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Editorial

By Milton S. Snitzer, Editor

ENGINEERING ENROLLMENTS DOWN SHARPLY

Because of a substantial dropoff in enrollments last fall, there are 26,000 fewer engineering students now than there were a year ago. This figure is from a study just completed by the Engineering Manpower Commission of the Engineers Joint Council. The survey covered almost 300 institutions offering bachelor's or higher degrees in the various engineering fields.

The decline hit all levels from beginning freshmen to doctoral candidates. Half the total drop occurred in the freshman class, which was 18 percent smaller in 1971 than in 1970, and 25 percent smaller than in 1967. The sophomore class was also hit, with a decrease of 10 percent. Junior and senior enrollments were lower by about 2 percent.

The reason for the dropoff is obvious. Primarily it is due to a fear of not being able to get a job when the training is completed. There have been a large number of layoffs in the engineering field so that it is no longer as glamorous as it used to be.

With all the talk these days about conserving our natural resources, it seems to us that the figures given above indicate a serious loss to all of us—a loss in technical manpower. Some will say that the overall effect is a good one since now only those who are seriously interested in engineering will be the ones to choose this as their profession. No longer will students go into engineering simply because it is the thing to do.

Despite the reduced levels of engineering recruiting and hiring in 1970 and 1971, new engineers generally fared better than graduates in most other disciplines, according to Dr. Robert J. Raudebaugh, President of Engineers Joint Council. Also, long-range projections by the U.S. Department of Labor continue to show a need for large numbers of engineers in the next decade.

We seem to be perpetually on a swinging pendulum of supply and demand. In the last year or two, the supply in certain areas has exceeded the demand, but now we see signs of an equalization. Perhaps in the near future the demand will again exceed the supply. The difference in the rates is what really hurts one side or the other.

In any case, it is safe to predict that the supply of engineers will start to drop while the demand in new areas for them increases. We seem to be more and more a country that is service-oriented as well as product-oriented. This bodes well for technical people who will be required to serve these areas.

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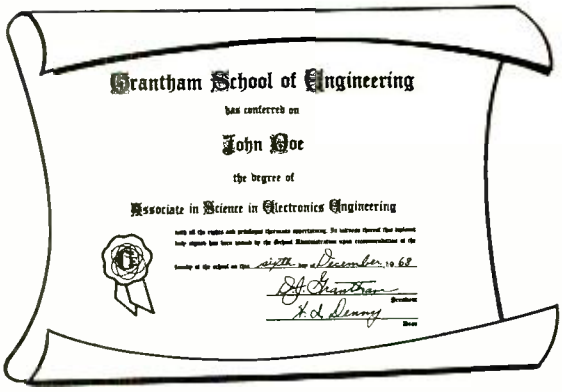

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Letters

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MARVIN JONES
Topeka, Kan.

We would like to hear from readers as to how many of you use the etching and drilling guides we print and what your feelings are on the use of such patterns in our projects.

HOSPITAL SAFETY COMMENTS CHALLENGED

For a short article on hospital electrical equipment, "Medical Electronic Equipment And Hospital Safety" (Jan. 1972) was quite good. However, a definition of leakage current would have been helpful to readers. Many people still do not understand that leakage current is still current and must obey Ohm's law.

My second comment concerns the last two paragraphs in the article. I don't know where you got your information or which hospital you visited, but the situation is nowhere near what you describe. Most hospitals have few, if any, technical personnel on their staffs. They provide only rudimentary in-service education on medical electronics and its proper use. I suppose you conclude optimistically to give the reader some sense of security. I would only say that we are far from the blissful picture you paint.

BURTON R. KLEIN
Director, Medical Electronics Dept.
Tufts-New England Medical Center
Boston, Mass.

Forgive an overexuberant editor who was responsible for the last two paragraphs. However, while our picture may have been a bit too blissful, the picture you paint appears a bit too dark.

THEY DON'T MAKE 'EM LIKE THEY USE TO

Recently, while cleaning out my basement, I came across an old Gilfillan radio of 1934

vintage. Of course, I had to plug it in to see if it still worked. Its performance was magnificent! At night, with only a couple of feet of wire, it pulled in BCB from all over the country—spaced only 10 kHz apart no less. Its 175-kHz i-f apparently was responsible for the receiver's excellent selectivity, and the tuned circuit ahead of the converter stage kept image response to a minimum.

This leaves one obvious question: Why don't the radio manufacturers build receivers like this nowadays? With the exception of the expensive German-made all-band receivers, there is apparently no AM radio offered with the performance of my 1938 Gilfillan. Answer please?

MONTY BANCROFT
Sun Valley, Calif.

That's a question you will have to ask the manufacturers. Right now, they are sinking all their efforts into the FM medium which traditionally is less prone to interference and offers better fidelity as a result of its wider bandwidth.

THE NOSTALGIA CORNER

Your new Surplus Scene column reawakens memories of my first visits to the New York surplus scene back in 1947. I recall that, by category, Canal Street was "junky," but it was well worth a visit to prowl around ceiling-high stacks of BC-375's and dynamotors. One great find was the control box for the C-1 autopilot, encrusted with switches, pots, and jeweled pilot lights. Cortland Street and environs (Radio Row to the initiate) was much more sophisticated with such nearby surplus titans as G&G, Leotone, TAB, North Radio, Edlie, Newark, and others—all now vanished into oblivion to make way for the World Trade Center towers. Their display windows, containing neatly labeled signs, were enough to tempt any electronics enthusiast as well as to accomplish instant bankruptcy.

Now, that unique area is vanished. I still get Edlie catalogs, but from the sterile isolation of distant Levittown on Long Island. If there are still any of the "old gang" around, I would like to know about them.

FREDERICK W. CHESSON
Waterbury, Conn.

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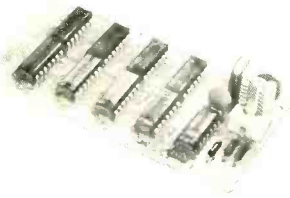
We have invested a large amount of time and money to the production of each kit for a very selfish reason: we want you to buy another one.



Crystal Frequency Standard

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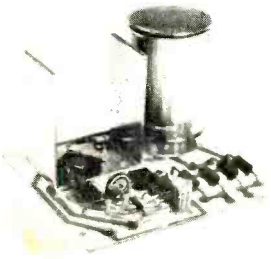
CRO-1D $21.95



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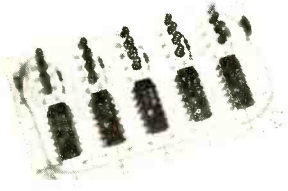
DPS-2A $10.95
TR-500 . . . . . Transformer 5.95



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LED Counter/Display Modules

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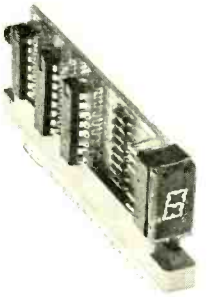
LR-110	20 MHz	$15.95
LR-110H	70 MHz	16.95
LR-110UD	Up/Down	18.95
PCC-18	connector	.95



Counter/Display Driver Modules

The NR-3 series universal decade counter/display drivers are compatible with nearly all 7-segment displays which require up to 15 V and 40 mA per segment. Modules are 1" x 3.5". Units may be cascaded. G-10 boards supplied with sockets for "Numitron" displays. Other models available, see 1972 catalog. Supplied less display.

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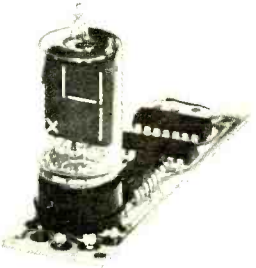
NR-3H	70 MHz	9.95
NR-3UD	Up/Down	10.95



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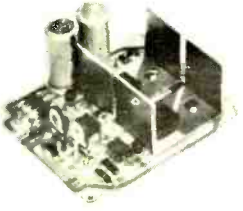

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Legal Booby Traps in Tape Recording

BY MARSHALL LINCOLN

THE tape recorder has given the world a handy, portable, and accurate secretarial service for both business and pleasure. Its versatility and usefulness, however, have given rise to a number of legal and ethical questions which ultimately influence how, where, and when it can be used.

Questions facing tape recorder owners include such gems as: May we use our recordings for anything we wish without limitations? To what other electronic equipment may we connect our recorders without causing the law to look our way? Are there any special limitations placed on private citizens in the manner in which we use our recorders (limitations which do not apply to certain privileged groups)?

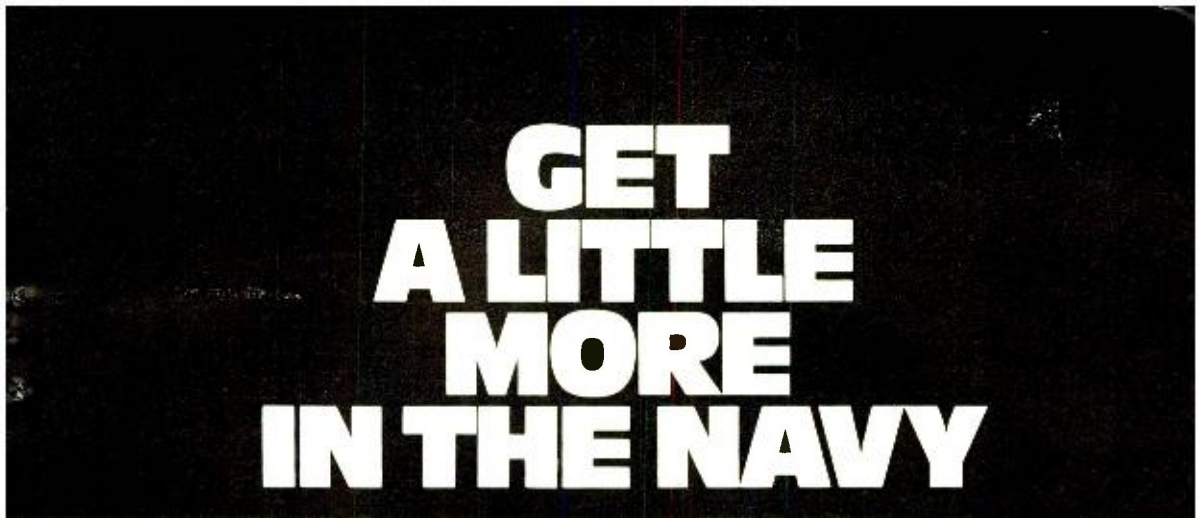
For those of us who own them, tape recorders have become part of our everyday lives; so, it is easy to overlook the fact that their use can create legal pitfalls. Some of these pitfalls may seem trivial at times, but it is good policy for each of us to be aware of circumstances which can bring the unwary under the scrutiny of the law.

Recording Phone Conversations. Let us take the case of a tape recorder being used as an "automatic notebook" for taking accurate notes of lectures, interviews, business calls, etc. When you are talking face to face with someone and openly using a tape recorder, there can be little doubt that the conversation is being taped. But in the absence of face-to-face confrontation, as in the case of a telephone conversation, are you free to record? Many tape recorder owners will be shocked to learn that they are *not* free to arbitrarily record telephone conversations.

The Federal Communications Commission's rules state that you cannot record phone conversations without prior arrangement with the telephone company! Another little known fact that may add to your astonishment is that the ruling does not apply to radio and TV broadcasters who are permitted to ignore the rule which applies to everyone else. This startling contradictory situation has its roots in a series of meetings held a few years ago between the Bell Telephone System and FCC officials. The meetings resulted in the drawing up of FCC Public Notice 60591, FCC Docket 6787, AT&T Tariff 263, and later, FCC Docket 18601. They state that a private citizen may record his own telephone calls only if his phone is connected to his recorder via a "coupling arrangement" containing a beeper rented from and installed by none other than Ma Bell. (The beeper generates an audio tone every 15 seconds or so to alert anyone on the line to the fact that the conversation is being taped.) In return for satisfying this requirement, you must (of course) pay the company a monthly service charge for use of the coupling arrangement.

A much simpler and superior way to record phone conversations is with an inductive coupler or telephone pickup coil, a low-cost item which can be purchased from any radio or tape recorder dealer. Inductive pickups have the advantage that they do not create interference on the telephone line since no physical connection is made to the phone wires. *But* when telephone recording methods were being considered by the FCC, Bell Telephone was categorically opposed to inductive pick-ups (which they could not control) while the FCC had no objections to their use.

The FCC pointed out that inductive couplers would eliminate any need for recorder salesmen to make special arrangements with the phone company whenever they



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wished to demonstrate their equipment. The telephone company took the position that the opposition to the inductive pick-up was based on the fact that it wanted to insure the privacy of its customers' calls. It insisted that some sort of signal must be put on the line to warn everyone that the call was being taped and made the claim that an inductive pick-up could not be used to do this (in fact, it can). The FCC finally yielded to the phone company's arguments.

The record of the FCC proceedings shows no trace of any consideration's being given to a simple requirement that a person making a recording must tell the party on the line that he is taping for purposes of accuracy or other legitimate reason.

More discrimination was on the way. In a later ruling, the FCC agreed to allow broadcasting stations, but no one else, to dispense with beepers. Broadcasters merely have to state that the call may be recorded or broadcast. At times, they do not even have to do that.

There is another wrinkle to Ma Bell's story: Beepers are *not* used on those recorders she rents to her customers. These recorders automatically answer business calls during hours when an office is closed, recording messages from the caller. The phone company contends that no beepers are needed because its "tariffs" specify them only for recording two-way telephone conversations. Actually, the FCC rule applies to all parties (with the broadcaster exception).

Once upon a time, broadcasters were required to use beepers because they were not permitted to connect their telephones to their transmitters. When FCC rules were amended to permit broadcasters to connect regular phone calls into their transmitters (a fringe benefit of the Carterfone Case of a few years ago), it meant that stations might not actually record calls before broadcasting them. So, they did not use a beeper because the rule specifically applied to *recordings* made from telephone lines.

The new FCC rule on this matter states that broadcasters may either record for broadcast or to directly broadcast telephone conversations with the only warning being a simple announcement at the beginning that the conversation may be taped or broadcast. In some cases, such as when the caller dials an "open-mike" number, the broadcasters are not even required to make the announcement. The FCC reasons that

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1
You couldn't reproduce bass notes through small speakers.

2
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3
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4
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* For those interested in the 12 years of research that led to the design of the 901, copies of the Audio Engineering Society paper "ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS," by Dr. A. G. Bose, are available from BOSE Corporation for fifty cents.

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CIRCLE NO. 10 ON READER SERVICE CARD

it may be assumed the public will know their voices may be recorded or broadcast because they dialed the number.

This convenience has been a great boon to broadcasters since they can dispense with the beep tone which they may consider annoying on the air. However, the FCC has not allowed individual citizens the same convenience of simply stating at the start of a call that it will be taped for their own use.

