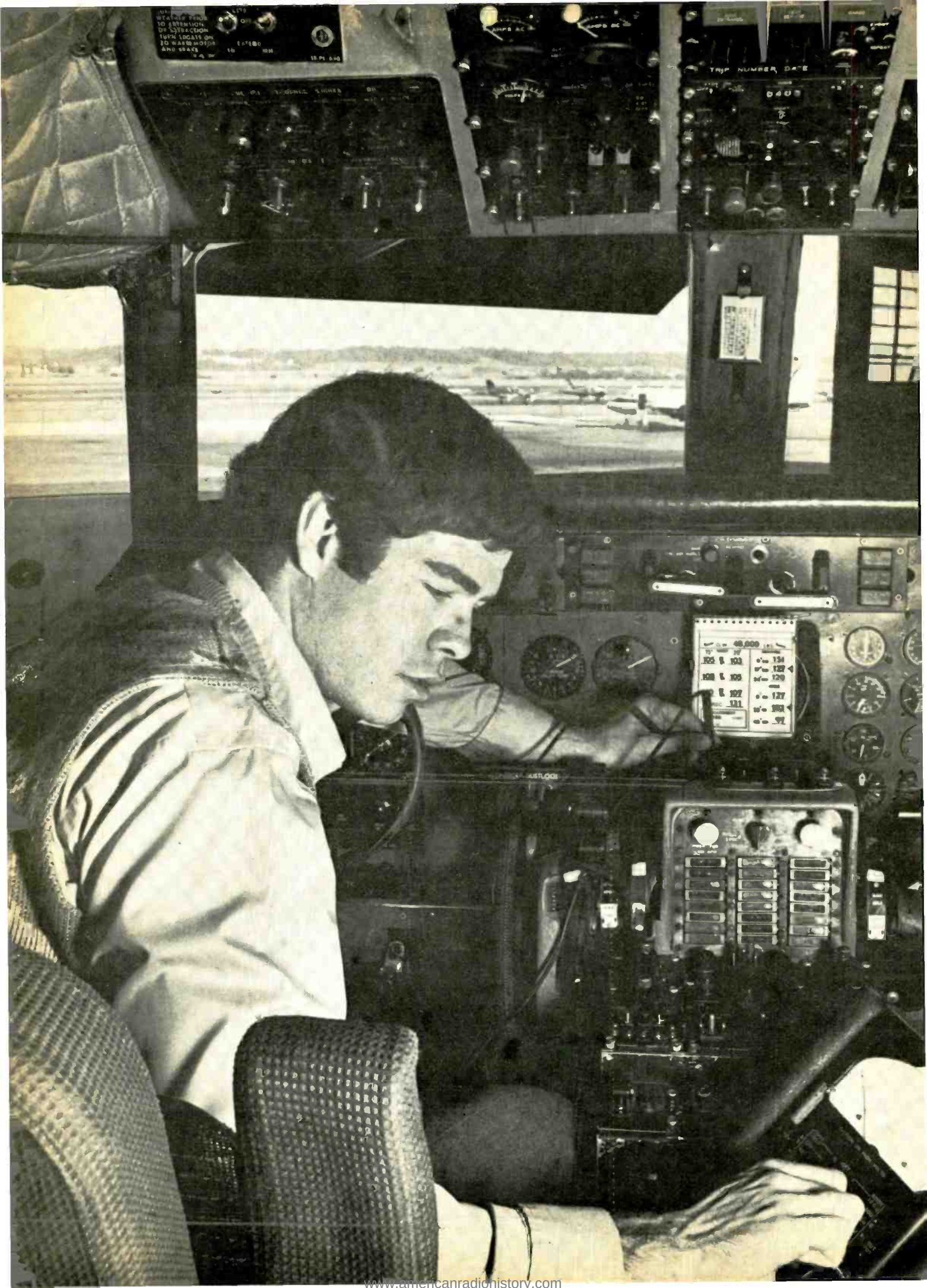

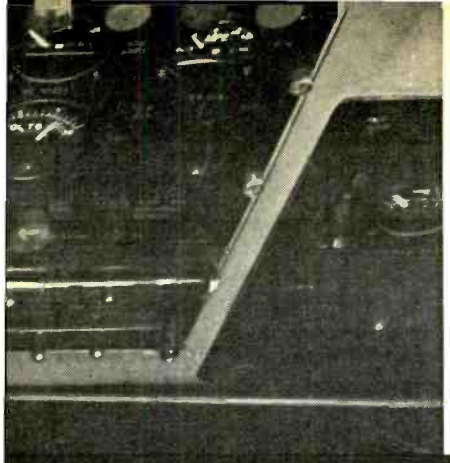

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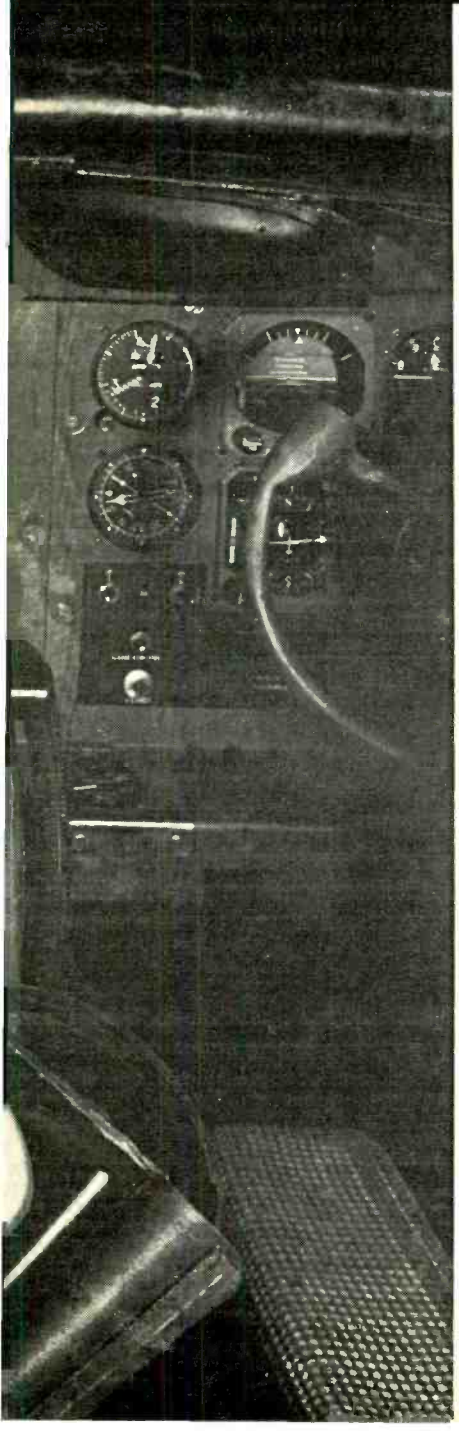

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same time. You are obviously getting B+ (+350 V) on the screens, through some kind of shunt path. This is too low voltage for the screens, and the pix tube is simply cut off.

Replace the B++ rectifier (RCA SK-3109) and the 68K resistor (use a 2-watt for luck) and I think you'll get results. If your *boost* voltage is normal, and B++ isn't, there are only two parts left!

ACC PROBLEM

I've got a fair picture on this Admiral 2H5 transistor TV chassis, but I get no snow at all with the antenna off. Weak-signal response very bad, and this set works on an antenna in a low signal area. My agc controls don't respond as they should. Where should I start?—R.G. Aurora, Colo.

Run a step-by-step check on the *action* of the whole agc circuit. Start by verifying the keying pulse and video signals on the i.f. agc keyer. Check the dc voltages on base and emitter; then take the antenna off and see if they *change;* they should!