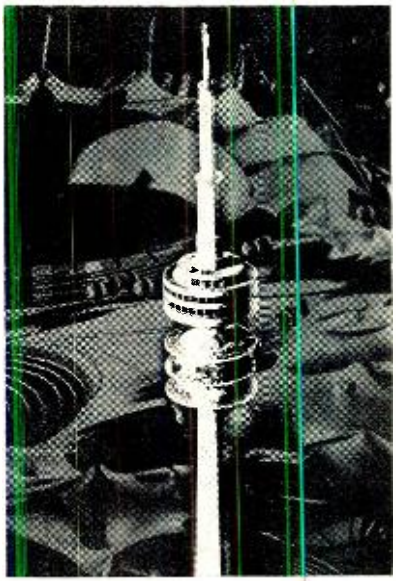
Recording from a Receiver. You can record anything you wish from a radio or TV receiver tuned to any frequency in the spectrum without first having to obtain permission from anyone. However, the nature of the transmission taped determines how you may use your recordings. Any radio or TV public information or entertainment broadcast is public domain and can be recorded and played back for anyone who wishes to hear it. But if you record from a commercial channel (police, fire, aircraft, mobile telephone, etc.), you are *forbidden* under the FCC's "Secrecy of Communications" regulation from playing the recording for anyone else. Furthermore, you are enjoined from even repeating the contents of any transmission heard.

Recording Live Performances. At live performances—especially concerts given by well-known performers—you can run into a whole series of prohibitions designed to prevent you from using your recorder. For one thing, musical and vocal performers nowadays are plagued by bootleg record companies which secretly tape performances and sell record copies to an unsuspecting public. The performers, needless to say, receive no compensation whatever from the bootleggers. (Some shady bootleggers get in as members of the audience with a small battery-powered recorder hidden on their persons. They use the recorders to make their "master tapes." The quality of the recordings possible from these small tape recorders may not be first class, but it is passable for hard rock and other loud music. Too, if the buyer has never heard a live performance by a given performer or group, he has no real way of determining whether or not the selection was bootlegged.)

The hard-nosed attitudes of performers' agents and theater managers toward anyone they see carrying a tape recorder into a live performance is understandable. They are protecting their interests and the interests of the performers. Hard to understand, however, are the union rules which forbid any recordings to be made unless a whole gang of union electricians is on hand (always assuming, of course, that you have received permission to make recordings). These rules are in union contracts; so, there is nothing a theater manager can do about the situation.

When you plan to take a recorder to a live performance, remember that you are treading on dangerous ground. If you are caught with a recorder at a performance, chances are good that you will be hustled out the nearest exit. It would be better (and safer) to check with the theater manager before walking in with a tape recorder. If you are convincing in the telling of why you want the recording, there is always the remote possibility that permission will be granted—but don't count on it. ◈

OLYMPICS COMMUNICATIONS



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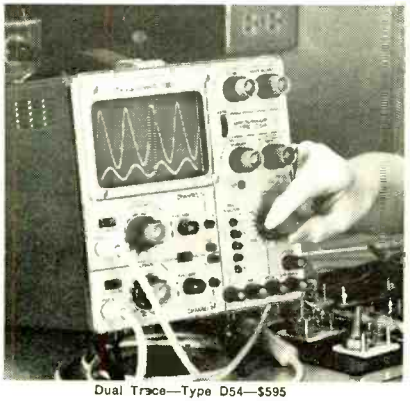

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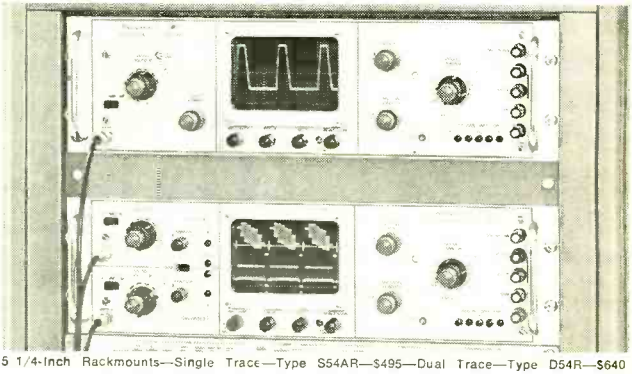

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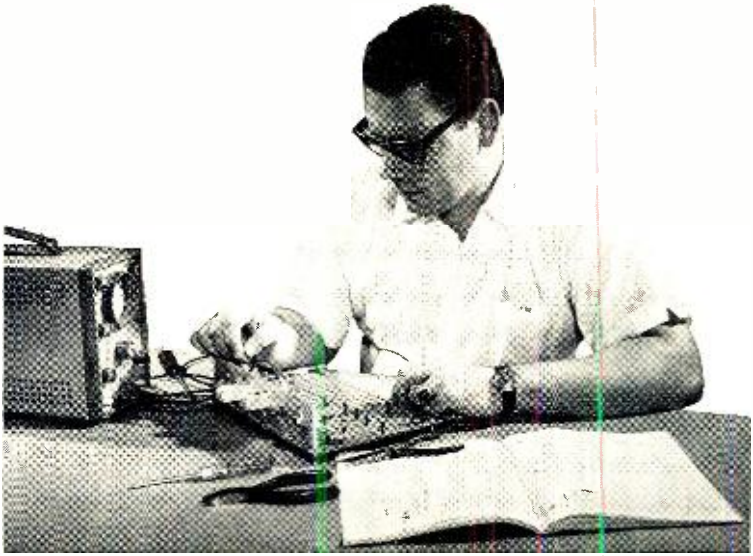

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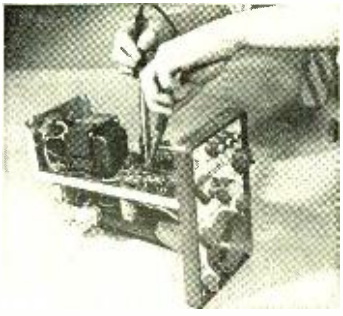
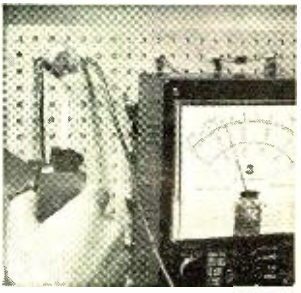


Construction of Oscilloscope.

Temperature experiment with transistors.



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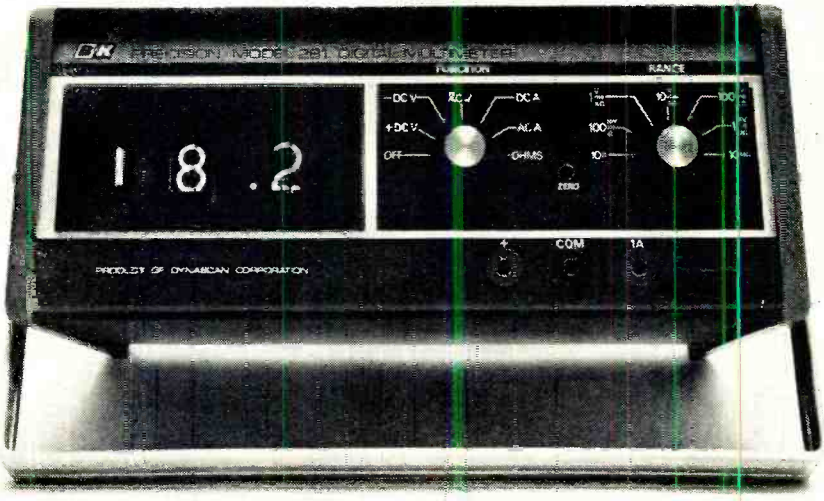

Product of Dynascan Corporation, 1801 West Belle Plaine Avenue, Chicago, Illinois 60613

CIRCLE NO. 7 ON READER SERVICE CARD

News Highlights

New Marine Anti-Collision Radar

A new fully automated radar data plotter has been installed on the Norwegian M/S Island Venture. The new equipment—called Digiplot by its developer, Iotron Corp.—graphically displays present and future positions of radar echoes potentially threatening a ship. Using a 16-in. cathode ray tube, the system is contained within a waist-high console installed alongside the ship's conventional radar. The course and speed of any target selected by the operator is displayed in digital form.

Columbia SQ 4-Channel System Adds More Licensees

A growing number of firms are coming out with products using the Columbia SQ matrix system for obtaining 4-channel sound from phono records. Kenwood Electronics is one of the most recent licensees to introduce such 4-channel equipment. In addition to Kenwood, other audio equipment manufacturers who have become licensees include: Sony, Sherwood, Harman-Kardon, Masterwork, Lafayette Radio, Radio Shack, Metrotec, and Instruteck Corp.

Students' Proposals for Skylab

Proposals for space experiments and demonstrations have been submitted by 3409 U.S. secondary school students for flight consideration aboard the Skylab manned space laboratory scheduled for launching next April. Called the Skylab Student Project, the program is designed to stimulate interest in science and technology by directly involving students in space research. A limited number of student proposals from the 25 national finalists will be chosen for flight by NASA.

New Compact Satellite Navigation Receivers for the Navy

The Navy has ordered from Magnavox 32 sets to be used on special purpose surface ships. The receivers will be used with the Navy Satellite Navigation System, better known as Transit. The system consists of several navigation satellites in circular polar orbit about 600 miles above the earth along with a network of ground stations which predict and record the satellites' constantly changing orbits. Due to the large size and great cost of the receiving equipment, the primary users until recently have been Polaris subs and a few surface ships. The new receivers and computers are two feet square and weigh only a few hundred pounds compared with the thousand pounds for the previous receiving gear.

Satellite Earth Stations in Red China

A satellite communications earth station supplied to the Peoples' Republic of China by RCA Global Communications went into commercial operation recently to handle TV and other communications services between China and the U.S. The station, installed near Shanghai in only 30 days, provided live TV coverage of President

Nixon's visit there. The station is operating with the new Intelsat IV satellite located above the Pacific and links Shanghai with the Jamesburg, Calif. earth station. Another earth station, installed by Western Union International, is located in Peking. This station has been working flawlessly to provide the same type of coverage. Other ground station news is the recent signing of a contract between ITT and the Greek Postal, Telephone and Telegraph Administration for a second earth station in Greece. The first ground station works with the Atlantic Ocean satellite while the second one will work with the Indian Ocean satellite.

TV Audio is Seen by the Deaf

Millions of TV viewers were unaware that subtitles were shown along with the pictures in a recent ABC network show. Scores of deaf students at Gallaudet College in Washington, D.C. were reading the dialog as they watched the show. The event showed how captions could be transmitted without disturbing the picture in any way. The system, called TV Time, devised at the National Bureau of Standards, sends the caption in electronic code on the bottom line of the TV screen which can be translated into visual messages on the picture of specially adapted receivers.

Computer Diagnosed Electrocardiograms

Hospitals may now have electrocardiograms completely diagnosed by computer in as little as two minutes through a new emergency service being offered by Cro-Med Bionics Corp. The system uses a computer to provide a detailed EKG diagnosis which can be used by any physician. At the same time that a hard-copy tracing of the patient's EKG is taken, the impulses are recorded on magnetic tape and transmitted by telephone to the company's computer center in New York. The diagnosis is then sent back to the hospital by telephone or teletypewriter.

Facsimile Via Phone Lines

A facsimile system that reduces the cost of transmitting newspaper and magazine pages to distant printing plants by as much as 80 per cent has been introduced by Litton Industries Datalog division. By compressing words and pictures on a printed page into digital pulse groups, the new system allows high-speed transmission of reproduction quality facsimile over low-cost telephone lines. Currently, full-page newspaper and magazine facsimiles are transmitted over expensive wide-band communication channels. Bandwidth required for the new system in about 3 kHz compared to the 48 kHz required for wide-band transmission.

Electronics for Law Enforcement

A new two-way radio system that automatically reports a patrol car's status has been installed by the Jefferson Parish, Louisiana, Sheriff's office. Radio interrogation of the vehicle produces an instantaneous response showing the vehicle's identity and its status. The system substitutes number codes for a variety of routine radio messages now relayed by voice. In addition to exchanging digital and voice messages, the new system, developed by RCA, can be used by the radio dispatcher to blow the horn of the patrol car when the officer is out of the vehicle. In a related development, an RCA computer has been credited by Camden, N.J. police authorities with increasing criminal arrests by 10 percent.

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CIRCLE NO. 35 ON READER SERVICE CARD

Four-Channel Sound

What, How, and When?

IN order to understand 4-channel sound, we must first understand what "high fidelity" means. According to Webster, it means "the reproduction of sound with a high degree of faithfulness to the original." For decades, this re-creation of a live concert perfomance in your home has been the goal of the audio industry. The whole chain of hardware—from the microphones which recorded the sound to the speakers that reproduced this sound in your living room—has been improved to the point where there is practically no difference in the live and recorded sound. But, do we now have true "high fidelity?" Not yet. The audio industry had actually arrived at this point, using a single channel of sound (monophonic), back in the late 1950's.

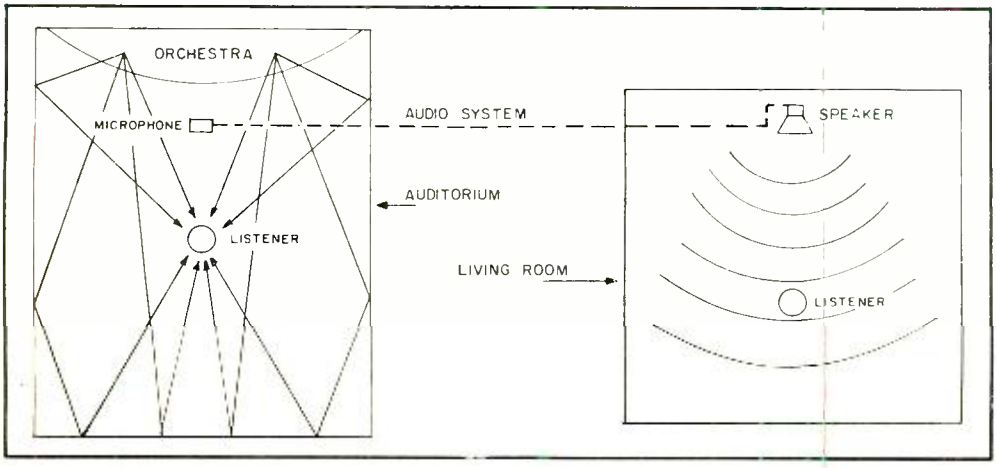
Fig. 1 is a simplified illustration of how an orchestra was recorded. Sometimes multiple microphones were used in a session, but they were mixed down to a single signal which eventually made its way into the listening environment of your home.

But, there was still something missing from the concert-hall environment. Stereo was developed in the late fifties and increased the "concert-hall" feeling considerably. As Fig. 2 shows, an orchestra was no longer beamed to the listener from a single point but was dispersed across a line stretching between two speakers in a virtual curtain of sound. The orchestra now had breadth. The violins seemed to come from the left side, the percussion from the middle, and the brass from the right—or however the conductor actually arranged his musicians. The recorded orchestra was now beginning to sound like its live counterpart.

However, one still did not have the illusion of "being there." The problem lay in the strange world of psycho-acoustics. This pertains to how our ears and brain interpret sound. In a concert hall, we are immersed in the sound coming from all directions: the direct sound from the orchestra on stage; the reflected sound bouncing off the side walls, the ceiling, and the rear wall; and the sounds of the audience clapping, talking, coughing, or moving in their seats. All of these sounds are present in the hall during a live concert.

Acoustic engineers have always been con-

Fig. 1. Basic operation of single-channel (monophonic) recording and playback system.



A STATUS REPORT ON QUADRAPHONIC SOUND— TELLING WHAT IT IS, HOW IT IS PRODUCED, AND WHEN YOU CAN EXPECT TO HEAR IT

BY WILLIAM CAWLFIELD
Ampex Corporation

cerned with the "liveness" or "ambiance" of a particular hall. You may not be aware of this ambiance until it is no longer present and you are sitting in the acoustically different environment of your living room.

Four-channel sound was conceived as a means of fooling your brain into thinking you are at a live performance. It is an illusion of being there and not the real thing —but still a very good illusion indeed. See Fig. 3.

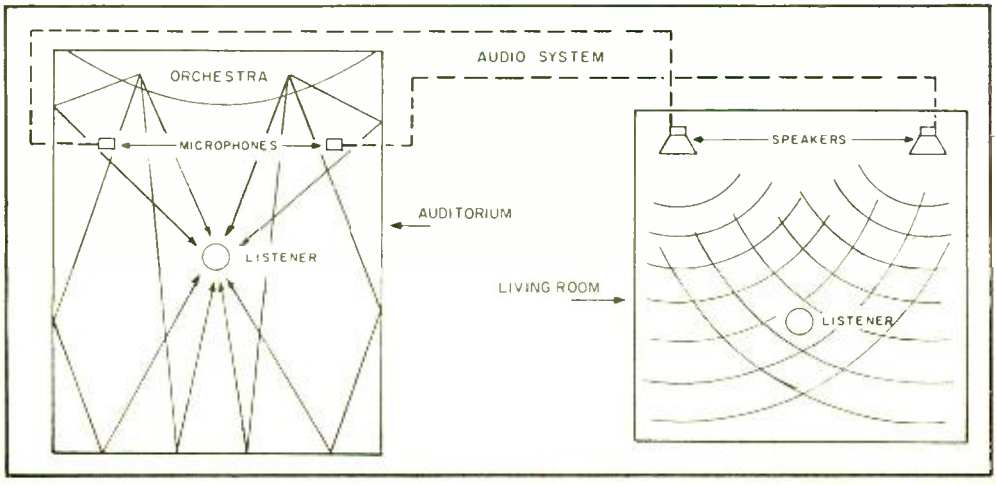
There has been some grumbling that the audio industry has just "created another gimmick." That all it is concerned with is to obsolete your present equipment and sell more speakers. This is simply not true.

Some people say, "Give me an excellent stereo rather than a good 4-channel system any day." The same thing was being said about stereo a decade ago: "Give me excellent mono rather than good stereo." These statements can sometimes be traced to an individual's concern over the "nuts and bolts" of his equipment rather than the total sound field generated by his system. They can also be traced to a reluctance to change.

The entire electronics industry is a dynamic one because of change; and each change has improved the overall enjoyment for the consumer. From radio to television, from black-and-white television to color TV, from tubes to transistors, from wire to magnetic tape—each step has caused some problems, but they were easily overcome. The advent of 4-channel does not mean that 2-channel sound is obsolete any more than color killed black-and-white television. Price and convenience will still make 2-channel stereo an important part of the audio scene for the foreseeable future.

Achieving 4-Channel Sound. Let us now look at the various ways of achieving 4-channel sound. The most straightforward method is called "discrete." This is a copy of the master tape which consists of the two tracks of music that was fed to the microphones near the orchestra and two tracks picked up by microphones placed out in the hall itself—generally toward the rear. These four channels of music are recorded onto a tape and reproduced in your home by means of a tape player that is equipped

Fig. 2. Two-channel (stereophonic) recording and playback is shown in this diagram.



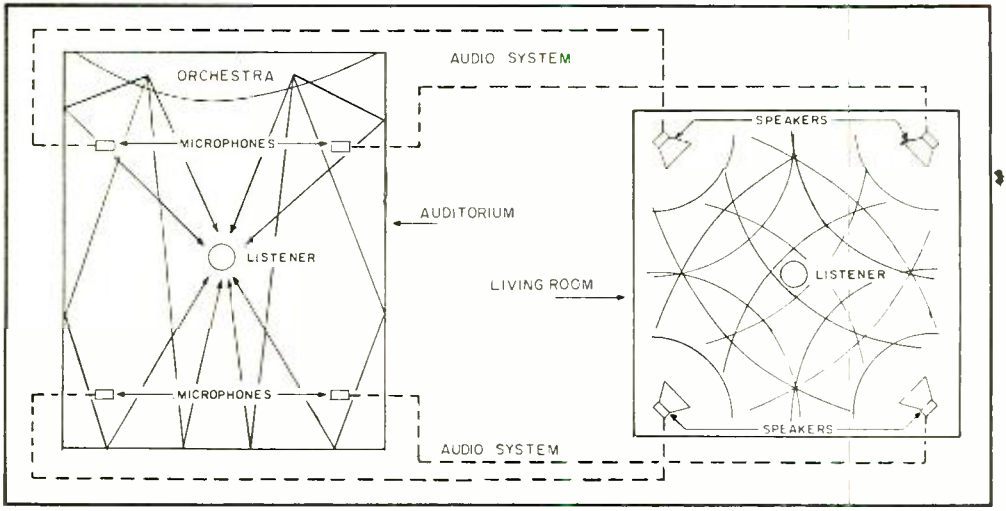


Fig. 3. Four-channel sound reproduction gives an illusion of concert-hall ambiance.

to pick up the four channels of music and send them through four amplifiers to four speakers (Fig. 4).

In this way, the orchestra comes to you from the front speakers while the rear speakers recreate the ambiance of the hall. You are literally there. You are immersed in the hall and, depending on your seating preference, you can adjust the front and rear balance and put yourself in the front row, a middle row, or way in the back.

The use of four channels has spun off another interesting byproduct. This is in the field of pop music which was never performed in a concert hall, but rather in a studio. Thus, the four channels can be used to surround the listener with singers or instrumentalists in the group.

Is this true high fidelity, as defined by Webster? Well, probably not, but increasing your enjoyment of the music is what it's all about. What one person enjoys may not be the same as what you like. One person likes jazz while another likes classical music. It is all a matter of personal preference. If someone likes to feel immersed in the orchestra, is it better or worse than sitting in front of the orchestra? Musical enjoyment, like art, is a very personal thing.

It is interesting to speculate whether some "purists" who look with disdain at this surround concept of 4-channel sound really know how most recordings are made today. One finds that most stereo discs are, in reality, two mono channels. The music, like a film, is "created" in the editing room where segments are blended, cut, overdubbed, slowed down, or speeded up to create a complete product. The whole orchestra may not even record in the same room or on the same day. Echo or reverberation is added during the mixing.

It is the author's feeling that it does not make any difference whether the complete product is sent into your home out of two channels or four. Neither concept is "purer" than the other. If the effect is more pleasing with four channels, then you should receive four channels. At times, 4-channel sound with the rear channels containing the ambiance material is pleasing, while at other times the surround-sound effect of being immersed in the music is preferable.

The most popular tape format for discrete 4-channel sound is the 8-track cartridge system. Its advantages are many, including the fact that, being a continuous loop, you never have to rewind after hearing the program; and, because of the immense popularity of the 8-track format, prerecorded material will be more readily available. It is too soon to know what the reel-to-reel market will do, but it is assumed that the only demand for the reel-to-reel format, until discrete records or FM broadcasts become available, will be from the live-recording hobbyist. The cassette, because of track-width restrictions, will probably go the way of records and FM broadcasts by achieving 4-channel sound through the use of a "matrix" system—for the next few years at least.

The Matrix System. The matrix method

of achieving 4-channel sound consists of encoding four channels of information into two channels by mixing them together in a complex phase and amplitude relationship. See Fig. 5. These two channels of information can then be pressed into a normal stereo record, broadcast over an FM-stereo station, or recorded onto a 2-channel stereo tape. When you play these two channels of music through the proper equipment, including a "matrix decoder," the two channels will be restored somewhat to the original four channels. The degree of restoration and the cost to the customer are the problems being debated in the industry.

Various companies have introduced matrix decoders. When all the marketing superlatives have been stripped away, the various systems have only two ingredients to work with—one is the coefficients and the other is phasing. The coefficients are the terms in the formulas that specify how much of each channel is mixed or separated from another. The phasing is an attempt to gain more distinctness between the channels. A commonly used phase shift is 180 degrees. The more complicated matrix circuits use 90-degree phase shifts.

One of the first major matrix systems was introduced by Electro-Voice. The heart of the unit is an IC chip that contains all the resistors, capacitors, and transistors that will decode by the proper coefficients and detect signals 180 degrees out-of-phase. It is the most popular matrix decoder because E-V made the IC available to all manufactures at small cost to encourage the adoption of its system. There is an encoder available to record companies and FM stations who wish to encode 4-channel music into two channels.

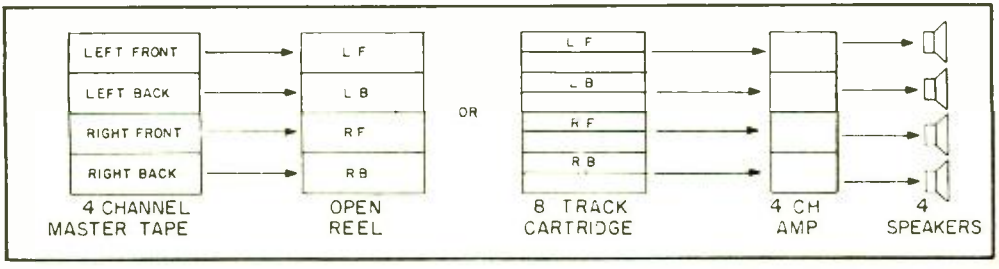
This system looked as if it would capture the market until CBS announced another matrix system that was claimed to be better. The problem was that it utilized different coefficients than E-V and 90-degree phase shifts. This 90-degree phase shifting is sometimes described by CBS as the mechanical movement of the record stylus tracing these signals. The stylus will create a clockwise or counterclockwise helix as it moves along the groove. The Columbia system, called "SQ," is licensed to Sony, Harman-Kardon, Sherwood, Masterwork, Lafayette, Metrotec, and Radio Shack at the present time—and probably to others by the time you read this. Columbia, Capitol, and Vanguard have all announced record releases under this system.

Sensing a battle of non-compatible systems and acknowledging the strength of Columbia's record library, E-V has announced that a new chip will soon be available containing coefficients compatible with the CBS SQ system and that the circuit will have additional components to detect 90-degree phase shifting. This latter development now provides two systems that are compatible.

Sansui offes another matrix decoder that features 90-degree phase-shift circuits. Sansui's main push so far is the use of its decoder as an enhancer of stereo recordings. This circuit, like Electro-Voice's, detects signals that are at various phase relationships with each other, and directs these signals into appropriate channels where they eventually emanate from four speakers to create a total sound field in the listening room. Originally, the missing link was an encoder. This encoder is now available, but may be changed—as various record companies, especially Columbia, begin pouring out discs encoded in the SQ format—so as to have similar coefficients in order to be compatible.

Everyone claims his idea is the best and this is actually good for any dynamic industry. However, sometimes the difference between two systems is so minute that there are no practical differences. This, then, brings us to the word "compatible." The

Fig. 4. The discrete four-channel systems keep the individual channels separate.



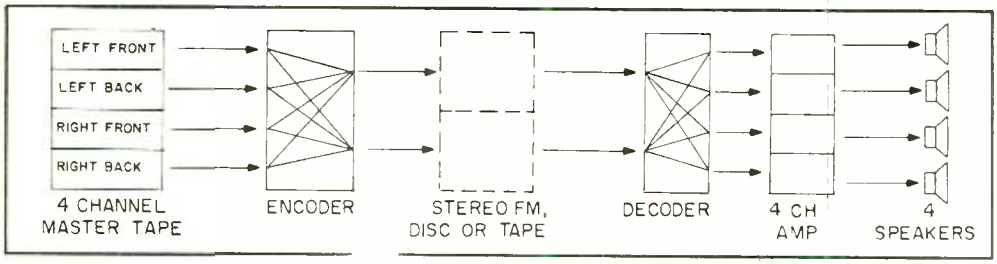


Fig. 5. In a matrix system, the four channels are combined into two as illustrated here.

author feels that if a recording is made with a solo trumpeter placed in the right-front channel and a drummer in the left-rear channel, any decoder that places them in the proper locations is compatible with the encoder used at the studio. And this is true regardless of whether the coefficients and phase angles used are identical or slightly different.

Again, psycho-acoustics come into play as to what we perceive as being a good reproduction of live perfomance. The degree of separation between channels from a matrix system is much less than with a discrete system. There is more blending of the channels in matrixing which some people actually prefer to the distinctness of the discrete tape system.

However, if more apparent separation is desired, a circuit can be added after the matrix decoder to enhance the 4-channel effect. This generally consists of a logic circuit that controls the gain of the four channels. When it detects an instrument that is louder in one channel than the rest, it will boost its level somewhat and reduce the levels of the other channels a bit. This gives the illusion that the instrument is located closer to that particular corner of the room than it was before the logic circuit took over.

These elaborate matrixing systems, some featuring this gain-riding logic circuit, will be more expensive and only appeal to the sophisticated music lover.

The matrix system has advantages over the discrete other than the fact that it can be used for 2-channel records, tape, and FM-stereo. This feature is that you can convert many existing stereo systems to 4-channel quite easily. The only requirement is that you can place this matrix decoder into your amplifier circuit before the final stage. This hookup requires having either separate amplifier, tuner, and phono components, or a tape-monitor jack on the amplifier. Some companies have placed special jacks on the backs of their music-playing systems which will accept matrix decoders.

The matrix decoder can sometimes be used to enhance normal 2-channel stereo music. The decoder will attempt to split it into four parts by analyzing phase and amplitude relationships and a "synthesized" 4-channel sound is created. This has led some people to confuse the main purpose of matrixing, which is to encode from four channels down to two and back to four. With this spinoff use of creating four out of two channels, the effect is quite pleasing. Because of the limited library of 4-channel music at present, you will find that most of the time the decoder is being used as a synthesizer.

Another method of bringing 4-channel sound into your home has been introduced by JVC of Japan. RCA and Panasonic have announced that they will be supplying records and equipment for this system. The method is not true discrete nor a matrix, as previously described, but a system in between. The four channels of a master tape are combined in a special formula and a coding signal is generated. This method is similar to the multiplex system used today in FM stereo. The coded signal is pressed onto the record as well as the multiplex and when played back the two signals combine to create four individual channels of information. Because of the better separation this system provides over the matrix method, it has been called a discrete system.

One drawback at present is that the record system must be able to handle frequencies as high as 45,000 Hz. This is not a major problem for a sophisticated phono cartridge to handle. The magnetic cartridge has this capability within sight. The problem will arise when this response is needed in an inexpensive ceramic cartridge.

You may ask why this is important when you own a sophisticated system? Well, the

music industry must produce records that will be purchased in the hundreds of thousands. In order to have a large selection of records from which to choose, this mass market must exist. A large choice of selections simply cannot be provided for a small, specialized market. If the RCA-JVC system is to survive, some improvements—which, incidently, RCA and JVC have said will be made—must occur. First, the need to produce an inexpensive ceramic cartridge for the mass market must be met; second, the problem of not being able to play this 4-channel record on a normal stereo machine without destroying the high-frequency coded signal must be overcome; and finally, the durability of the disc must be improved.

The catch is that even if all these things are done, the system may not be practical. To use this system on FM will require years of testing before the FCC will sanction it. This would then make the RCA-JVC system work only for discs, not FM or tape. So, at the present time, the E-V or CBS matrix system, which can be used today on any format without FCC approval, would seem to give the matrix a favorable edge.

Four-Channel Converters. Many consumers today want to try 4-channel sound in their homes, but are not quite sure if they will like the effect or what system to go into. They are taking a "building block" approach. This involves the purchase of a small "black box" converter sold by many companies now, but originally conceived by Dynaco. See Fig. 6.