This is a three-stage agc circuit; i.f. agc keyer, rf agc, and an rf agc delay transistor. The dc voltages on *all*

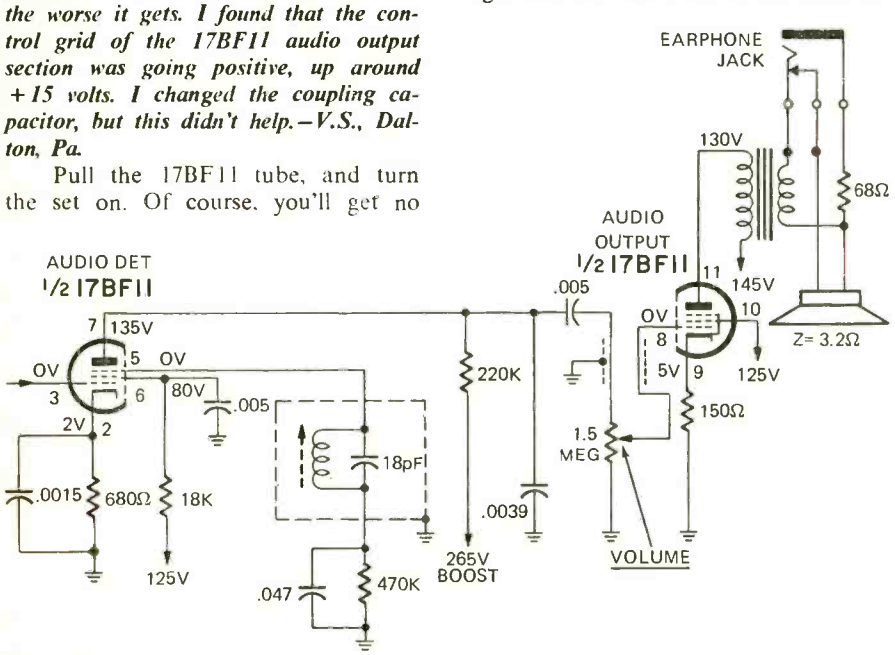
of these should change when the signal is taken off or put on. If you find one that doesn't, there you are. (Watch out for bad solder joints! I found one of these with the same symptoms, and the emitter lead of the i.f. agc transistor was loose.)

BAD SOUND

I've got a GE portable, with a funny sound problem. The longer it's on, the worse it gets. I found that the control grid of the 17BF11 audio output section was going positive, up around +15 volts. I changed the coupling capacitor, but this didn't help.—V.S., Dalton, Pa.

Pull the 17BF11 tube, and turn the set on. Of course, you'll get no raster since the heater string will be open. However, you'll have B+ on the plate (pin-7) of the audio detector. Take a reading at the grid terminal of the output section, pin 8. This should read zero. If there's any leakage across the socket, etc., it will show up here.

If this test shows no leakage, replace the 17BF11 tube. The chances are that it has developed internal leakage, like the old 50B5's, etc used to.



The grid slowly went more positive, and the sound went bad, just as you say.

AM GOOD, FM DEAD

The AM works fine on this Zenith 9ZT15 radio, but I can't get anything on FM. It's completely dead. Where would you look for this?—E.B., Adams, Mass.

If you can get an AM signal through, the first two i.f. transistors and i.f. transformers are OK. They work on both AM and FM. However, there is a 3rd i.f. transistor which is used only on FM. Check this one. It's probably open or shorted. For a definite check, feed a 10.7 MHz AM signal into the i.f. input. If this won't go through, that's it.

If it does, the trouble is in the FM oscillator or rf transistor, or the FM tuner; loose solder joint, coil, etc.

BLUE BOWING OF HORIZONTAL LINES

I've replaced the flyback in a Magnavox T-931 color chassis. Now, everything else is OK, but I have a severe bowing of the blue horizontal lines. Can't converge them at all. I've tried everything I can think of.—G.O. Towner, N.D.

Go back through the convergence circuitry and check the pulses from the flyback. Be sure that they are of the right amplitude and polarity! I have a suspicion that you'll find some leads reversed somewhere, causing a pulse of the wrong polarity to be fed to the blue circuitry. This would throw the blue out of convergence instead of pulling it in. Diode X8 will probably get warm, too. (Field feedback from reader confirmed this. The leads to terminals 1 and 2 on the replacement flyback were reversed. Swapping these cured the trouble.

THERMAL RUNAWAY

I've got a Coronado RA60 radio on the bench. It's dead, output transistors very hot. Replaced them with RCA SK-3004 and it worked. After about an hour—the transistors got hot and it went dead. I cooled them off, and it started up, and ran for another hour. Voltages look OK.—S.G. Lakewood, Ohio

You seem to be getting a fine example of thermal runaway. This is probably due to insufficient heat-sinking of the output transistors. I've had the same trouble. With the SK-3004 transistors, you can make a "clamp" type heat-sink and tie them to the chassis, on the biggest piece of solid metal. This ought to keep them cool enough.

Don't try this with transistors that

have their collectors connected to the case, unless you insulate the cases very well. Sheet mica, and silicone transistor-grease will help to raise the heat-transfer.

NO FOCUS

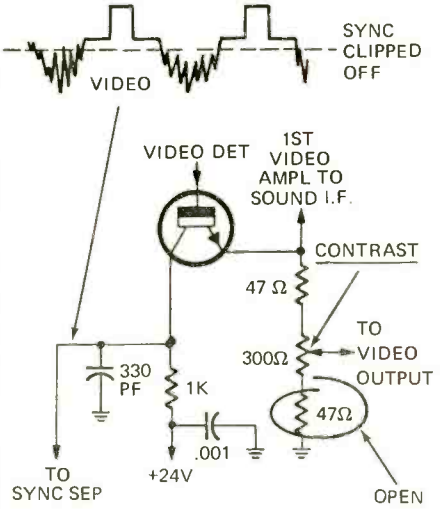
I've got no focus voltage at all on a Zenith 25LC30. The focus-rectifier socket has burnt up. This is riveted to the flyback cage. Can I replace this with a solid-state focus rectifier?—R.M., Mena, Ark.

You sure can. An RCA SK-3066 can be soldered in place inside the flyback cage, with little trouble. Connect the cathode to the 2.7-megohm resistor going to the focus control, and the anode to the grey wire from the flyback; this went to pin 9 of the 1V2 tube. Mount this on a small terminal strip soldered to the frame of the flyback. You can put a dab of high-voltage putty around the terminal for luck, if you want to.

NO SYNC

In a Zenith 22ABS5 solid-state black and white TV, there is no sync at all. The picture can be stopped by very delicate adjustment of the holds. Video looks normal in amplitude. A scope shows the signal at the sync input with the sync clipped off like it had been shaved with a razor. Transistor good, by substitution. Collector voltage is high. R.Q., Ft. Smith, Ark.

Check your contrast control. If it has no effect at all, the circuit is probably open. This upsets the loading on the emitter, and lets the transistor clip the sync, though the video goes through. I found the same thing in one of these, with a weird cause; the lower 47-ohm resistor was open, and it looked as if the wire lead to the resistor had *fatigued* and broken. Of course, I thought someone had accidentally clipped it, but examination with a glass showed it wasn't. This upsets video to both sync and agc. **R-E**



new products

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

8-TRACK STEREO RECORDER-PLAYER, *Model 8055,* has preamplified deck with a counter that displays elapsed time in minutes and seconds.

Cartridge unit is capable of moving the tape at 2-½ times actual speed in the fast-forward mode. Cueing system assures that the tape is always at the beginning when recording. Automatic eject

prevents accidental erasure of previously recorded material.

Other features include a pause lock, illuminated dual VU meters and a switchable automatic record level control. Signal to noise ratio is better than 50 dB and frequency response is 40 to 15,000 Hz. $159.95.—**3M Company,** P.O. Box 33600, St. Paul, Minn. 55133.

Circle 31 on reader service card

AUTOMATIC TURNTABLE, *Model 625,* features all-pushbutton operation; precision cueing for playing any desired band on a record during single-play operation; balanced tone-arm and a built-in stylus-force dial, accurate to within 0.1 gram, from 0 to 6.5 grams, and effective

antiskate; a balanced four-pole asynchronous motor, and a heavy pressure-formed turntable platter that reduce annoying wow and flutter.

Conventional 4-speed operation is offered and in automatic mode, the model will accommodate a stack of up to ten records, 7″, 10″ or 12″. Regardless of the height of the stack, speed accuracy is better than 1% from first to last record in the stack. Interchangeable insert for the tone-arm accepts all standard phono cartridges.—**Benjamin Electronic Sound Corp.,** 40 Smith Street, Farmingdale, N.Y. 11735.

Circle 32 on reader service card

4-CHANNEL DECODER KIT *AD-2022.* Unit decodes all matrix encoded records now on the market and also enhances recorded stereo material and stereo FM broadcasts by reproducing the out-of-phase ambience common to 2-channel programming. This hidden presence is fed to two rear speakers resulting in a 4-

channel effect.

All that's needed to convert a stereo system to 4-channel using this unit is an existing stereo amplifier with tape-monitor jacks, any additional stereo amplifier and two additional rear speakers.—**Heath Company** Benton Harbor, Mich. 49022.

Circle 100 on reader service card

AUDIO CABLE, *Model 44-359,* is 12-feet long with a 3-conductor cable, standard 3-way phone plug to standard 3-way in-line jack.

This model was designed for use as a

headphone and stereo speaker extension cable, for tape recorders, receivers or 8-track and cassette tape players. $3.08.—**Weltron Company,** 305 S. Dillard Street, Durham, N.C. 27702.