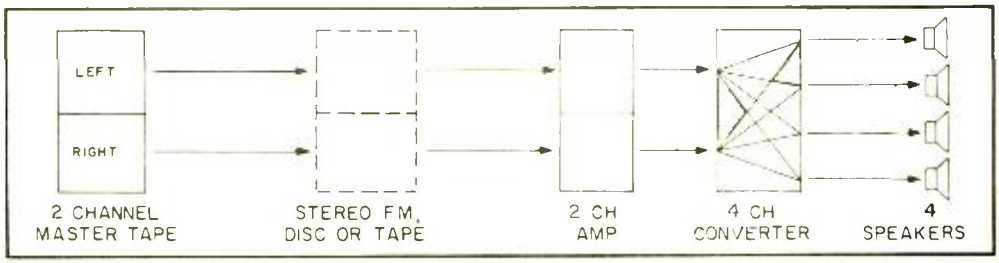
All that is required as an investment is the converter and two more speakers. If, at a later date, you decided to go further by investing in a matrix decoder and/or discrete tape player, the speakers have already been purchased and the matrix decoder or tape player will then require just another stereo amplifier. The only casualty in this build-up approach was the original inexpensive "black box."

The converter takes advantage of a very simple concept. Many times during a recording session, sounds that are 180 degrees out-of-phase with the rest of the music will be recorded on the tape. This is generally not a problem when listening through a normal stereo system and, therefore, no efforts are made to eliminate these signals. Many records or tapes out in the field have this "hidden music" on them. Through the use of a simple resistive network across the two positive terminals of the stereo amplifier, the out-of-phase sound is recovered and fed to the rear speakers. Some of the ambiance of the live recording appears at the forward microphones out-of-phase and so, in this hookup, the recorded ambiance will be accented in the rear speakers. A solo instrument or singer that appears equally in the left- and right-front speakers will be canceled out of the rear speakers. In this way you will be surrounded by music and yet instruments will seem to come from various parts of your listening room.

The system does not have the accuracy of the true matrix system but it is a simple way to get started if you are not quite sure you will like the effect. Also, because it does not require any hookups before the amplifier but is merely connected to the existing speaker terminals, this conversion can be done by anyone.

So, in the months to come, you will see many different methods of obtaining 4-channel reproduction. If you know what the various methods involve, you will find it less confusing. If you know how far you want to go, how much existing equipment you want to keep, and how much distinctness in the separation of channels you want, you will find equipment for your purpose now—and in the very near future—available on your retail dealer's shelves. ◈

Fig. 6. This is a derived or ambiance recovery system using a four-channel converter.



Minicomputers -What They Are and What They Can Do

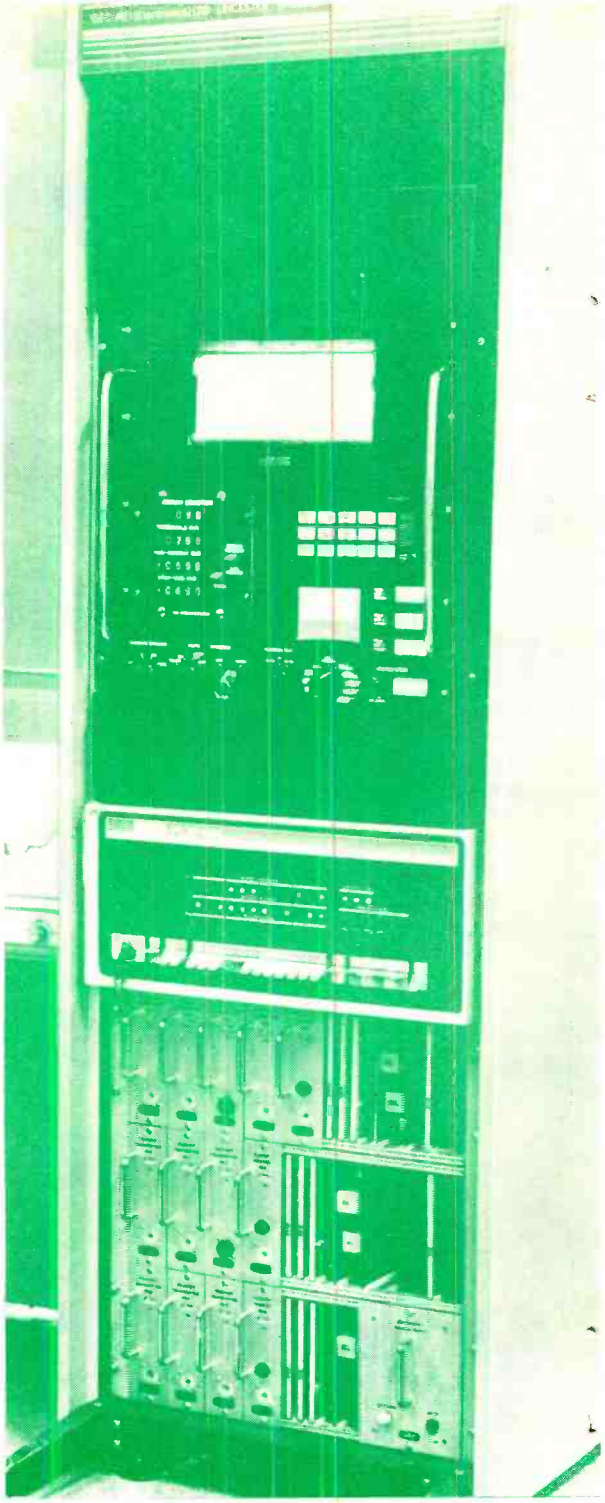
A LOOK AT APPLICATIONS OF THE INCREASINGLY POPULAR SMALL-SIZED COMPUTER

BY DAVID L. HEISERMAN

ANYONE who is familiar with the meaning of such mod terms as "miniskirt" and "minibike" can conjure up at least a vague notion of what is meant by the term "minicomputer." In simple terms, a minicomputer is a small computer—at least as far as size is concerned.

The sale prices of minicomputers are not very small, but neither is the present rate of sales. Even with price tags for the bread-box-size computers ranging from $6000 to $25,000, more than 10,000 of them have found their ways into new kinds of electronic instrumentation since 1968. More than half of these were sold during 1970, and the rate of sales will most likely double again in 1972.

There must be something revolutionary about minicomputers which cost more than a new Cadillac but still sell faster than candy bars at the movies. They must offer



Digital Equipment Corp. minicomputer with host of input/output blocks uses airport runway data measured photoelectrically to obtain visual range.

the buyer something unique and useful. Any little instrument that can keep more than 70 computer manufacturers—many of them flourishing new companies—turning out minicomputers at full capacity is bound to have a powerful impact on modern business, industry, and technology.

Minicomputers are basically stripped-down versions of the large general-purpose machines. In fact, many of the well established computer firms make their minis from a small selection of the most important circuit boards and components used in their large computer products. Some minis have a few more "accessories" than others; a few have larger memories, operate faster, and can handle more sophisticated tasks. But all minicomputers behave like their larger counterparts. Only the prices and data-handling capacities are "mini."

Stripped-Down Computers. One of the first things minicomputer engineers strip away from big computer designs to make a mini is the number of bits that appear in each instruction or data word. Whereas the large computer typically handles up to 36 bits of information per word, minis generally take on between 8 and 16 bits per word. It is possible to parallel several minis or use some programming tricks to extend the word length, but for most minicomputer applications, 16-bit words are long enough.

Another cut is in the size of the ferrite memory core. Large computers have storage space for millions of bits of digital information. Most minis come equipped with a memory capacity of 4000 16-bit words. The user can, however, buy extra 4000-word memory modules to expand storage capacity to 32,000 words.

The third major cut in sophistication is in the mini's programming capability. Any computer's internal workings operate on a complicated sequence of "1" and "0" binary codes. It is possible, and sometimes necessary, to program a minicomputer by feeding it a program written in the awkward binary form. A set of switches and lights allows the user to "converse" with the mini in binary language.

Since binary language is awkward for most people, manufacturers now include an assembly program in their minicomputers. This fixed program lets the user instruct the computer via standard typewriter symbols and words. The user still has to feed in one

Minicomputers, such as this one from Xerox Data Systems, are used as aids in many different kinds of research.

instruction for each tiny step the circuits must take, but the built-in assembly program makes custom programming a simpler and speedier process.

Newer minicomputers take the programming one step further. Many models currently available have compiler language such as FORTRAN, ALGOL, and BASIC fixed into their memories. These sophisticated programs take a simple input command—such as "add"—and translate it into the dozens of separate binary commands the machine needs for carrying out the operation.

Like the custom programs, built-in assembly and compiler programs take up valuable memory space and thus add to the cost and complexity of the minicomputer. The FORTRAN program, for example, takes up a full 4000-word memory module in most cases. If the user wants a 4000-word capacity for his custom program, he must outfit a mini with at least an 8000-word memory, 4000 to do the real work and another 4000 to make programming easier.

Because memory space in a minicomputer is precious, users seldom try to store more than one custom program at a time. Whenever a program change is wanted, new instructions are fed in via punched cards,

paper or magnetic tape, or a teletypewriter keyboard. This type of reprogramming can be troublesome and time consuming; so, most minis operate in a dedicated mode (one-program) application.

Within the limits imposed by the small size of the memories and arithmetic units, a mini can perform just about any type of task a large general-purpose computer can handle. Although a mini might spend its entire lifetime performing only one of several different types of tasks, the user has a virtually unlimited number of tasks from which to choose.

Considering its small size, rugged construction, and relatively low cost, a minicomputer is far more suitable for most on-the-spot data acquisition, control, and data processing operations than is any large computer.

Gathering The Data. Many scientific and industrial processes require the gathering of large amounts of data from many different sensing devices over a very short period of time. Using a minicomputer data acquisition system, data can be gathered from hundreds of sensors virtually instantaneously with the results printed out on a teletypewriter.

A mini can take care of all the data manipulations as fast as the sensors can provide the information. It can calculate averages, smooth out random fluctuations, look for critical readings, and construct graphs and tables in less time than it takes a man to jot down a single set of readings.

This minicomputer system from Varian Data Machines, like many others, is used in medical research/treatment.

A single centrally located computer could take over the work of dozens of minis scattered around a large plant or lab facility, but the cost of a single large system is far greater than that of ten of the more expensive minis. Too, a user can buy minis a few at a time and spread out their cost as opposed to the large initial outlay for a single general-purpose computer.

Most kinds of sensors (thermocouples, pressure sensors, strain gauges, etc.) generate analog signals. A minicomputer, a digital device, employs input amplifiers to scale the analog voltages to the proper levels and analog-to-digital (A/D) circuits to translate the analog signals into digital form. These input devices and the mini and peripheral equipment make up the building blocks for a complete minicomputer data acquisition system.

Under the control of an acquisition program stored in the mini's memory, the system samples data from each sensor, assigns binary codes, and stores the data in another part of the memory. If the program calls for data manipulations, the computer pulls the appropriate data out of the memory and performs the assigned operations. Using a display program, the mini can print out the results on a piece of paper, display it on a CRT screen, or store it on punched cards or magnetic tape.

Minicomputer data acquisition systems do more than just gather and print out data. They also manipulate the data, putting it into a form that is more useful to the human operator and other machines.

Process Control Applications. The only real difference between using a mini for data acquisition and in control applications is that, in the latter, emphasis is on controlling other machines rather than gathering data from them. Minicomputers are so well suited for process control applications that they are beginning to take over from punched-tape machine controls.

Instead of taking instructions from a moving punched tape, the mini quickly calls up rapid sequences of control instructions from its memory. By means of a preset program, it can control motors and valves in machinery as simple as a punch-press or in systems as complex as NASA's Lunar Excursion Module.

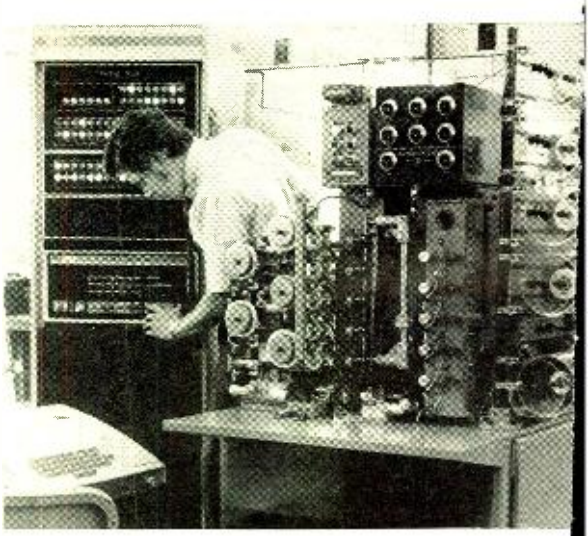
Just as most sensing devices produce analog signals, a goodly number of the devices a mini must control operate on analog volt-

ages. This means that D/A converters and power amplifiers must be used between the mini and the devices it controls. Using a building-block approach, an engineer can assemble just about any kind of custom minicomputer control system he desires.

Traditional Mini Roles. Minicomputers demonstrate their most unique capabilities in industrial data acquisition and process control applications where no other computing device has been able to meet, effectively and economically, so many different kinds of challenges. So, it is easy to overlook some of the more traditional jobs they can perform.

In an engineering office, for example, a mini can carry out most design and analysis problems engineers encounter. With a small mini close at hand, there is no need to wait in line for time at a big computer, and there is no need to struggle with the schedules and peculiar operating characteristics of commercial computer time-sharing services. The minicomputer is available at all times; and, since most users buy their minis outright, there are no running-charges to deal with.

These advantages apply to business offices as well. Office users of minicomputers include those who must process a lot of information daily but would have insufficient running time to justify the cost of a large computer system. In business data processing applications, minis can operate in conjunction with any of the traditional computer input and output devices, including



Digital Equipment Corp. minicomputer used in conjunction with controller of an automatic coil winding machine.

punched card and magnetic tape equipment.

Throughout most of the 25-year history of modern computer technology, engineers have placed emphasis upon developing faster computers which can handle more information with more efficiency. With the coming of large-scale integrated circuits (LSI's), this trend is reaching a new plateau. There will always be a demand for larger and more sophisticated computer systems, but there is a greater and more immediate need for computers at the minicomputer end of the scale. ◈

COLOR TV PROJECTION SYSTEM

A NEWLY developed color video projection system that can project color TV images on a large screen was demonstrated recently to the press. Using a simple optical projection system, the image from a 12-in Trinitron CRT was projected onto a screen measuring 30 by 40 inches. Developed by Sony Corp., components of the new system are expected to go on sale in the U. S. this fall. (See News Highlights column for May.)

Projected TV images were viewed in a darkened room. Picture quality was excellent.

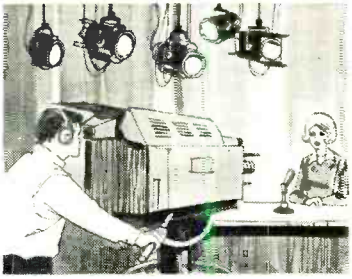
The "Sony Color Video Projection System," as it is called, can project pre-recorded programs from a video player, or it can project programs taken off the air with the aid of an additional TV tuner/adapter.

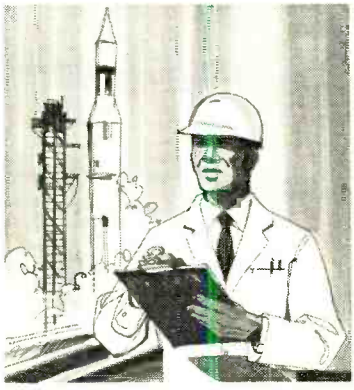
Price of the video projector will be around $2000. The special curved screen will cost an additional $250. The screen has high reflection efficiency and good contrast. Price of the video player is just under $1000, while the selling price of the TV tuner/adapter, although not established as yet, is expected to be around the price of a color TV receiver.

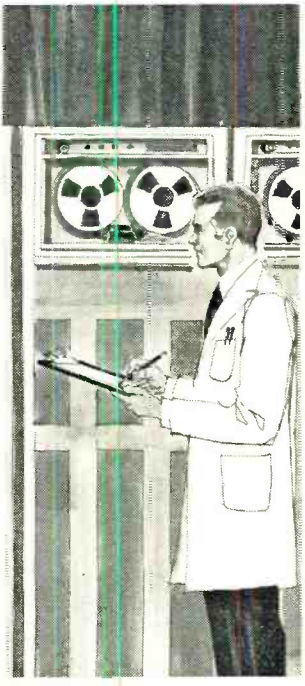
It is expected that the first uses of the new system will be in the commercial area, in schools, or in public places, such as airports, hotel lobbies, or exhibition halls. Later the system may find use in the home where the screen could be mounted on a wall.

The 12-in. Trinitron, the heart of the projector, uses new, highly efficient phosphors and is operated at a high brightness level. ◈

Great careers







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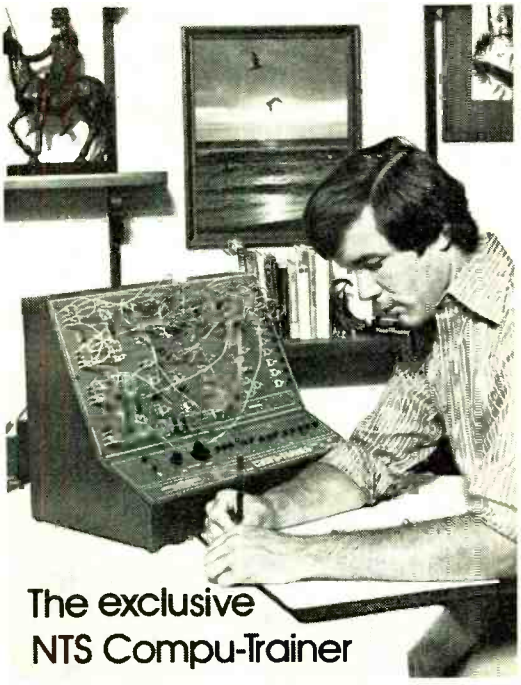

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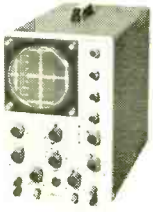

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New Thermal Viewer Has Civilian Uses

IF YOU really want to see a black cat in a coalbin at midnight, the Night Vision Laboratory of the Army Electronics Command has developed just the thing for the job. It is the Thermoviewer, a handheld thermal viewer (AN PAS-7) whose civilian applications may well exceed its primary military use of detecting and recognizing personnel targets at night.

Handheld Thermoviewer detects objects by observing temperature differences.

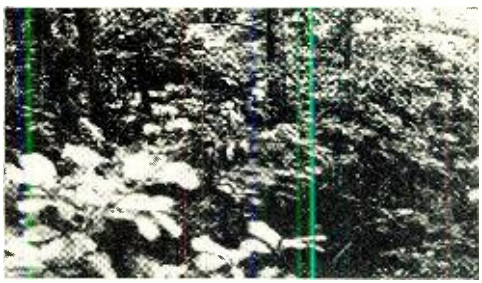
The Thermoviewer has already been successfully used to detect loose rock that might cause mine cave-ins and to study earth surface temperatures in geological surveys. Other potential uses include detection and mapping of thermal pollution in water and a variety of medical applications—such as detecting cancerous tissue beneath the skin and studying burned tissue.

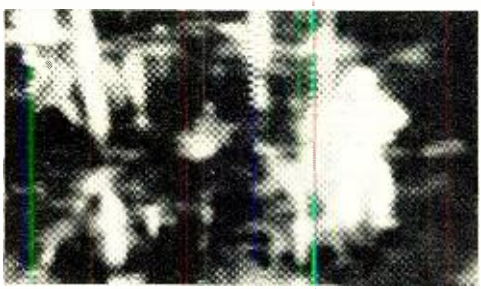
Weighing only 6 lb, the Thermoviewer can be handled as easily as a pair of binoculars. It is powered by a belt-mounted rechargeable battery pack capable of 12 hours of continuous operation.

Images are created by sensing temperature differences between the object being viewed and its background. The Thermoviewer has a detector array of lead selenide, thermoelectrically cooled to almost −160° F. The array is scanned electronically to create an image on a phosphor screen visible through the eyepiece. The principle used is not new, but previous equipment was heavy, bulky, and took 20 minutes to create a visible image. The Thermoviewer, however, works in real time, creating images instantaneously. Furthermore, it needs no outside illumination for creating the image.

Since the Thermoviewer detects only differences in temperature, it can be used in either darkness or daylight. It can also be used to see through light fog or haze because it works at a longer wavelength than that of visible light.

In its significant civilian use to date, the Thermoviewer was used by the U.S. Bureau of Mines in conjunction with the Night Vi-

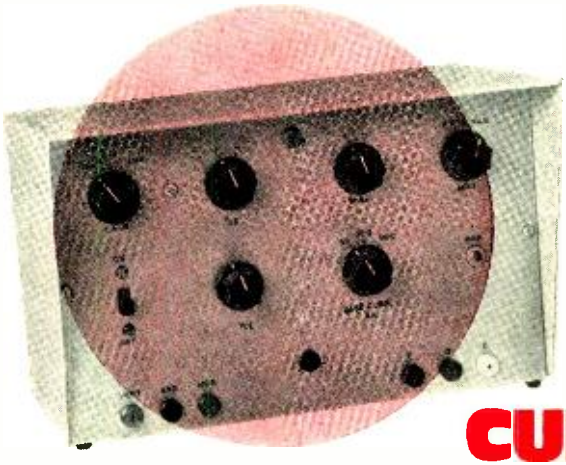




In photo above, soldier in foliage is virtually invisible. Below, the viewer spots him easily, near right side.

sion Laboratory to find hazardous loose rock behind apparently solid mine walls, and by the Remote Sensing Geophysics Group of the U.S. Geological Survey in making a detailed study of conditions which affect surface temperatures of the earth.

Phillips Broadcast Equipment Co. of Mahwah, N.J. was selected to build 20 models of the Thermoviewer for the Army and civilian agencies. ◈



BUILD A VERSATILE SEMI-CONDUCTOR CURVE TRACER

CREATES CHARACTERISTIC CURVES FOR MOST SEMICONDUCTORS

BY JOHN KEITH

SEMICONDUCTOR characteristic curve tracers have been used very little by experimenters and hobbyists because many people are just not familiar with their operation. Then too, commercial units are expensive. However, a curve tracer is almost indispensable when you need to know the characteristics of the semiconductors you have on hand, especially when you are looking for a pair of matched devices for a particular application.

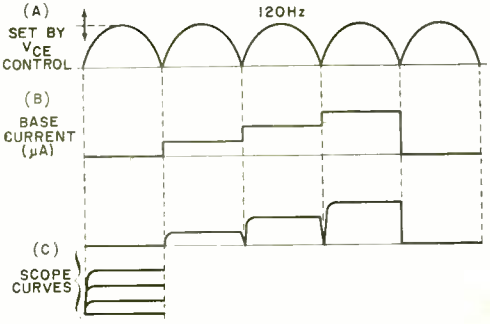
A curve tracer automatically displays the voltage-current parameters of a semiconductor device by varying one parameter while measuring another. Although this can be done manually, it is a slow, tedious job requiring many individual plots. An automatic tracer, used in conjunction with an oscilloscope, can display a family of curves in a matter of seconds. For example, the collector current curves of a transistor are created by applying the selected collector-to-emitter voltage through a load resistor and varying the base current. A voltmeter connected across the collector resistor will show a variation in indicated voltage as the base bias is varied. Obviously, a selection of different values of applied base bias currents will be needed to plot a "family" of curves such as those seen in transistor manuals.

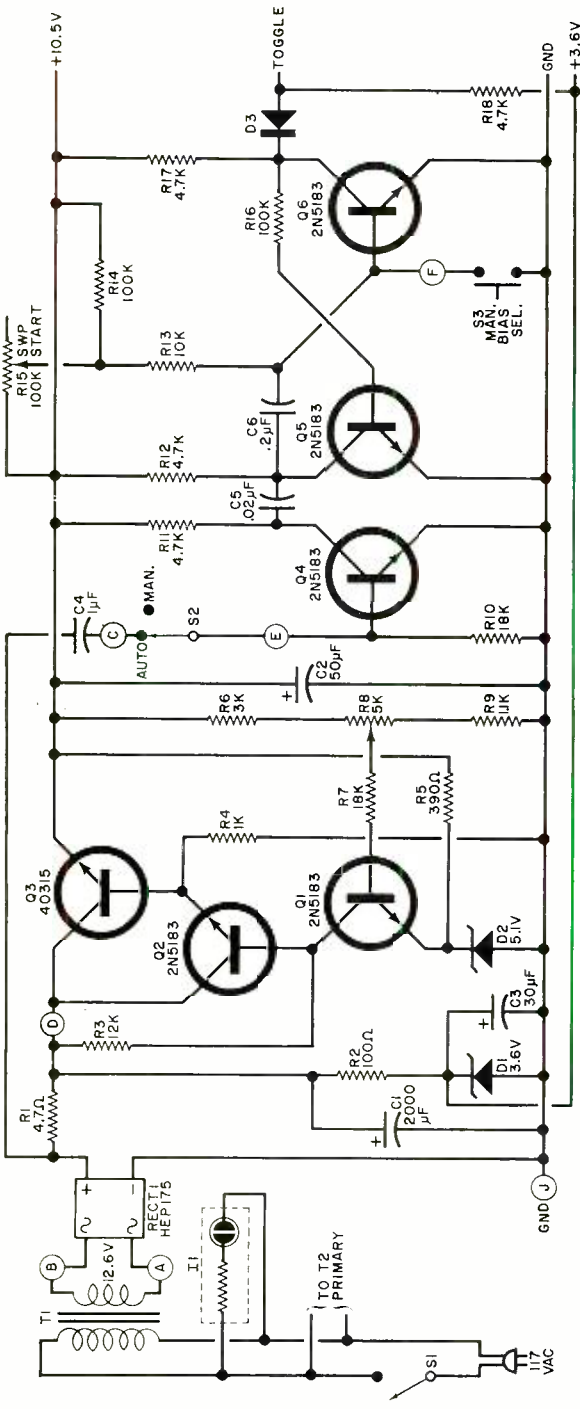
The low-cost automatic curve tracer described here is straightforward in design, easy to use, and makes an excellent addition to any workbench.

Details of Circuit Design. Timing in the curve tracer circuit is set by the frequency of the ac power input. After it is rectified, the input is a 120-Hz half sine wave with a maximum value of about 20 volts as shown in Fig. 1A. This voltage is used as the collector-emitter supply (V_{CE}) for the transistor being tested, with the upper limit determined by a potentiometer. The V_{CE} supply is also used for the horizontal sweep on the external scope while the collector-emitter voltage drop (across a resistor) is applied to the scope's vertical sweep.

During the time of one 120-Hz sweep, the base bias current to the transistor under test is held at a selected constant value by a built-in "staircase" generator that changes

Fig. 1. Waveform at (A) is basic timing voltage. Transistor base current is at (B); while (C) shows how family of characteristic curves is generated.





PARTS LIST

C1—2000-μF, 15-volt electrolytic capacitor
C2—50-μF, 15-volt electrolytic capacitor
C3—30-μF, 15-volt electrolytic capacitor
C4—1-μF, 15-volt disc capacitor
C5—0.02-μF, 15-volt disc capacitor
C6—0.2-μF, 15-volt disc capacitor
D1—3.6-volt, 1-watt zener diode (HEP102 or similar)
D2—5.1-volt, 300mW zener diode (HEPZ0211 or similar)
D3,D5-D13—Any silicon diode
D4—10-volt zener diode (HEPZ0220 or similar)
D14-D17—Rectifier (1N4002, HEP156 or similar)
F1—¾-ampere fuse and holder
I1—117-volt neon lamp assembly (with internal resistor)
IC1—Integrated circuit (MC790P or HEP572)
J1-J6—Five-way binding post
Q1,Q2,Q4-Q10—Transistor (2N5183 or HEPS3001)
Q3—Transistor with heat sink (RCA40315 or HEP53)
R1—4.7-ohm, ½-watt resistor
R2—100-ohm, 2-watt resistor
R3—12,000-ohm, ¼-watt resistor
R4—1000-ohm, ¼-watt resistor
R5—390-ohm, ¼-watt resistor
R6—3000-ohm, ¼-watt resistor
R7,R10,R19,R20,R21—18,000-ohm, ¼-watt resistor
R8—5000-ohm trimmer potentiometer (CTS type U-201 or similar)
R9—1100-ohm, ¼-watt resistor
R11,R12,R17,R18,R27—4700-ohm, ¼-watt resistor
R13—10,000-ohm, ¼-watt resistor
R14,R16—100,000-ohm, ¼-watt resistor
R15—100,000-ohm trimmer potentiometer (CTS type U-201 or similar)
R22—2700-ohm, ¼-watt resistor
R23—500-ohm trimmer potentiometer (CTS type U-201 or similar)
R24—680-ohm, ¼-watt resistor
R25—250-ohm trimmer potentiometer (CTS type U-201 or similar)
R26—1500-ohm, ¼-watt resistor
R28—470-ohm, ¼-watt resistor
R29—10,000-ohm, 5%, ¼-watt resistor
R30—30,000-ohm, 5%, ¼-watt resistor
R31—100,000-ohm, 5%, ¼-watt resistor
R32—100-ohm, 5%, 2-watt resistor
R33—250-ohm, 5W, wirewound potentiometer
R34—10,000-ohm, 5%, ¼-watt resistor
S1,S2—Spst switch
S3—Normally open pushbutton switch
S4,S7—Single-pole, 3-position rotary switch
S5,S6—Dpdt switch
T1—Transformer: 12.6V, 1A
T2—Transformer: 24V, 1A
Misc.—Suitable chassis, knobs (6) terminal strips, line cord and grommet, rubber feet (4), spacers, mounting hardware, etc.

Fig. 2. Power supply and delay circuit of tracer. Regulated supply insures stable operation. The sweep start control is adjusted to remove any curve instability.