Circle 33 on reader service card

AUDIO FREQUENCY METER, *Model 1200A,* incorporates the latest LSI integrated circuit chips and a 4-digit solid-state LED display.

Frequency can be read directly up to 1.999 MHz and indirectly to typically 3.5 MHz over three ranges. The lowest range extends the sample period to ten seconds and provides 0.1-Hz resolution necessary for calibrating electronic musical instruments.

The high input impedance and sensitivity minimize loading and allow measurements in low-level circuitry. Despite the 20-mV sensitivity, the model can withstand a 200 Vac and 400 Vdc overload indefinitely. The monolithic input circuitry in conjunction with the threshold control eliminate false triggering from noise and high harmonic levels. The built-in hysteresis is proportional to the input signal level. $245.00.—**Linear Digital Systems,** Box 954, Glenwood Springs, Colo. 81601.

Circle 34 on reader service card

MUSICAL INSTRUMENT TUNER, *Model 747,* tunes any electric, acoustic or bass 4- and 6-string guitars.

Electronic tuning-fork device provides a reference tone signal at the precise

frequency of each string. When tuning the guitar, the operator can hear the accurate reference tone and the guitar string. There is also an audio indication

of tuning accuracy.

Accuracy of tuning is within 0.01% or approximately ¼ Hz. $129.95.—**Electro-Tunes, Inc.,** 2116 N. Scottsdale Road, Scottsdale, Ariz. 85257.

Circle 35 on reader service card

DESOLDERING IRON, *Model 510,* offers three features—safety power indicating light, 3-way on-idle-off switch and bracket to insure alignment and prevent

damage.

It operates at 40W and idles at 20W for longer tip life. Located inside the handle, the light indicates operation at both heats with different intensity for each.

Other features include six tip sizes for every job, cool, unbreakable poly-carbonate handle and flexible, burn resistant neoprene cord. 8½" long, 3½ oz. $16.00.—**Enterprise Development Corp.**, 5127 East 65th Street, Indianapolis, Ind. 46220.

Circle 36 on reader service card

POWER SUPPLY KITS. Unregulated kits range from 5 to 48 Vdc at 1, 5 and 10 amps. Regulated kits range from 5 to ±15 Vdc at 2, 5 and 10 amps with

0.15% line and 0.2% load regulation. Highly regulated kits range from 5 to ±18 Vdc at 0.25, 0.5, 1, 5 and 10 amps with 0.01% + 1mV load regulation. Prices start at $13.—**Tecnetics Inc.**, Boulder Industrial Park, Boulder, Colo. 80302.

Circle 37 on reader service card

COLOR BAR GENERATOR, *WR-508B,* provides test signals to adjust convergence, color-phasing, purity and linearity of color TV receivers. AC or battery operation. Crystal-controlled solid-state circuitry provides stable patterns with no flicker. Three pattern adjustment controls on the rear panel.

Ten color bars are provided simultaneously in the color bar pattern spaced at 30-degree intervals. This pattern is used to check color phase and matrix circuits and adjust the automatic frequency phase control. Narrow brightness pulses are added to the edges of color bar to aid in checking the color fit or registration of the brightness and color signals. $85.00.—**RCA, Electronic Components,** Harrison, N.J. 07029. **R-E**

Circle 38 on reader service card

new lit

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

CARTRIDGE STYLUS GUIDEBOOK, *"A Visit To The Small World Of A Stylus."* The stylus in a hi-fi stereo cartridge is the source of sound for any high fidelity stereo system. The catalog tells about the function, care and replacement of this vital component.

The stylus is actually a miniaturized electromagnetic convertor that must carry the full burden of translating ultracomplex stereo record grooves into usable electric impulses without adding or subtracting from what is on the recording.—**Shure Brothers, Inc.** 222 Hartrey Avenue, Evanston, Ill. 60204.

Circle 39 on reader service card

REPLACEMENT PHONO CARTRIDGE CATALOG, *No. 72C* designed for quick access to all the information a technician requires.

Sections include alphanumeric index, numerical listing of Electro-Voice Cartridges, alphabetical listing of cartridges by brand names and listing of set manufacturers' model numbers cross-referenced to Electro-Voice Cartridge replacement. Also included is full line of replacement record changer and phono motors, centerposts, tone arms and 45-rpm adaptors for record changer use. Complete line of stereo headphones and audio accessories is also listed.—**E-V/Game, Inc.,** 80 Commercial St., P.O. Box 711, Freeport, N.Y. 11520.

Circle 40 on reader service card

TEST JIG ACCESSORIES. 12-page brochure illustrates the various cables and adapters used with RCA Industry Compatible Test Jig. Color TV sets of 41 manufacturers can be serviced with an RCA Color TV Test Jig.

Pictured in the brochure are extension cables and Universal adapters, all identified by their appropriate stock numbers. Deflection yoke adapters, convergence adapters and automatic degaussing adapters are also listed.

The brochure has a cross-reference chart listing all cables included in the program by description, numerical order.—**RCA Parts and Accessories,** 2000 Clements Bridge Rd., Deptford, N.J. 08096. **R-E**

Circle 41 on reader service card

Circle 73 on reader service card

Circle 74 on reader service card

HARD ROCK AND HEARING
(continued from page 68)

lected in order to have the same instruments in all the records. The music was played at levels varying from 100 to 120 dB. By carefully positioning the loudspeakers, the same level was obtained throughout the room.

After three hours of dancing (no strong drinks were allowed), another audiogram was made for each student. The average results of both measurements are shown in Fig. 2.

Boys showed an average hearing loss of about 10 dB, while girls showed a loss of only about 6 dB. Of course, these preliminary results are in no way conclusive. But they are thought-provoking. I was unable to make audiograms of the students for the next day in order to measure hearing recovery, if any was present.

Although we know very little about the possible dangers of music played at high levels, we may summarize our present knowledge as follows:

Sound levels below some 80 dB may be considered absolutely harmless, unless exposure to them is very long.

The hearing of most people begins to be impaired at 100 dB, and in some cases probably, at 90 dB. Music at these levels may prove dangerous for the inner ear.

People under 25 are more likely to suffer from exposure to high sound levels than are middle-aged persons.

Music played at high levels will lift the hearing threshold of practically any keen-eared youth beginning at 2,000 to 3,000 Hz where the ear is most sensitive, but we do not know if this impairment is permanent.

It is known that musicians in military bands become hard of hearing at an early age. That probably will be the case for people who play electronic instruments at high volume.

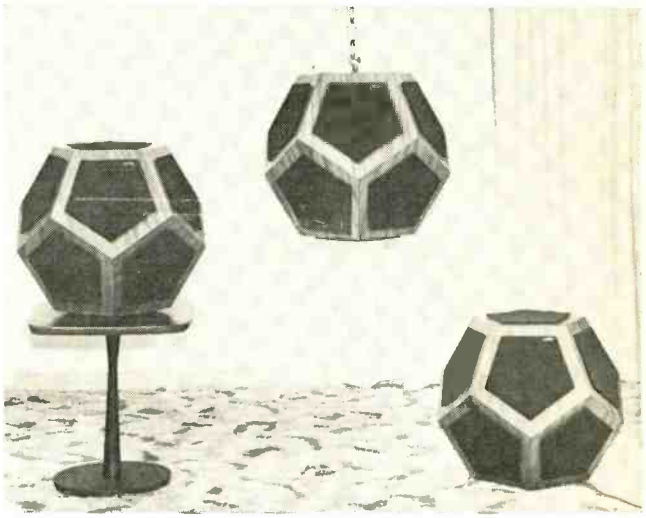
Using earphones for listening to music or practicing with an electronic instrument is equally dangerous if high volume is used. I have found youngsters sometimes introduce 120 dB into their ears with earphones.

To lessen dangers to your hearing, never practice with an electronic guitar or any other high-level instrument in a small room with closed doors or windows. It's preferable to deal with angry neighbors than risk a hearing loss. If you play for long periods for profit or fun, use ear plugs to reduce the sensitivity of your ears. **R-E**

(continued from page 50)

dispersion pattern, the systems are ideal for use in modern decorating schemes, but can also be effective in traditional decor.

Another multi-duty model for ceiling suspension, pedestal, or direct on-the-floor use comes from Carlu Manufacturing Co., Gardena, California. This 12-sided sphere



TWELVE-SIDED SPHERES are speaker systems by Carlu. Models are for ceiling suspension, pedestal or on-the-floor locations.

contains four 3½-inch tweeters, midrange, and a six-inch woofer, arranged for a 360-degree dispersion pattern. The system—called the Carlu Six—has a claimed frequency response of 40 to 20,000 Hz. Framework of the Carlu Six is of simulated or genuine walnut, and the design would be appropriate to virtually any decor. Prices are $79.95 for simulated walnut finish, and $99.95 for genuine walnut.