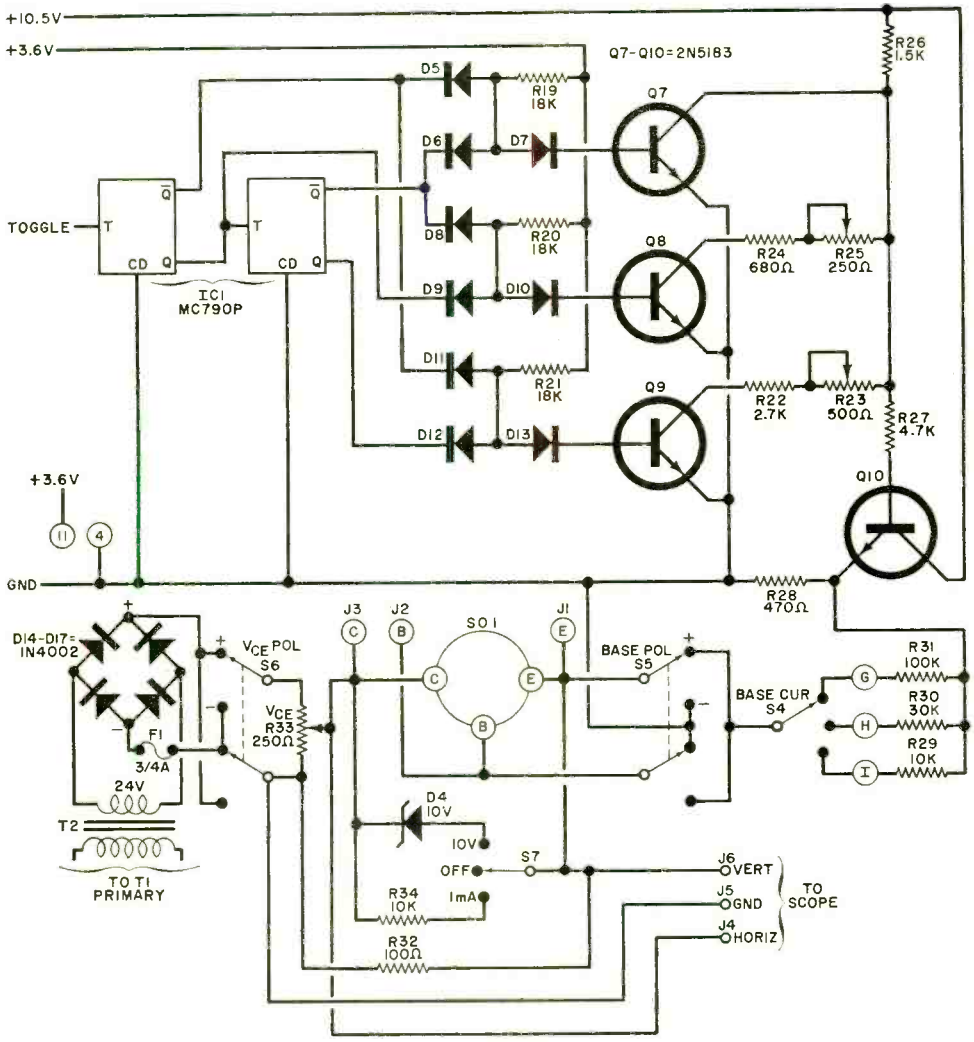


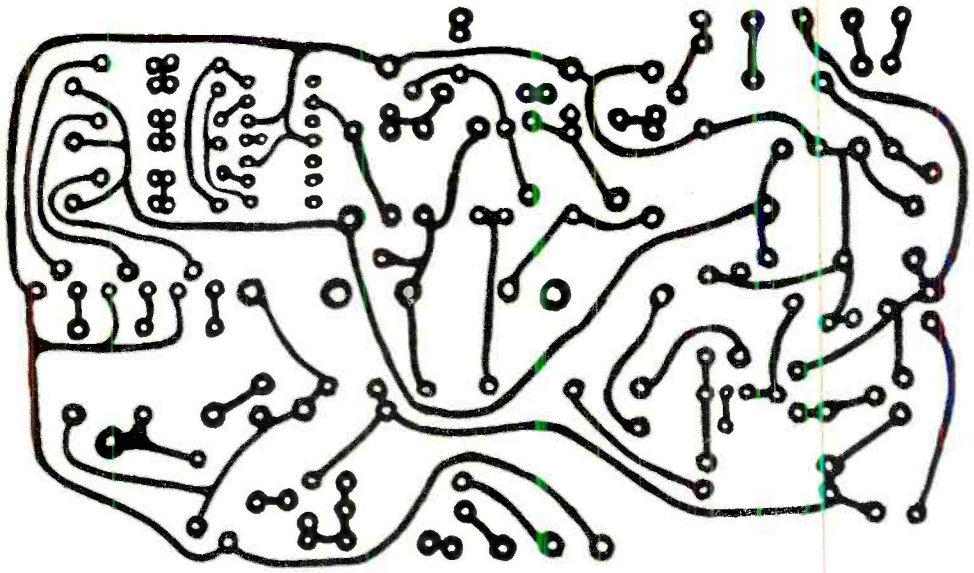
Fig. 3. Staircase generator uses divide-by-four logic circuit in association with diode gating to produce the four bias levels needed to create family of curves.

the bias current during each sweep interval to display a family of four curves. The staircase generator is synchronized to the power line frequency as shown in Fig. 1B. Figure 1C shows the scope curves for each value of base bias, and the final composite family of curves.

As shown in Figs. 2 and 3, a delay circuit consisting of *Q4*, *Q5* and *Q6* provides a variable delay to insure that the staircase switches at exactly the same time as the V_{CE} trace starts. This prevents "clutter" in the display.

Integrated circuit *IC1* provides a binary four count which is applied to *Q7*, *Q8*, and *Q9* through a diode gating network to produce the staircase bias levels. These are summed in *Q10* whose emitter is always at one of four voltage states: 0, 3, 6, or 9 volts. These voltages are determined by the divider made up of *R22* through *R26*; and they are preset by *R8*, *R23*, and *R25*.

The voltage staircase is coupled through one of three series bias resistors—*R29*, *R30*, or *R31*, selected by *S4*. This provides bias current values of 30, 60, and 90 microam-



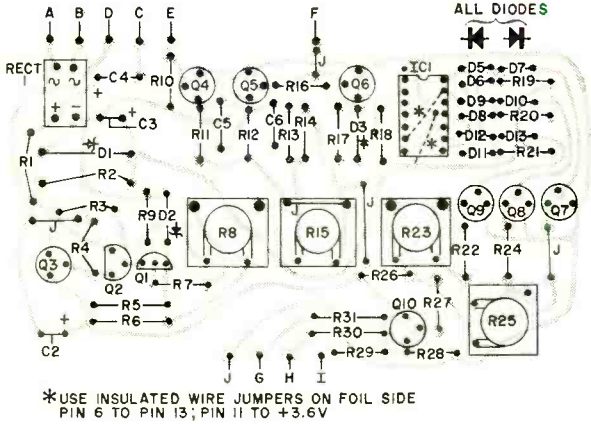


Fig. 4. Actual size foil pattern for circuit board is shown above with component layout at left. Circuit can be assembled on a standard perf board if preferred.

peres; 100, 200, and 300 microamperes; and 300, 600, and 900 microamperes. Each has an automatic zero voltage preceding it.

To add versatility, the polarities of V_{CE} and the base bias are independently selected by *S6* and *S5*, respectively. This permits the analysis of both junction and insulated gate FET's, as well as conventional npn and pnp transistors.

Construction. The curve tracer can be built on a perf board or a printed circuit board (Fig. 4). The board and other components can be mounted as shown in the photograph of the prototype. There is nothing critical about the layout, except that the horizontal and vertical scope termination wires should be kept away from other leads.

Calibration. With the circuit complete and power turned on, check that pin 11 of *IC1* is at 3.6 volts dc. Connect the dc voltmeter to the emitter of *Q3* (ground to minus side of *RECT1*), and adjust trimmer *R8* for 10.5 volts.

To check the staircase generator, connect an oscilloscope to the emitter of *Q10*, making sure that *S2* is in the AUTO position. When the existence of the staircase wave has been confirmed, remove the scope and place *S2* in the MANUAL position. Reconnect the dc voltmeter (10-volt scale) to the emitter of *Q10*. Operate pushbutton *S3* until the voltmeter indicates approximately 9 volts. (There should be four discrete voltage levels indicated as *S3* is operated.) With the voltmeter indicating approximately 9 volts,

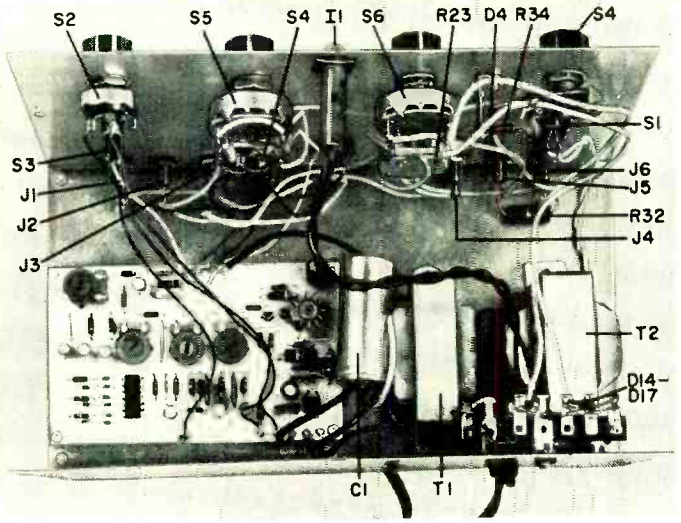


Photo of author's prototype. Note how C1 is not mounted on circuit board. Power supply components are mounted at right.

adjust *R8* for exactly 9 volts. Operating S3 once should cause the voltage to drop to zero, and operating S3 once more should bring the needle up near the 3-volt mark. Adjust *R25* to obtain exactly 3 volts. The next operation of S3 should produce a 6-volt indication which is set by *R23*. The zero is automatic. Retest S3 to indicate 0, 3, 6, and 9 volts at the emitter of *Q10*. When S2 is placed in the AUTOMATIC position, the voltage will be an average 4.5 volts.

For most purposes, the base currents developed by these voltages can be assumed to be correct. However, it is actually one of these voltages minus the base-emitter drop of the transistor under test. For accurate calculations (if needed), the exact base currents can be found from the staircase voltage minus V_{BE} divided by *R23*, *R30*, or *R31*.

Operation. Connect the vertical, ground, and horizontal outputs to the proper terminals on the oscilloscope and set the scope for external horizontal input. To calibrate the scope graticule, place the CAL switch (*S7*) to the 10V position, set V_{CE} control (*R33*) to minimum, and place V_{CE} polarity switch on +. Rotate *R33* until the horizontal scope trace curves up. At this point, V_{CE} equals 10 volts (determined by diode *D4*). Adjustment of the scope horizontal gain enables calibration in volts per inch. Setting S7 to the 1-mA position and adjusting the scope vertical control permits calibration in milliamperes per inch.

Insert a known good transistor in socket *SO1* and set polarity switch *S6* accordingly (+ for npn; − for pnp). Place switch S2 on AUTO and select the desired base currents with *S4*. A family of four curves will be displayed on the scope. If you are using an ac-coupled scope, the curves will center about the zero axis; however, with a dc scope, the display will be more stable. Adjust *R15* for a stable display. ◈

I really don't think this is the way we should be deciding which of our designs is best for the project.

KODAK ENTERS VIDEO RECORDER/PLAYER MARKET

USING SUPER 8 MOVIE FILM INSTEAD OF MAGNETIC TAPE

BY AUBREY HARRIS

THE video recorder/player has been in the news fairly often during the past few years; and with good reason, since quite a few big-name companies are involved in its development. Now, there is yet another entry. This time it is Eastman-Kodak Company. The recording medium is, quite logically for them, Super 8mm color film.

The Kodak Videoplayer system is by far the lowest cost recording system yet announced. This is because the camera used can be a simple, inexpensive Instamatic movie camera as opposed to regular color TV cameras (required for color videotape systems) priced in the range of $5000.

Kodak's system operates as follows. Super 8 is exposed in a movie camera in the same manner as it normally would be for projector showing. Once exposed, the film is sent off for processing and, on its return from the lab is fitted into a plastic cartridge, reel and all. The cartridge is then placed in the Videoplayer which automatically threads and starts playing the film. From here, the Videoplayer is connected through its built-in r-f modulator to the antenna terminals of a conventional TV receiver to display the picture.

The Videoplayer has certain unique features. First is that the film is moved continuously as opposed to the intermittent 24 frame/second motion of a standard projector. Continuous motion is less damaging to the film and sprocket holes than is intermittent motion.

The video information is generated by a flying-spot scanner and photomultiplier tube system. In a flying-spot scanner, a plain unmodulated TV raster generated by a cathode ray tube is optically focused onto and projected through the film frame. On the other side of the film are an optical beam splitter and photomultiplier tubes. An advantage of this kind of scanner is that there are no image registration problems.

Special steps have been taken to produce a 60 field/second TV waveform from the 24 frame/second film rate. The method used is known as "Two-Three" scanning where one frame is scanned twice by the TV raster, while the next film frame is scanned three times.

The player unit will reproduce sound recorded on a magnetic stripe on the Super 8 film. The sound also passes through the modulator, emerging from the audio section of the TV receiver. Magnetic sound recording can be accomplished in the camera or in a sound-recording projector. It cannot be accomplished in the Videoplayer.

The cost of the Videoplayer is estimated to be in the neighborhood of $900, with availability sometime in 1974. This is a comparable figure for many of the presently available ½" color VTR's.

Another of the advantages of Kodak's system is that the medium can readily be edited and spliced using existing equipment, and copies can be made easily in the labs. There is also complete interchangeability between all Super 8 projectors, films, and the Videoplayer cartridges. Furthermore, the films are not "standard-conscious." This last is in contrast to video tapes and EVR films which must be played only on the standard on which they were recorded.

Kodak's Videoplayer also has a few disadvantages. There is the delay for processing between taking pictures and viewing them. A one-hour film, after processing, costs $100-$120, whereas a one-hour ½" videotape costs only $20-$30 and is reusable whereas the Super 8 film is not. ◈

JOBS FOR LASERS

A roundup of applications for various type of lasers

BY JOHN R. COLLINS

A LEADING clothing manufacturer has announced a revolutionary advance in the making of wearing apparel: the cutting of cloth by laser beam. Developed by Hughes Aircraft Co., the laser beam cutting system is installed in the clothing factory of Genesco, Inc., Fredericksburg, Va. The system consists of a computer, a cutting head, a fabric conveyor, and a laser.

In operation, the conveyor rolls out a single layer of cloth from a bolt, the laser is automatically turned on, and the cutting head begins to trace what may be a very complex pattern over the cloth. The laser itself is stationary, but its beam is directed to the cutting head by silicon mirrors. The computer controls the movements of the head and also manipulates the mirrors so that the beam follows the head's gyrations. Gold-plated aluminum mirrors inside the cutting head focus the beam on the cloth in a pinpoint of intense energy.

The laser can and does cut to a tolerance of the width of a single thread, much more neatly than can conventional tools. Each garment is tailored for size and style according to instructions stored on magnetic tape. This precision system assures that every size 40 will be the same as every other size 40, with no errors to be corrected in the sewing room. When the cutting is complete, the conveyor moves the material along, the cut pieces are removed, and another section of fabric enters the cutting area.

Laser Developments. The Hughes-designed cloth cutting system came into being little more than a decade after Dr. Theodore H. Maiman, a scientist working at the Hughes Research Laboratories, developed the first successful laser. It was a remarkably fast transition from the research laboratory to the factory.

The fascinating possibilities for utilizing the intense beam of coherent laser light were immediately apparent to the scientific world. Intensified research efforts following the initial breakthrough led to the discovery of hundreds of different kinds of lasers. Among the most widely used today are solid-state lasers using ruby, glass, or yttrium aluminum garnet and gas lasers containing argon, krypton, carbon-dioxide, or a helium-neon mixture. Much experimental work is still in progress and other (possibly better) types of lasers may be developed in the future. Chemical lasers, for example, show promise of providing power far beyond anything now possible.