Electrophonic Corp. of America also has spherical speaker systems, some for ceiling suspension, some for pedestal mounting. There are 10 models, ranging from $64 to $126 per pair. They range in size from 11 to 13 inches in diameter. Five models use 6½-inch full-range speakers, the rest use two speakers, of various sizes. But more! Two models additionally function as hanging lamps. Two function as swag-lamp psychedelic speaker systems which, a brochure notes, "provide a thrilling and unusual effect, the multicolor light system in the lower half perfectly coordinated with the program material to illuminate and glow with the signal." And two models function as pedestal-sphere psychedelic light speaker systems, with light-to-music emanating from the top half of the spheres.

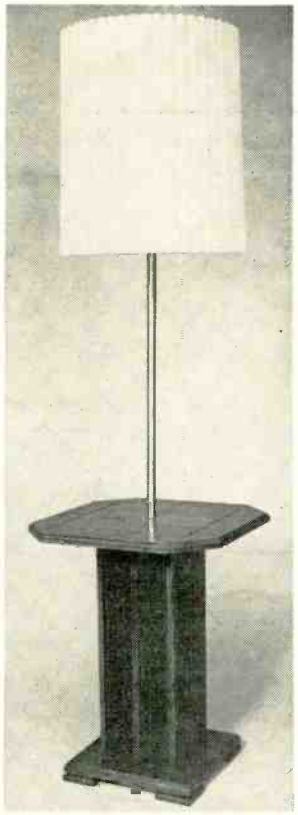
Lamp, clock, table, and novelty models

Two other companies have come on the scene with speaker products that represent a frank wooing of both factions in a 4-channel "expression of wills." They are Dee Gee Products, Chicago, and Richards Manufacturing Co. of Los Angeles. Dee Gee has perhaps the largest assemblage of off-beat speaker systems designed primarily for back-channel use in 4-channel applications. They are available as 12 models of stack tables, commode tables, cube tables, and end tables in modern, colonial and contemporary designs. They also come as: 36 models of floor lamps, four price ranges of table lamps, hanging lamps in nine styles; as four models of wall clocks; as a wall plaque in the shape of a barrel end; and—hold your breath—guitars, ukuleles, banjos and bongo drums. The table models use either wide-range four-inch or 5¼-inch single speakers, or a combination of 6½-inch woofer-midrange and 3-inch tweeter. The lamp

units and other models use either a 4-inch or 5¼-inch single speaker. All connecting cords are 18-feet long. The lamp models come in five furniture styles.

Richards Manufacturing has devised a line of lamps in table and hanging form incorporating wide-range speakers

MODEL 143 CLOCK AND MODEL 110 LAMP TABLE are but two of the approximately 36 different offbeat speaker systems by Dee Gee.



and with a 360-degree dispersion pattern. The devices will most certainly appeal to The Keeper of the Decor in that they are rather elegant, embracing 13 models (eight table, five hanging) covering modern, Mediterranean and traditional design concepts. The 8-inch speakers are mounted within the confines of the shade and are not visible to the casual eye. Their frequency response is said to be 30 to 19,000 Hz. They are priced between $69.95 and $89.95.

And that's it . . . We hope you'll find among the foregoing an approach that will win over The Little Woman, and satisfy your yen for quadraphonic sound. **R-E**

LIST OF MANUFACTURERS

Acoustic Fiber Sound Systems, 2831 N. Webster Ave., Indianapolis, Ind. 46219
Carlu Manufacturing Co., 18002 S. Hobart Blvd., Gardena, Calif. 90248
Dee Gee Products, 5415 N. Clark Street, Chicago, Ill. 60640
Electrophonic Corp. of America, 101-10 Foster Ave., Brooklyn, N.Y. 11236
EPI (Epicure Products, Inc.), 1 Charles Street, Newburyport, Mass. 01950
Equasound Co., 3330 S. Sepulveda Blvd., Los Angeles.
Fisher Radio Corp., 11-35 45th Road, Long Island City, N.Y. 11101
Hi-Vi Systems, 3817 South El Camino Real, San Clemente, Calif. 92672
JBL (James B. Lansing Sound, Inc.), 3249 Casitas Ave., Los Angeles, Calif. 90039
JVC America, Inc., 50-35 56th Road, Maspeth, N.Y.
Magitran Co., 311 East Park Street, Moonachie, N.J.
Richards Manufacturing Co., 4505 Bandini Blvd., Los Angeles, Calif. 90040
Sound West, Inc., 14201 Bessemer, Van Nuys, Calif.

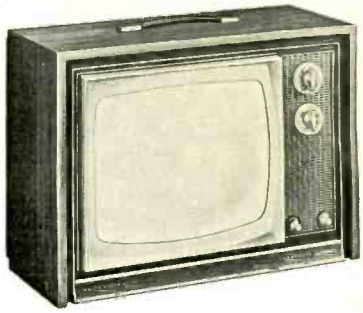
Save on Heathkit® Color TV...

Save $50.00*

Price reduced on 18 in. diagonal Color TV — was 399.95* NOW 349.95* (less cabinet)

Solid-state modular circuitry spells reliable operation and easy assembly. And as in all Heathkit TVs, the GR-269 comes with a full complement of alignment and self-service equipment — dot generator, convergence board, test meter and troubleshooting book. Factory assembled and aligned AFT module for perfect picture and sound at a touch. VHF tuner with MOSFET circuitry for high sensitivity, superior reception under marginal conditions. UHF tuner with hot-carrier diode design for low noise, high sensitivity. Both tuners factory assembled and aligned as is the 3-stage IF assembly. "Instant-on", switch-controlled degaussing, hi-fi sound output; 75 and 300 ohm antenna inputs; exclusive Heath Magna-Shield, standard. Picture tube warranted 2 full years. **Kit GR-269,** less cabinet, 100 lbs. **Assembled GRA-402-18,** walnut-grained vinyl clad wood cabinet shown, 16½" H x 25" W x 11" D, 27 lbs. . . . **29.95***

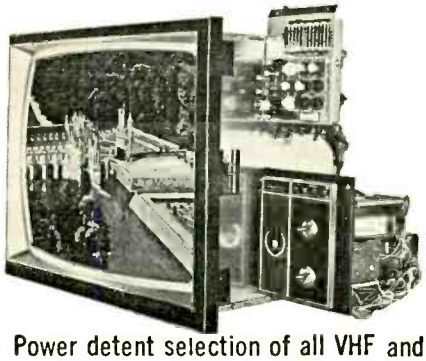
Save $50.00*



Price reduced on 14 in. diagonal Portable Color TV — was 349.95* NOW 299.95* (includes cabinet)

Set aside about a dozen evenings. Build-up 10 circuit boards, prepare the chassis, terminals and connectors. Install and solder the wiring harness and point-to-point conductors. Result: the Heathkit GR-169, with picture purity and brightness that puts it at the top of its class. And, thanks to built-in maintenance equipment, you keep it that way — with plug-in modular circuit boards, troubleshooting meter and data book to help you fix it right at home. A "big" little TV, the GR-169 has all the secondary controls found in our larger models — color, tint, contrast, horizontal and vertical hold, height, AGC, color killer, switch-controlled degaussing. Measures a compact 16" H x 20½" W x 16" D. Carry it from room to room or across the country — this is the portable that bounces back with console-like performance. **Kit GR-169,** 69 lbs., including cabinet.

and on 350 other electronic kits in the FREE '73 Heathkit Catalog



Our best 25 in. diagonal solid-state Color TV ...599.95* (less cabinet)

Power detent selection of all VHF and any 12 pre-selected UHF channels; exclusive angular tint control for consistently better flesh tones; voltage controlled varactor UHF tuner and MOSFET VHF tuner for unmatched sensitivity; black matrix tube, built-in dot generator, convergence panel and volt-ohm meter — full remote control options, too. It's Heathkit TV at its finest. **Kit GR-900**, less cabinet, 125 lbs.

NEW 4-Channel Amplifier with "Universal" decoder circuitry... 359.95* (less cabinet)

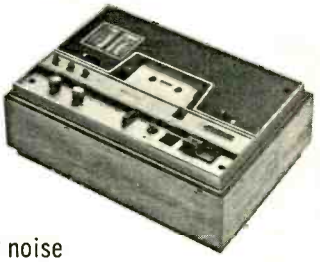
You select discrete 4-channel, or switch-in the "Universal" decoder for reproduction of all the matrixed 4-channel discs now on the market, plus "derived" 4-channel from conventional stereo. Four solid-state amplifiers produce 200 watts (4x50 IHF) into 8 ohms, with power bandwidth on all channels from less than 5 Hz to greater than 45 kHz at 0.25% distortion. **Kit AA2010**, 37 lbs. **AAA-2004-1**, pecan cabinet, 7 lbs. **24.95***

NEW "Universal" 4-Channel Decoder...39.95*

Reproduces all matrixed discs, plus "derived" 4-channel from conventional stereo materials. Plug it into your receiver's tape monitor circuit, add a second stereo amp and speakers and you're set. **Kit AD-2022**, 4 lbs.

NEW Ultrasonic Intrusion Alarm... 49.95*

Disguised as an ordinary library book, this novel device fits unobtrusively anywhere in the home. Transmitter disperses a 41 kHz signal which bounces off walls and returns to the receiver where it's monitored for any change in amplitude. Triggers lights and any conventional alarm device — just plug them into AC outlets on the rear panel. Can be installed anywhere there's a 120 VAC outlet. An enjoyable 2-evening kit. **Kit GD-39**, 5 lbs.



NEW Cassette Deck with Dolby circuitry ...249.95*

A kit-form cassette deck utilizing the famous Dolby® noise reduction system. Accommodates the greater fidelity and dynamic range of chromium dioxide cassettes. Independent switches provide Dolby on/off and regular or CrO_2 bias control. Domestic-make tape transport comes preassembled for easy kit building. **Kit AD-1530**, 21 lbs.

NEW 6-Digit Electronic Alarm Clock...54.95*

Displays hours, minutes and seconds on highly visible cold-cathode readout tubes. A gentle "beeper" alarm can be set for 24-hour cycle and features a snooze switch that gives you seven more minutes of sleep before the alarm sounds off again. Conventional 12-hour or 24-hour international time display. **Kit GC-1005**, 4 lbs.

See them all at your Heathkit Electronic Center...or send for Free '73 Heathkit Catalog.

HEATHKIT ELECTRONIC CENTERS

ARIZ.: Phoenix, 2727 W. Indian School Rd.; **CALIF.: Anaheim,** 330 E. Ball Rd.; **El Cerrito,** 6000 Potrero Ave.; **Los Angeles,** 2309 S. Flower St.; **Pomona,** 1555 Orange Grove Ave. N.; **Redwood City,** 2001 Middlefield Rd.; **San Diego (La Mesa),** 8363 Center Dr.; **Woodland Hills,** 22504 Ventura Blvd.; **COLO.: Denver,** 5940 W. 38th Ave.; **CONN.: Hartford (Avon),** 395 W. Main St. (Rte. 44); **FLA.: Miami (Hialeah),** 4705 W. 16th Ave.; **GA.: Atlanta,** 5285 Roswell Rd.; **ILL.: Chicago,** 3462-66 W. Devon Ave.; **Downers Grove,** 224 Ogden Ave.; **IND.: Indianapolis,** 2112 E. 62nd Ave.; **KANSAS: Kansas City (Mission),** 5960 Lamar Ave.; **MD.: Baltimore,** 1713 E. Joppa Rd.; **Rockville,** 5542 Nicholson 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

new books

HOW TO INTERPRET TV WAVEFORMS, by Forest H. Belt. TAB Books, Blue Ridge Summit, Pa. 17214. 5½ x 8¾ in. 256 pp. Hardcover, $7.95; Softcover, $4.95.

A comprehensive photo/text guidebook created specifically to clear up many of the mysteries of TV waveforms for the service technician. More than 250 waveform photographs in this volume have been collected through intensive study of television circuit breakdowns. Every one is authentic, actually taken from a set that has malfunctioned. Not only does the book show specifically what normal waveforms should look like at key test points, it shows what happens to each key waveform under various component fault conditions.

ABC'S OF BOOLEAN ALGEBRA, by Allan Lytel and Lawrence Buckmaster. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 5¼ x 8½ In. 128 pp. Softcover, $3.50; In Canada, $4.40.

Boolean algebra is the algebra of logic, an abstract mathematical structure appearing in three different forms—a switching algebra, a propositional calculus and an algebra of sets. With simple block diagrams, this book shows you the relationship between language and switches, the principles of logical design and examples of the application of these principles. It tells you how to write logical expressions, how to expand and simplify them and how to use relays and switches in simple practical circuits.

USING ELECTRONIC TESTERS FOR AUTOMOTIVE TUNE-UP, by Albert Wanninger. TAB Books, Blue Ridge Summit, Pa. 17214. 5¾ x 8¾ In. 256 pp. Hardcover, $7.95; Softcover, $4.95.

An all-in-one manual that provides complete information and operating instructions for all commonly-available electronic devices used for auto tune-up. Starting with simple voltage and continuity checks, the author continues through the more involved procedures, employing os-

cilloscopes and specialized testers and ends with complete automotive tune-up on console-type analyzers. Brief discussions of how the equipment operates is included to make the meter indications more meaningful to the technician.

MODERN DICTIONARY OF ELECTRONICS, Fourth Edition, by Rudolf F. Graf. Expanded & Revised. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46268. 6½ x 8½ In. 688 pp. Hardcover, $12.95.

As new technologies evolve, fresh terminology must be developed to communicate, describe and define the previously unknown concepts, components and techniques. Here's where this fourth edition of a popular electronics dictionary plays a vital role. This latest work contains concise definitions of more than 18,000 terms in electronics, communications, microelectronics, fiberoptics, semiconductors, reliability, computers and medical electronics. Approximately 2,000 terms have been added and hundreds of existing definitions have been updated.

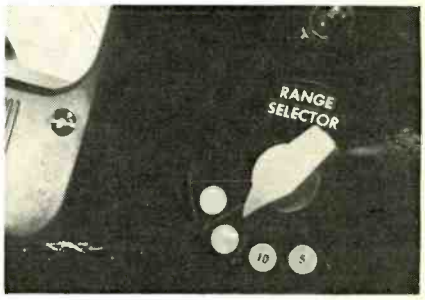
199 COLOR TV TROUBLES & SOLUTIONS, by Robert L. Goodman. TAB Books, Blue Ridge Summit, Pa. 17214. 5½ x 8½ In. 224 pp. Hardcover, $7.95, Softcover, $4.95.

This is an all-in-one case history book of "tough dog" and recurring troubles that can save TV service technicians many frustrating hours of troubleshooting time. It describes 199 actual problems gleaned from the author's extensive case history file and offers practical solutions to them. Virtually all of the case histories are accompanied by a schematic diagram and in every case a complete description of the symptons and the cure is included. The content is arranged by brand names, from Admiral to Zenith. This comprehensive guide should increase the technician's ability to pinpoint other troubles, as well as those described in the book, more quickly. **R-E**

try this

HANDY PANEL MARKERS

A gimmick borrowed from the photographer can come in handy on your electronics workbench. The small, consecutively numbered dots

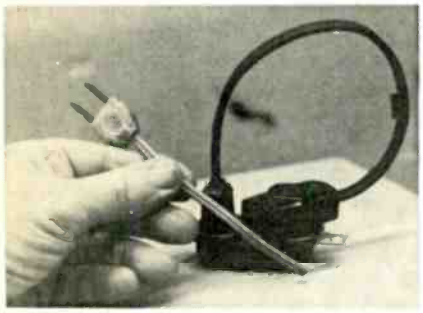


used to mark color slides serve well as dial calibrations and panel markers, and can be used to identify terminals or cables. They are inexpensive and can be bought at most camera and stationery stores. They come in vari-

ous colors with self-adhesive backing which sticks to almost anything. If used for permanent markings on dials or panels, spray or brush the markings with a coat or two of clear varnish.—*Frank I. Gilpin*

SHORTY EXTENSION CORD

A "foot-long" extension cord with



multiple sockets at one end will prove extremely useful to any tool user. Plugs with multiple sockets are available but the shorty extension cord provides much greater flexibility. It can be a permanent installation for that "tight" wall receptacle that will only accommodate two plugs, or for the tool kit, however small. To make a "shorty," use a good end from any discarded lamp or appliance cord, attach a multiple receptacle a foot from the molded plug and it is ready for use.—*Glen F. Stillwell* **R-E**

next month

APRIL 1973

- **Add-On Electronics For Your Car**
  A survey of the latest electronic devices you might want to add to your car. Everything from electronic ignition to windshield-wiper pause controls.

- **Build A Digital Tach For Your Dash**
  Compact easy-to-build unit tells you in numbers how many rpm your engine is turning over. Use IC's and digital readout tubes to speed construction.

- **Transistor Substitution Directory**
  This second part presents complete listings of about 250 transistor types and their replacements from eight suppliers.