New laser materials may be sought for purely economic reasons since rare materials or gases are more expensive than are their more commonplace counterparts. The amount of power which can be practicably extracted from a given system is also a factor. It is not feasible, for example, to make a ruby crystal large enough to yield the amount of power that can be readily provided by a CO_2 laser. Another consideration is the fact that different laser materials provide light of different wavelengths. This can be a critical factor when considering practical applications because wavelength determines how the beam will react with the materials it contacts.

A laser beam striking a substance may be reflected, transmitted, or absorbed. If a laser is to perform actual work, as in cutting cloth, the beam must be absorbed. A material which absorbs light of one wavelength, however, will transmit a beam with a different wavelength. For example, germanium is often used to make lenses for infrared lasers, although it is opaque to light in the visible range. Much experimen-

tation is needed to determine the best laser to use for a given application.

Lasers characteristically provide very narrow output beams which can be focused to points smaller than a millimeter across, but the narrowest beams can be obtained with light of the shortest wavelength. For this reason, a blue laser beam can be focused to a finer spot than can a red one.

Precise Measurements. Unlike conventional light sources, a laser beam will travel in a very narrow beam over long distances with little dispersion. A laser beam is available for reference at any distance in front of a laser. This characteristic led to the early uses of lasers for reference lines. In the aircraft industry, a 200′ beam gives far greater precision in the alignment of tools and jigs than could the old tight-wire method. Tunnels several miles long are now built with deviations of less than ⅜″ at any point. On a smaller scale, some plumbing firms use lasers in establishing grade when installing sewer pipe.

Lasers, like radar, can be used to measure distances. Because the wavelength of light is shorter than that of a radar beam, a laser gives far greater accuracy. Oil companies make laser measurements of distances of up to 15 miles with accuracies of 1″ when installing pipelines. When used in airplanes for mapping, a laser can distinguish between curb and street levels.

A complex system employing the accuracy of a laser is the new aircraft tracking system developed by Sylvania to assess the in-flight performance of the new DC-10 jet transport. Completely self-contained in a transportable van, the system is controlled by a single operator. A low-power infrared laser beam, originating from the van, illuminates a reflector mounted on the flying aircraft. The reflected beam is returned to detectors in the van which determine the azimuth, elevation, and range at rates of up to 100 measurements per second. The data is recorded on magnetic tape for computer analysis; the results assist engineers in evaluating avionic, aerodynamic, and acoustic functions of the airplane by providing highly precise information on aircraft location at altitudes of up to 60,000 feet.

Micromachining. The delicacy with which they can be manipulated recommends lasers for precision work in the micromachining of small electronic components and circuits. Solid-state yttrium-aluminum-garnet (YAG) lasers have found wide acceptance for these operations.

YAG lasers are usually Q-switched to increase their effectiveness. This involves detuning the laser's resonant cavity by some means while a great amount of energy is pumped into the cavity. Resonance is suddenly restored and the laser releases all of its energy in a single pulse which may last for less than a microsecond. A YAG laser for micromachining produced by Coherent Radiation, for example, has an average power of only 6 watts but can deliver a peak power of up to 4000 watts in 500-nanosecond pulses.

Applications in Electronics. In the production of such electronic components as resistors and capacitors, it is usually not feasible to deposit films to the necessary accuracy. Q-switched YAG lasers are widely used to trim them to precise specifications by vaporizing the excess metal. Because of the short pulse duration, this can be done without damage even with heat-sensitive substrates.

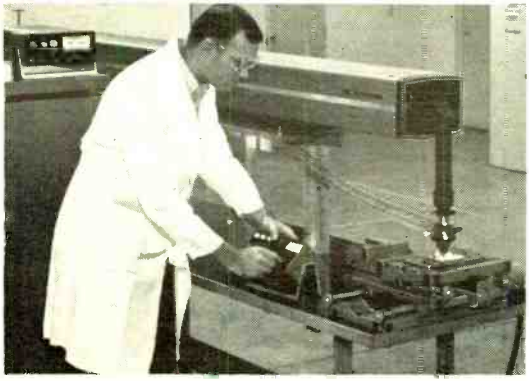
Reflecting mirrors sweep the laser beam over the metallic film of the component while instruments monitor the changes in its value. The components can be trimmed separately or, since the laser makes no physical contact, as part of a functioning circuit. The process may be controlled by a computer for high-volume production, yielding up to 10,000 resistors an hour with tolerances exceeding 0.1 percent.

Until recently, the frequencies of quartz crystals were adjusted either by removing some of the quartz with a diamond tool or by adding fine depositions of silver. However, these methods are slow since they do not readily lend themselves to automation. Now a YAG laser can be used to adjust the frequency of a quartz crystal. The crystal is placed in an oscillator circuit and its frequency is monitored during the trimming process. The film is vaporized in successive spots until the desired frequency is reached, at which point the apparatus automatically shuts off. The crystal is not harmed because the pulses are of short duration and the quartz is transparent to the 1.06-micron wavelength of the YAG laser; so, the beam passes through the crystal without heating it. A quartz crystal can be tuned in this manner in a fraction of a second.

YAG lasers are also used for scribing the

Above, quartz tubing is cut with Sylvania carbon dioxide laser. Below, jet of oxygen is used on Coherent Radiation laser to supply extra power for cutting titanium sheet.

Laser fabric cutter (above) was developed by Hughes for Genesco, a large apparel concern. Carbon dioxide laser (below), with emission in the far infrared, has many industrial applications. Output is 250 watts continuously or 25 kilowatts if it is switched. (Photo courtesy Coherent Radiation.)



silicon wafers used as substrates for semiconductors, a job conventionally performed with diamond scribing tools which are relatively slow and subject to wear. A Q-switched YAG laser, on the other hand, can scribe a silicon substrate to a depth of 2.5 mils at a rate of 2 in./second with practically 100 percent yield.

A highly precise YAG laser system developed by Sylvania is used by a manufacturing plant of the Bulova Watch Co. for regulating the frequency of tiny balance wheels for timepieces. Balance wheels are machine-stamped in large quantities, leaving excess weight which must be trimmed away to regulate them accurately. The output of a YAG laser is directed through a series of lenses into a beam splitter which produces two equal-intensity beams pulsed at a 100-μs rate. The dual-beam optical system enables the laser to drill out equal amounts of excess material from opposite sides of the wheel, thereby maintaining balance. The process takes only a minute with the laser, compared to 20 minutes if done manually. Also, the laser method yields ten times better accuracy.

Carbon-Dioxide Lasers. The development of the CO_2 laser was a great advance for industrial utilization of lasers. Most lasers convert excitation energy to light output at less than 1 percent efficiency. The CO_2 laser converts with a 15-percent efficiency. The average power output of most lasers is measured in milliwatts to a few watts; the CO_2 laser can generate several hundred watts of average power. Finally, the output of the CO_2 laser is in the far infrared (10.6 microns) which is totally absorbed by many classes of materials including most metal oxides, glass, quartz, plastics, and natural organic materials such as wood, fur, and natural fabrics.

The considerable power provided by CO_2 lasers led to new applications in areas where conventional techniques were inadequate or inefficient. To illustrate, the industries which produce boxes and cartons are highly automated. Their cartons are cut and glued at great speed. However, the making of dies for the machines which do the cutting and gluing is a manual task requiring the services of skilled craftsmen. A jig, or single-piece die, is the most stable type; but it is difficult for a diemaker to execute the number of interior cuts required in the die with the necessary accuracy. So, most diemakers compromise on stability and make block dies consisting of a number of pieces.

To overcome this problem, Coherent Radiation developed an automated diemaking machine consisting of a CO_2 laser mounted on a mechanical table and guided by numerical control equipment. A drawing of the die is prepared and information on the dimensions and sequence of cuts is transferred to a plastic tape by means of an automatic typewriter equipped with integral tape punching and reading facilities. This can be done speedily. (The tape for a flip-top box can be prepared in a little more than an hour.) Once the tape has been made and the plywood die blank placed on a bed of steel rods, the operation is completely automatic.

The most challenging task for lasers is the cutting of very hard materials like quartz tubing and tough materials like carbon steel. The extra power needed is supplied by using a coaxial oxygen source. The oxygen converts the laser power, measured in hundreds of watts, to an effective power of about 40,000 watts. As in the oxygen-acetylene welding torch, the chemical reaction induced by the laser-beam/oxygen combination produces most of the energy needed for the cutting process. The laser beam heats the metal to a high temperature so that the metal will react to the oxygen, and the gas jet blows the waste away.

Looking Ahead. Despite the great strides already made in bringing the laser into practical use, it is likely that the surface has barely been scratched. Experiments show that the laser beam can be used for communication, where it is estimated that ten trillion (10^{13}) separate messages could be placed on a single laser beam with a diameter of 1 mm. This is equivalent to all the communications taking place at one time the world over.

A number of problems exist before the laser's potential for communication can be realized. But whatever it takes to solve them, the potential exists and will most certainly be exploited with maximum effort.

A second rich prospective use for lasers is in the area of holography, or lensless photography which stores and projects true three-dimensional images. Applications for entertainment (TV and motion pictures) and commercial data storage and retrieval are limitless. ◈

(Photo courtesy General Motors Corp.)

VEHICLE ALARM SYSTEM

KEYLESS SYSTEM OFFERS THREE OPERATIONAL MODES

BY FRANK J. DIELSI

WITH automobile thefts increasing—in spite of the best efforts of Detroit in providing locking steering columns and buzzer warning systems on the ignition—it is apparent that a reliable alarm system is necessary to protect not only the vehicle but its contents as well.

Most available alarm systems require the installation of an outside "pick proof" lock with an additional key that has to be carried around and separate switches installed at each door, the trunk, and the hood. Unfortunately, many of these systems are still vulnerable because the vehicle battery can be disconnected simply by reaching under the car and cutting the cable.

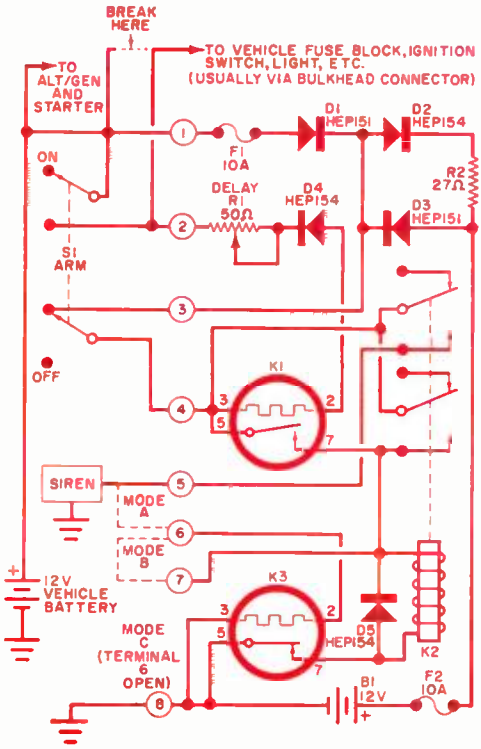
The alarm system described here eliminates all of these problems. It is operated by the switch on the door which turns on the dome light or by switches on the hood and trunk if present. Installation is very simple since only one wire of the car's electrical system has to be modified. The alarm has a self-contained battery that is continuously trickle-charged; and the arming switch can be hidden in any convenient location in the car. When armed, the alarm disables all other electrical systems in the car including the starter, ignition, and lights; but it does not draw any current until triggered. To prevent triggering the alarm by the driver, an adjustable 3- to 8-second time delay is used, allowing ample time to arm the system before leaving the car and disarm it upon returning. It would take much longer than that for an intruder to analyze the system and find the switch—even if he knew that the car was protected by an alarm. Since most trunk and hood lights are operated by tilt switches, the car can also be protected against any unauthorized hoist and tow if the switches are set to trigger at a slight tilt from horizontal.

The driver also has the option of 3 modes of siren operation to suit different

situations. In mode A, when the door, hood, or trunk is opened, after the initial delay, the siren sounds for 60 seconds and then goes on and off at approximately 7-second intervals until the door is closed, the arming switch is turned off, or the batteries are exhausted. If the door is closed after the siren starts, it sounds for 60 seconds only and then stops and is ready to sound again when a new threat occurs.

In mode B, after the initial delay, the siren sounds for 60 seconds only and then stops whether the door remains open or is closed. If the door is closed, the alarm resets. This mode is suitable for parking in crowded areas where a 60-second siren is sufficient to frighten off an intruder without creating excessive noise.

In mode C, after the initial delay, the siren sounds continuously until the arming switch is turned off or the batteries are exhausted, whether the door remains open or closed. If the owner is within hearing range, mode C can be used.



PARTS LIST

B1—Eight rechargeable alkaline D cells
D1,D3—HEP151 diode
D2,D4,D5—HEP154 diode
F1,F2—10A, 3AG fuse and holder
K1—12V, normally open, 2-second delay thermostatic relay (Amperite 12N02)
K2—Dpdt, 12V dc relay (Line MK02D or similar)
K3—12V, normally closed, 60-second delay thermostatic relay (Amperite 12C60)
R1—50-ohm, 2-watt potentiometer (Ohmite CLU500J or similar)
R2—27-ohm, 2-watt resistor
S1—Dpdt, 20A slide or toggle switch
Misc.—Battery holders, suitable chassis (Bud CU729HG or similar), octal sockets for K1 and K3, 8-terminal barrier strip, 12-volt siren, mounting hardware, wire, etc.

Fig. 1. Alarm system has three modes of operation for different parking situations. Connection to vehicle's system is shown by the broken line.

How It Works. The system (see Fig. 1) was designed for use with a negative-ground battery system, but it can be changed for use with a positive ground by reversing the polarities of all the diodes and the auxiliary battery.

Thermostatic relays are used because they are simple and inexpensive. They are hermetically sealed in an inert gas to assure long life; and they are temperature compensated and unaffected by mechanical vibrations.

When the arming switch (*S1*) is on and a door is opened, the heating element of *K1* is put in series with the car battery through the door (or trunk or hood) switch. If the car battery is disconnected, power is supplied by the auxiliary battery. After the delay interval, the normally open contacts of *K1* close and *K2* is energized. Relay *K2* locks in through one set of contacts and supplies voltage to the siren through the other set. If terminal 6 is connected to 5 (mode A) the heater of *K3* is energized. After 60 seconds, the contacts of *K3* open to de-energize *K2*, turning off the siren and the heater of *K3*. When the heater of *K3* cools (about 7 seconds), its contacts close, energizing *K2*, the siren and *K3*'s heater. Since the heater hadn't completely cooled, the contacts will again open in about 7 seconds. This cycle continues until the door is closed to turn off *K1*. Relay *K2* remains locked in until the contacts of *K3* open to reset the alarm.