- **Build A Liquid Crystal Clock**
  Use COSMOS IC's, a 4-digit liquid-crystal display and a printed-circuit board to build a battery-powered crystal-controlled clock

PLUS:
State-Of-Solid State TV Service Clinic
Step-By-Step Trouble-shooting
Measuring dB With your Scope

IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

NEW – COSMOS INTEGRATED CIRCUIT

Said to be the "New Wave" in integrated circuits of the future. Ultra low power drain (microwatts)

☐ 4000AE	Dual 3 Input Nor & Inv	$ .99
☐ 4001AE	Quad 2 Input Nor	$ .99
☐ 4002AE	Dual 4 Input Nor	$ .99
☐ 4006AE	18 Stage Static Shift Register	$4.99
☐ 4007AE	Dual Complementary Pair & Inv	$ .99
☐ 4009AE	Hex Buffer, Inverting	$2.19
☐ 4010AE	Hex Buffer Non Inverting	$2.19
☐ 4011AE	Quad 2 Input Nand	$ .99
☐ 4012AE	Dual 4 Input Nand	$ .99
☐ 4013AE	Dual "D" Flip Flop	$1.99
☐ 4014AE	8 Stage Static Shift Register	$5.99
☐ 4015AE	Dual 4 Stage Static Shift Register	$5.99
☐ 4016AE	Quad Bilateral Switch	$1.99
☐ 4017AE	Decade Counter W/Decoder	$5.99
☐ 4018AE	Presettable Divide by "N" Counter	$5.99
☐ 4019AE	Quad and/or Select Gate	$2.39
☐ 4020AE	14 Stage Binary Ripple Counter	$5.99
☐ 4021AE	8 Stage Static Shift Register	$5.49
☐ 4022AE	Octal Counter W/Decoder	$5.19
☐ 4023AE	Triple 3 Input Nand	$ .99
☐ 4024AE	7 Stage Counter	$3.99
☐ 4025AE	Triple 3 Input Nor	$ .99
☐ 4026AE	Decade Counter/7 Segment Decoder	$7.49
☐ 4027AE	Dual J-K Flip Flop	$2.99
☐ 4029AE	Presettable Up/Down Counter	$7.99
☐ 4030AE	Quad Exclusive Or	$1.99
☐ 4033AE	Decade Counter/7 Segment Decoder	$7.49

SPECTRA – STRIP FLAT BONDED

We know this is what everyone wants for their home-brew projects, because they always ask for it. We now have over 5 by 10^6 feet, but it won't last long, so order now before it's all gone. We don't want any broken hearts. Specs: 20 conductors, 24 AWG, 7 strands, size is .88" x .044". We could give all its virtues, but most people know them or could easily look it up in any industrial electronics house catalogue.

Sh. Wt. 1lb./10 feet . . . . Order No. SSFBRC (ft.)

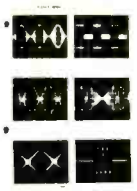
☐$ .35/1 ft. ☐$ 1.00/3 ft. ☐$ 5.00/18 ft.
☐$30.00/100 ft. ☐$ 55.00/200 ft. ☐$100.00/400 ft.
☐$200.00/900 ft. ☐$500.00/2000 ft.

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. Twenty-page manufacturer's instruction book included. Sanken amplifiers have proved so simple and reliable that they are being used for industrial applications, such as servo amplifiers & wide band laboratory application.

☐ SI1010Y 10 watts 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, economy grade	$14.00
☐ SI1050E 50 watt RMS amplifier, economy 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

WAVEFORM GENERATOR, BF-5



Just one of these BF-5 devices produces sine, square, traingle, ramp and sawtooth waveforms without additional active components. By adding a second BF-5, you can create amplitude, frequency or phase modulated varieties of these waveforms. They are able to replace large discrete waveform generators costing from $200.00 to $1300.00. At the same time, they greatly reduce system weight and power consumption. Full technical data, P.C. layout, assembly, and hook-up instructions included.

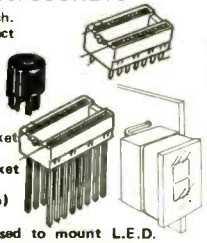
☐ BF-5 WAVEFORM GENERATOR . . . . $ 9.75

WIRE-WRAP COMPUTER WIRE

New surplus from a large computer company. Solid silver-plated OFHC copper conductor. Special high-temperature, thin-wall insulation of teflon, and other quality materials. Extremely rugged and flexible wire-wrap wire. In addition to usual applications, can be used for effective breadboarding, and wherever quick stripping of solid wire is desired. Different colors are now available. State first, second, and third choice of colors. Shipping weight per 500' is 1 lb.

Conductor Size	Order No.	500'	1000'	10,000'
30	WWW30(ft.)	$5.00	$9.00	$75.00
26	WWW26(ft.)	$6.00	$11.00	$95.00
24	WWW24(ft.)	$6.50	$12.00	$100.00

SUPER QUALITY I.C. SOCKETS



Sockets made by T.I. and Cinch. All are low-profile, compact types.

14 Pin Dip Solder Tale Sockets
3 for $1.25 16 for $5.00
16 Pin Dip Solder Tale Sockets
2 for $1.00 13 for $5.00
14 Pin Dip Gold Wire Wrap Socket
2 for $1.25 10 for $5.00
16 Pin Dip Gold Wire Wrap Socket
2 for $1.50 8 for $5.00
10 Pin to 5 Gold Sockets (Cinch)
2 for $1.00 13 for $5.00
14 Pin Right Angle Socket. Used to mount L.E.D. displays directly to P.C. board at correct viewing angle $1.00

SINGLE CHIP 7-SEGMENT DISPLAY COUNTER, AND DECODER.

That's right! A single chip TTL decade counter with latches, BCD outputs, a 7-segment decoder driver, AND a 7-segment LED display (with decimal) on top. Only 0.15" thick (not counting pins), the chip mounts in a standard 16-pin DIP socket. Digits are 0.270" high and can be latched in during the next count or blanked.

☐ 0.27 DLD $15.00

70 WATT RMS AUDIO AMPLIFIER BASIC PACKAGE, STEREO $5.50

Take advantage of Signetic's NE540 power driver, (class AB amp). Designed for 35 watts RMS per channel. Distortion .5% frequency response, ± .5db 20Hz to 100 Hz. NE540 requires two power transistors, a 2N5296 (NPN) and a 2N6109 (PNP), supplied per NE540. Kit package includes (2) NE540, (2) 2N5296, (2) 2N6109, information on P.C. board layout, parts and circuitry, and a list of miscellaneous small parts required to build the 70 watt amplifier for stereo.

☐ NE540	$2.25/ea.
☐ 2N5296 35 watt NPN	.75/ea.
☐ 2N6109 40 watt PNP	.75/ea.
☐ 70 watt Stereo Kit	$5.50/ea.
☐ 35 watt Mono Kit	$2.95/ea.

FAIRCHILD VOLTAGE REGULATORS

This is the UA 7800 Series. Three terminal regulator, with thermal overload protection and internal current limiting, making it essentially blow-out proof. Because simple circuitry is used with this device, designing regulated power supplies is duck soup. Output is rated at 0 to 1 ampere; maximum input voltage is 35 volts. Choice of voltages: 5, 6, 8, 12, 15, 18, or 24 Volts. Order as 7805, 7806, 7808, etc.

☐ Voltage Regulator (Sepcify Voltage) $2.00

PRINTED CIRCUIT MATERIAL

Epoxy glass G10 material. Specify single or double copper clad. Thickness 1/16 inch.

☐ 4 x 12 Sheets	$1.00, 5 for $ 3.50
☐ 12 x 12 Sheets	$2.50, 5 for $10.00
☐ Assorted cut pieces at least 4" x 4" 2 square feet	$2.50

COMPACT BRIDGE

2 Amp	200 Volt	$ .60
2 Amp	400 Volt	$1.00
2 Amp	600 Volt	$1.50
2 Amp	800 Volt	$2.00
2 Amp	1000 Volt	$2.50
4 Amp	400 Volt	$1.50
4 Amp	600 Volt	$2.00
4 Amp	800 Volt	$2.50

LOGIC AND OPERATIONAL AMP. SUPPLIES

☐ Figure A, plotted 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, similar 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
☐ Op amp and logic supply. Supplies ±15 volts at 100 milliamperes and 5 volts at 1 ampere. Similar to Figure "B" but larger. Ultra-low ripple. Built by Elcom	$32.50

64 CHARACTER ASCI CODE ALPHANUMERIC L.E.D. DISPLAY

This display consists of 35 L.E.D.'s (light emitting diodes) arranged in a 5 x 7 matrix. Numbers and letters of the alphabet can be formed by lighting the appropriate segments, i.e. from our 2513 character generator Rom. One 2513 can be used to drive up to 64 displays by time sharing. In 14 Pin Dip Package.

☐ 64 Character 5 x 7 LED Display	$ 9.75
☐ 2513 Character Generator Rom	$12.00

SHRINK TUBING. B and F has a truckload of shrink tubing, but we still expect it to go fast. If you have ever used shrink, you know it is indispensable for electronic construction. Made a wire too short? Just splice and shrink tubing over it and it will look like new. Pins too close? Same solution. Excellent results with hot-air gun, soldering iron, or even a match. This is polyolefin type where outer wall shrinks, inner wall melts to encapsulate wire.

SHRINK TUBING ASSORTMENT, 25 feet each, of 1/8, 3/16, 1/4-inch tubing $5.00

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

CATALOG. Check reader's card or write.

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

CHARGES WELCOME!

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

BANKAMERICARD — $10.00 MINIMUM CHARGE — master charge

B. & F. ENTERPRISES

Phone (617) 532-2323

P.O. Box 44, Hathorne, Massachusetts 01937

Circle 88 on reader service card

APPLIANCE CLINIC

(continued from page 32)

that both sides are in good shape.

The timer-drive motor is a small sealed synchronous unit, a lot like those used in electric clocks. A gear-train is used to give the little motor enough torque to drive the cam assembly. We find very little trouble with these motors, although if the machine has been visited by lightning, the winding may be open. Normally, neither the motor or gear train will require lubrication.

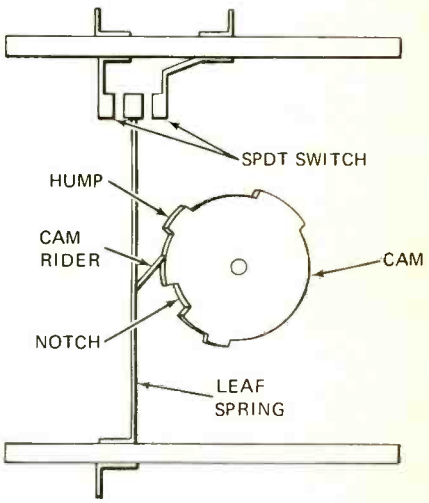


FIG. 2—CAM DRIVES CONTACT ARMS in timer, as shown here.

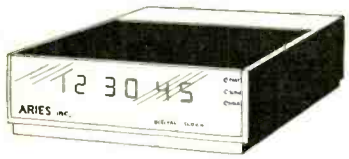
This type of motor isn't repairable; the whole motor must be replaced. In most units, this can be done without even taking the timer off. Take out two or three screws and it drops off into your hand. Exact duplicate replacements must be used, of course. These are available from the distributor for this make of appliance, or from independent parts-wholesalers.

As I said, we have very few troubles with motors like this. When we do though, it's sometimes a dandy. In one notable case, an air-conditioning system had a very puzzling intermittent. Most of the time it worked perfectly. Once in a while, it would start, then shut down. After much head-scratching, and some not-too-nice language, we "caught it in the act". These tiny motors are synchronous and they always start in the same direction. This one had to start a timer, and run through a couple of operations, so that the system could start cooling properly.

While watching it on start-up, we finally saw what it was doing. It was running *backward.*

We haven't figured out exactly *what* went wrong inside the little monster, but I still have it on my desk. **R-E**

ARIES



NEW FROM ARIES! ULTRA LOW COST DIGITAL CLOCK (STANDARD TIME CHRONOMETER)

Aries/BF has sold over 12,000 digital clocks, to the best of our knowledge more that the combined output of all other manufacturers. Because of our huge purchasing power, and the engineering background gained, we can offer the features listed below. Compare with any other manufacturer and see if they can offer all these features:

- Decorator solid walnut case. A Striking addition to even the most luxurious living room. Our sketches just don't do it justice.
- Superb accuracy, seconds per month
- Choice of 50 or 60 Hz operation. 12 or 24 hour display in hours, minutes, seconds.
- BCD outputs, for auxiliary readouts etc.
- Excellent beginners kit, elaborate step by step instructions debugged by trial construction by experimenters who have never built a kit before. Only a soldering iron, wire snip and screwdriver needed. Guaranteed success (maximum repair charge $10.00)

☐ Low-cost Digital Clock Kit..... $47.50

OPTIONS

☐ 00 – Standard readouts, GE florescent standard unless otherwise specified. Cool blue green color, best for decor of living rooms, bedrooms etc., this is the unit that draws Oh's and Ah's.

☐ 01 – Burroughs B5750 nixie tube readout instead of GE hot orange color. Looks at home in a lab. No extra charge.

☐ 02 – Man 1 L.E.D. readouts. Intense red, monochromatic light output, laboratory environment type display. Add $22.50 additional for this display.

☐ 03 – Quartz crystal time standard. In most environments standard line operated units will give accuracy of a second a month. If you live in an area where line frequency is poor, this will give you an independent time base of .0005% accuracy when properly trimmed. Add $22.50 for this crystal time base.

- Special – National MM5311 clock chip and readouts only, with instructions for do it yourself clock projects. Specify GE florescent or Burroughs B5750 nixie tubes as readouts $24.50

TEXAS INSTRUMENTS "ELECTRONIC SLIDE RULE" CALCULATOR

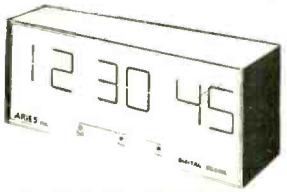
This brand new calculator from T.I. promises to revolutionize engineering calculations! Use scientific notation, i.e., 4235.7867 is expressed as 4.2357867×10^3. Does squares, square roots, reciprocals, adds, subtracts, multiplies, divides. If you have been looking at electronic slide rules you know what a phenomenal deal this is. By the way this is direct entry as opposed to HP's indirect entry.

☐ T.I. "Electronic Slide Rule" $149.00

FUNCTION GENERATOR KIT IMPOSSIBLE?

A $700.00 function generator for $99.00? But true! The new, low-cost EXAR-205 monolithic waveform generator makes this price possible. Our kit uses two generator circuits – one is a carrier generator, and produces sine, triangle, square, sawtooth, ramp and pulse waveforms. The second is a modulation generator, for amplitude or frequency modulation of the output waveforms. Output frequency range is from 20 Hz to 1.5 megaHertz. Modulation is switch-selectable for internal AM, internal FM, or external modulation.

☐ Model AR-620K Function Generator . . . $99.00



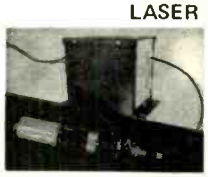
GIANT 2½" NUMERAL "NIXIE" CLOCK KIT

New! For factories, offices, and commercial establishments, and those people who like large displays, characters appear as a bright continuous line which can be read from distances as great as 150 feet. All drive circuits are solid state, and unit employs new custom LSI clock chip. Indicates hour, minutes, and seconds. May be wired for 24 hour or 12 hour operation with a simple jumper change. Kit offered complete with or without case for custom installations. Parts include P.C. board, sockets, solid state components, hardware, resistors, caps, viewing filter, etc.

Sh.Wt. 15 lbs.

☐ GNNC/C With Case $98.50
☐ GNNC Without Case $84.50

VIEW HOLOGRAMS! PERFORM OTHER EXCITING EXPERIMENTS LASER KIT!



Now available only from Aries! Brand new Hughes "Hip Pocket" type tube, and Aries power supply kit, plus complete experimental accessories. These tubes are completely guaranteed by Aries and Hughes, but are available at this bargain price because their power output is slightly below Hughes standard. Because of this fortunate purchase, you can purchase the complete experimental kit for less than the price of the tube alone. The Hughes specification for this tube is 1.4 milliwatts output power when new, so that minimum power specification of 1 milliwatt can be met throughout life of tube. Our specification is initial power between 0.9 and 1.4 milliwatts, guaranteed not to go below 0.5 milliwatt during the guarantee period (6 months continuous operation!) Our kit includes experimental accessories such as lenses, pinholes, mirrors and a hologram to perform hundreds of fascinating experiments. Holograms viewing is easily demonstrated with this kit, hologram making is possible, but is recommended only for advanced experimenters.

☐ Laser Experimental Kit $119.00

AIRCRAFT/AUTO/BOAT QUARTZ CRYSTAL CHRONOMETER

Revolutionary!, was the reaction of our customers when they saw our latest kit. Measuring only 2½" x 2½" x 2-3/8", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechanical clocks in cars, boats and airplanes.

Fits into a standard 2¼" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e. replacing battery in car). The clock is wried so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligable power drain. The low price is only possible because of a new one chip MOS clock circuit, developed for quartz crystal wristwatches.

Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit 59 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

☐ Quartz Chronometer, Kit Form.....$69.50
☐ Quartz Chronometer, Wired $99.50
☐ 24 Volt Adapter $10.00

50 MHz DIGITAL COUNTER LABORATORY SPECIFICATIONS AT A BUDGET PRICE!

We feel the most important thing about building a kit is saving money. There are a lot of other advantages of course . . . maintainability, use of standard parts, complete documentation, and the experience and fun of building it, but the overriding consideration is economy. This kit costs less than half that of the lowest priced competitive unit on the market.

The Aries 50 MHz counter is designed for years of maintenance free service. MSI integrated circuitry, cold cathode display tubes and conservatively rated transformers mean low temperature rise. All displays and I.C.'s are in sockets for easy maintainability. The master oscillator is a 1.0 MHz crystal in a custom designed cosmos oscillator circuit, having a stability of ± 3 PPM. Accuracy is 0.005% worst case, 0.0002% or better when adjusted to WWV with a communications receiver. A front panel selects a timing interval of 1.0 seconds, 0.1 seconds or 10 milliseconds. A variable monostable multivibrator holds the count on the front panel for a period of a fraction of a second to infinity. For use in the period mode, the 1.0 MHz oscillator is connected to the main counting chain and gated by the input signal.

Assembly time for the kit is approx. 10 hours. The semiconductor complement is (1) 7400, (1) 7408, (1) 7442, (10) 7490, (2) 74122, (6) 74141, (1) 74193, (1) 74196, (1) 74S11, (1) CD 4007AE, (1) LM309, (6) Diodes, and (1) Transistor. If you always wanted a laboratory quality counter, but could never justify the price, here is your chance.

☐ 50 MHz Counter Kit, Complete with Crystal Time Base and Case – Postpaid in USA $125.50

POCKET CALCULATOR

We expected a favorable reaction to our calculator, however, we were overwhelmed when we received orders for hundredds at a time. The reaction of our customers was that they felt this was the most advanced pocket calculator on the market, and priced so low, they could assemble and market it at a profit. The features that make this so exciting are:

- So compact it fits in a shirt pocket (3-13/16 x 4-5/8 x 1-1/4).
- Performs every function you would expect in a desk calculator, and then some, multiplies, divides, adds, subtracts and gives true credit balance. Includes constant and chain operation, full floating decimal, suppressed trailing zeroes, and automatic single entry squaring.
- Powered by self contained AA batteries with up to six hours operation (Nicad batteries with charger option, up to five hours per charge).
- Calculations performed by a single 40 pin LSI (large scale integration) chip. Displays are 8 digit LED's (light emitting diodes) and overflow and minus signs are also LED's.

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
☐ Pocket Calculator Completed $99.00
☐ NiCad Batteries & Charger $17.50
☐ Batteries & Charger Completed $25.00

☐ Check Enclosed ☐ Master Charge ☐ BankAmericard

Charge No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

ARIES, Inc.
119 Foster Street, Peabody, Mass. 01960
(617) 532-0450

Circle 92 on reader service card

circuits

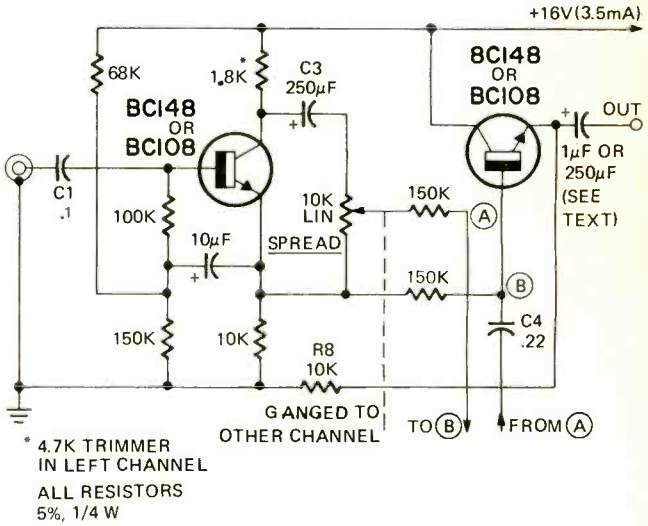
STEREO WIDTH CONTROL

If you are sometimes bothered by insufficient spread from some stereo material, this simple device (Mullard's *Sound-Source Width Control*) may be the answer. The diagram shows the circuit of one of the two almost identical channels. (In one channel the input collector load resistor is a preset 4700-ohm trimmer resistor.)

Circuit gain is 0.5, input impedance is 750,000 ohms, output impedance 47,000 ohms and response is 20 Hz to 20,000 kHz at 3-dB points. Total distortion is less than 0.1% for 0.5 volt output and about 0.15% for 1.0 volt out.

The output blocking capacitor can be 1 μF when working into a load of at least 10,000 ohms. For lower load impedances, use a 250-μF blocking capacitor.

The sound-source width control is connected in the



stereo signal path where the signal level is 0.25 to 1.0 volt as between preamp and main amplifier, between tape output and tape-monitor jacks, or between two tape recorders. A 4-pole double-throw switch can be used to take the width control out of operation or you can simply mark the position of the SPREAD control where the normal stereo affect is not affected. Here is how it's done:

1—Connect the device to a stereo system.

2—Disconnect the right-channel output from the main amplifier or replace the right speaker with a dummy load.

3—Feed a signal into the right channel only and turn up the volume control until you hear a reasonably loud signal from the left channel.

4—Adjust the SPREAD control for minimum volume from the left speaker. Mark this position and make sure that the control setting is not changed any more.

5—Turn off the sound source. Connect the right channel and disconnect the left channel.

6—Feed a signal into the left channel and turn up the volume for a moderate signal from the right speaker.

7—Adjust the 4700-ohm trimmer for minimum output.

This completes the set-up operation. The SPREAD control now gives a mono effect at one end of its range, ordinary stereo in the "null" position located in Step 4 and extra-wide stereo at the other end of its range. **R-E**

market center

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QUICK cash . . . for electronic equipment components, unused tubes. Send list now! **BARRY,** 512 Broadway, New York, N.Y. 10012, 212 Walker 5-7000

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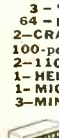

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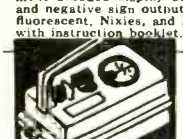

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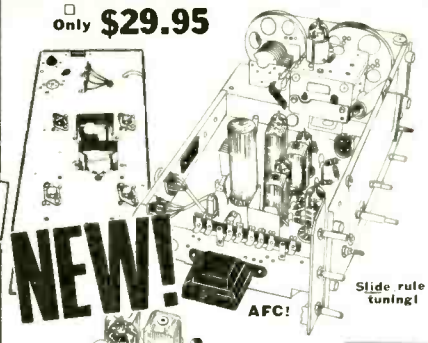

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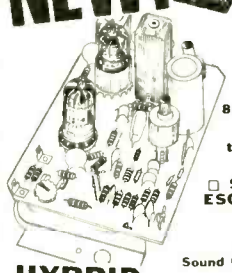

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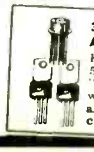

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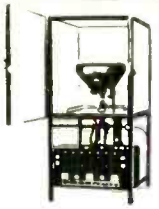

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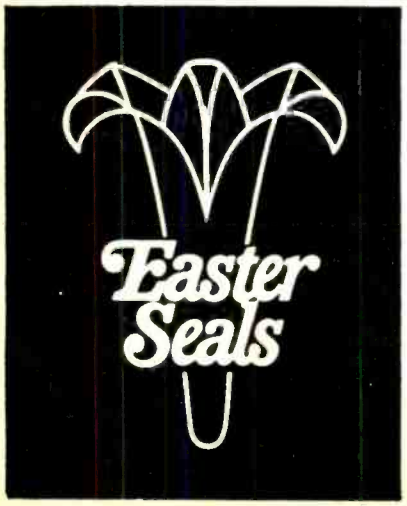

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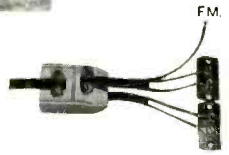
HA-130

Winegard's new "Hideaway" Travel antenna for trailers, boats, campers, folds like an umbrella for travel!



CS-380 BAND SEPARATOR
Band separators to connect 75 or 300 ohm downlead to 300 ohm UHF, VHF & FM terminals.

TR-35 TV OUTLET
TV outlets in a variety of models for all-channel TV and FM reception plus rotor.

AC-823B CARTRIDGE PRE-AMPLIFIER
Antenna-mounted pre-amplifiers in 8 models for all-channel, UHF, VHF-FM and FM use, each in its own weather-proof housing.

WINEGARD
TELEVISION SYSTEMS

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