In mode B, terminals 6 and 7 are connected together. After *K1* and *K2* are energized, *K3* will operate after 60 seconds to de-energize *K2*. If *K1* is still on, the *K3* heater will stay on, keeping *K2* and the siren off. If the door is closed, the *K1* contacts

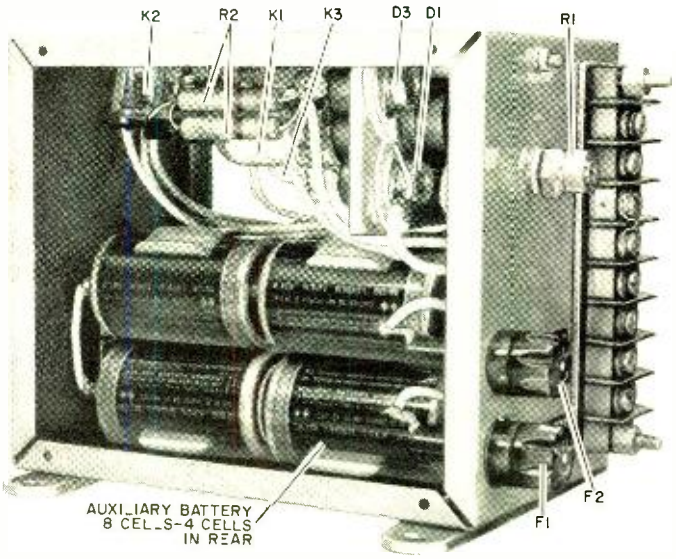


Fig. 2. Circuit can be mounted in any enclosure which will fit conveniently in vehicle. The arrangement shown here used 4 x 5 x 6 in. box. Hide the unit as carefully as possible and try to conceal wiring.

open but *K2* is locked in until the 60-second delay of *K3* is completed. Then *K2* is de-energized and the alarm is reset.

In mode C, *K3* is never energized so that once *K1* is energized, *K2* locks in and the siren sounds continuously.

Diode *D1* prevents the auxiliary battery from discharging into the car's electrical system when the car's battery voltage is below that of the auxiliary battery (during cranking interval). Diode *D3* protects the auxiliary battery from overcharge while *D4* keeps the car battery from holding *K1* closed after the arming switch is turned off. Diode *D5* protects the contacts of *K3* from the inductive surge when *K2* is de-energized.

The eight rechargeable D cells in the auxiliary battery can operate a 4-ampere siren for about 15 minutes and should have a useful life of at least 50 discharge-charge cycles. The charging circuit through *R2* limits the charge current to 150 mA with an alternator voltage of 14.5 volts and auxiliary battery voltage of 8.8. volts. When the auxiliary battery is charged up to 12 volts, the trickle current from the alternator is limited to about 35 mA. The fully charged auxiliary battery does not draw any current from the car's battery because the 0.6-volt difference between the batteries is less than the 1.5-volt drop across *D1* and *D2*. In a discharged state of 8.8 volts, the auxiliary battery will charge at about 80 mA from the car's battery alone.

Construction. The complete unit, including the 8-cell auxiliary battery can be enclosed in a 4" x 5" x 6" box as shown in Fig. 2. The layout is not critical and can be changed to suit the space and mounting conditions of the car. The two stud-mounted diodes (*D1* and *D3*) are mounted with insulating washers on a ¼-inch aluminum panel that also holds the sockets for relays *K1* and *K3*. Switch *S1* should be connected to terminals 1 and 2 with No. 12 (or larger) wire and to terminals 3 and 4 with No. 16 wire.

Installation. Hide the alarm unit as well as possible and disguise the wiring so that it looks like normal car wiring. The original car horns are not recommended for the alarm because their location makes them very vulnerable. Two small sirens can possibly be hidden in different locations instead of one large siren.

To test the auxiliary battery, remove fuse *F1* and turn on the alarm with the door open.

The only part of the car's normal wiring that has to be changed is the single wire than connects the battery to the headlight switch, ignition switch and fuse block. This wire can usually be found at the bulkhead connector or tie point on the horn relay. The normal connections to the alternator voltage regulator and starter solenoid should remain on the battery side of the alarm system. ◈

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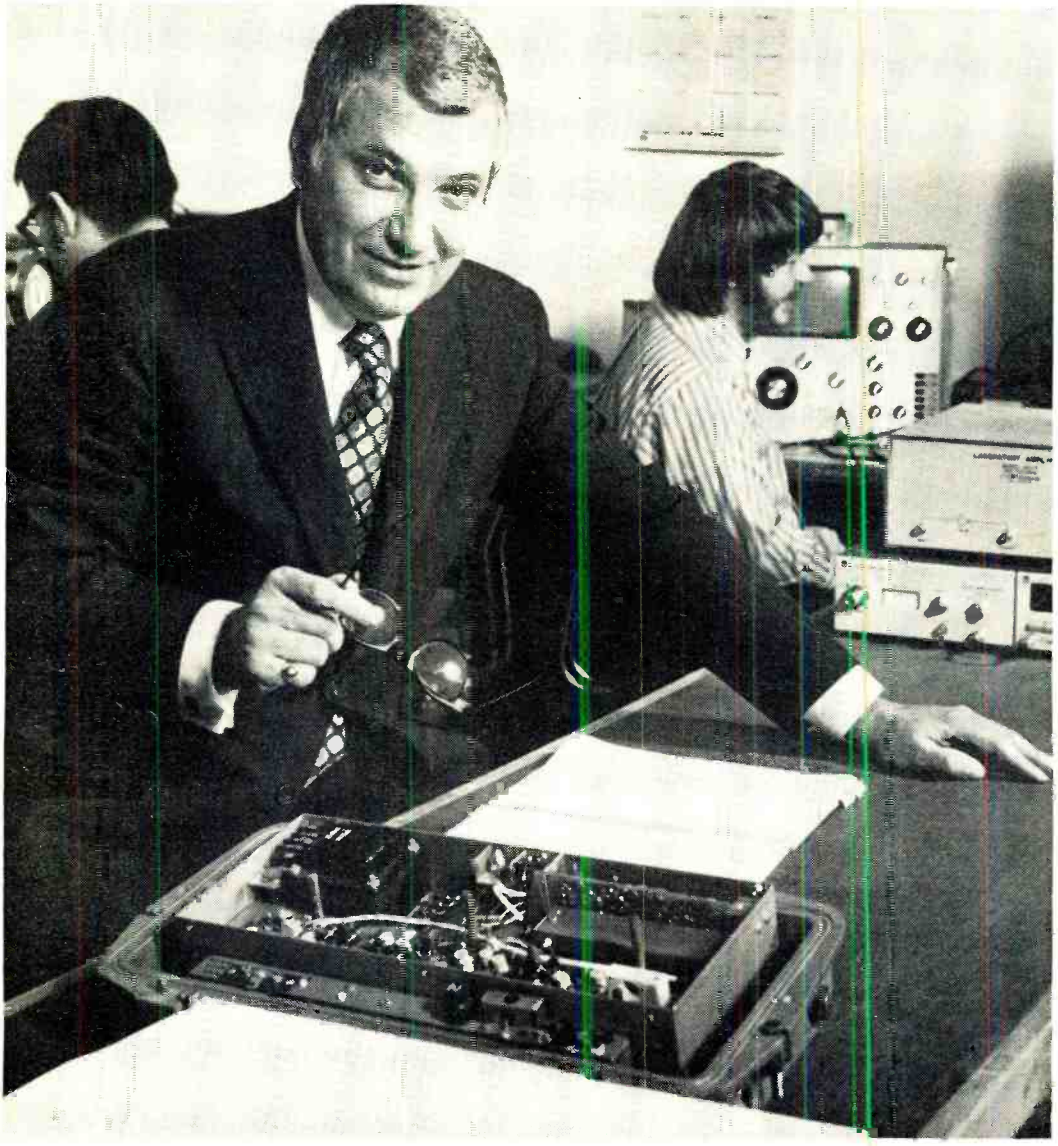

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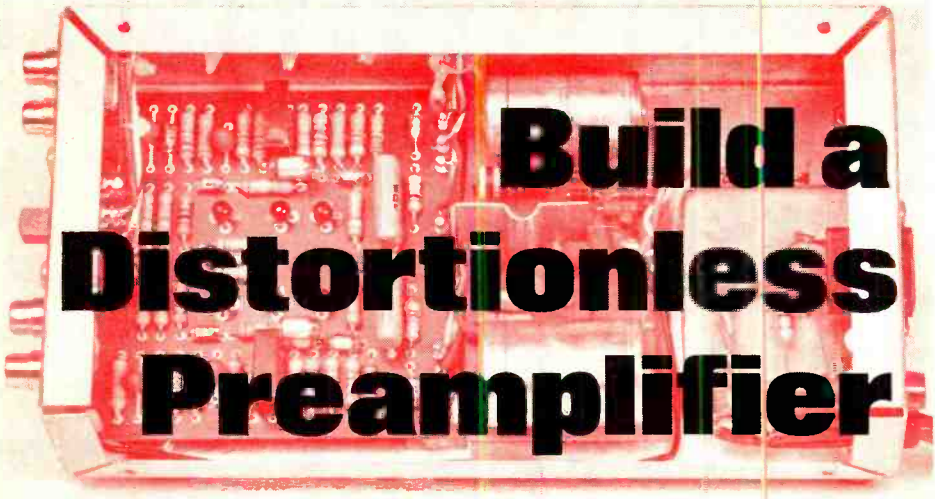


Build a Distortionless Preamplifier

PREPARING FOR FOUR CHANNEL?
YOU MAY WANT TO USE THIS PREAMP

BY JAMES BONGIORNO

THE ADVENT of four-channel stereo need not necessarily obsolete your present hi-fi system. Regardless of which four-channel system is finally agreed on as a standard, we feel that it's a safe bet that the conventional two-channel front end will remain and the four-channel decoding will take place after this stage. Therefore, it is more important than ever that the two-channel front end be of the best quality available. In essence, what you need is a noise-free, distortionless, nonoverloading amplifier that will follow the RIAA curve faithfully.

The phono preamplifier whose schematic is shown in Fig. 1 (only one channel is shown) comes as close to this "perfect" preamp as the state of the art permits. It is virtually impossible to overload this unit with

PARTS LIST
PREAMPLIFIER

Components common to both channels:
C10—68-μF, 3-volt 20% tantalum capacitor
D1,D2—1N914 diode
R18—43,000-ohm resistor
S1—Dpdt slide switch
Duplicate components in each channel:
C1,C4—22-μF, 60-volt, 20% tantalum capacitor
C2—56-pF, 5% polystyrene capacitor
C3—33-pF, 5% polystyrene capacitor
C5—0.47-μF, 100-volt, 10% Mylar capacitor
C6—330-pF, 5% polystyrene capacitor
C7—5600-pF, 2% polystyrene capacitor
C8—1650-pF, 2% polystyrene capacitor (1500 and 150 in parallel)
C9—47-pF, 5% polystyrene capacitor
J1,J2—Phono jack
Q1,Q3—2N4250 transistor
Q2—2N5089 transistor
R1,R14,R16—47,000-ohm, 2% resistor
R2,R3—390-ohm, 10% resistor
R4—1-megohm, 10% resistor
R5—62,000-ohm, 5% resistor
R6—Selected (see text)
R7—22,000-ohm, 5% resistor
R8,R17—470-ohm, 2% resistor
R9—681,000-ohm, 1% resistor
R10—3900-ohm, 5% resistor
R11—2700-ohm, 5% resistor
R12—1000-ohm, 10% resistor
R13—2.2-megohm, 1% resistor
R15—2200-ohm, 1% resistor
Note—For miscellaneous items and availability of parts see Parts List for Power Supply. (All resistors are ½ watt.)

any cartridge presently available (at any frequency). The gain at 1 kHz is 42 dB (125 times) which means that even the most sensitive of cartridges may be used. But along with this high gain, the noise level is 0.7 μV referred to the input (63 dB below 1 mV). Since some audio measurements laboratories state noise as so many dB's below 10 mV, this unit has a figure of −83 dB below 10 mV, which makes it a very quiet operator.

The output level is about 12 volts rms; and below 4 volts output, the distortion is just about unmeasurable, rising to 0.1% at the 12-volt output. This high level of output is available across the audio bandwidth of 20 to 20,000 Hz. The feedback loop maintains the frequency response flat to within ±0.5 dB of the ideal RIAA curve. There is also a switch to change the feedback loop to provide a flat response for use with an optional microphone input.

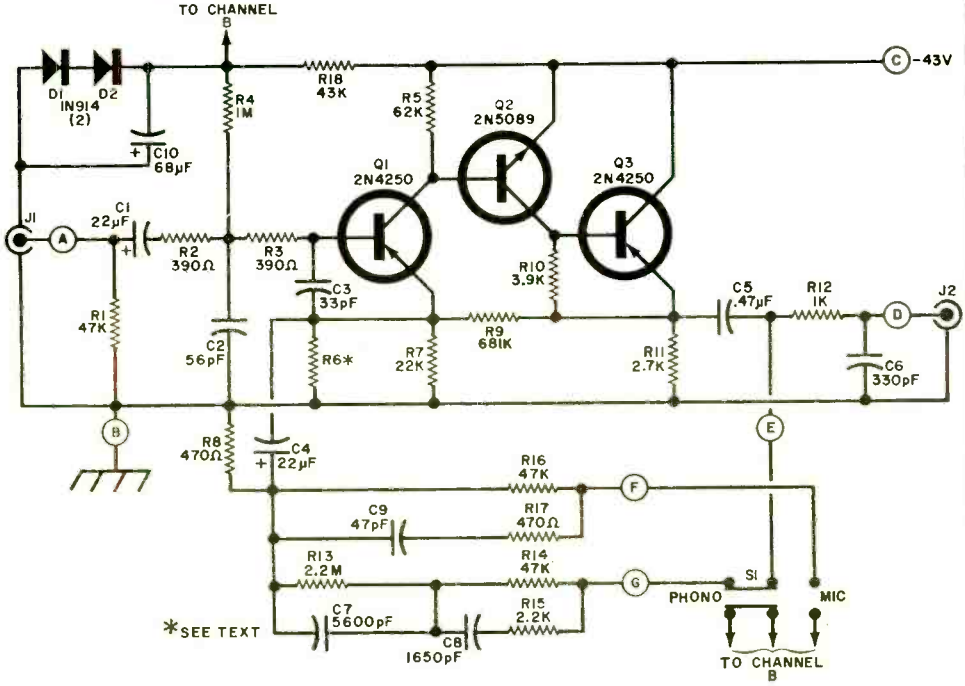
Construction. The foil pattern shown in Fig. 2 covers both channels of a stereo pair. The component indications are the same for both channels, with *R18, C10, D1 and D2,* and *S1* common to both channels.

The schematic of the power supply for the amplifier is shown in Fig. 3. It would appear at first glance to be somewhat elaborate but it is essential that the system be free of hum since the amplifier gain at 60

TECHNICAL SPECIFICATIONS

Gain: 60 dB at 20 Hz, 42dB at 1kHz, 23 dB at 20 kHz; all within 0.5 dB of RIAA.
Gain with Microphone: within 0.5 dB from 20 to 20,000 Hz.
Sensitivity: 0.8 millivolts rms with 100 millivolts output.
Noise: 0.7 microvolts unweighted (RIAA bandwidth referred to shorted input).
Maximum Output before Clipping: 12 volts rms, 20 to 20,000 Hz.
Input Overload: 13 mV at 20 Hz, 100 mV at 1 kHz, 850 mV at 20 kHz.
Distortion: Unmeasurable at 1-volt output, increasing gradually to about 0.2% at clipping.

Fig. 1. This is the schematic for one channel of the preamp, except for components, as mentioned in Parts List, that are common to both.



Hz is almost 60 dB. For the same reason, transformer *T1* is a fully shielded toroid. In addition to the −43 volts used in the amplifier, the supply also provides −47 volts for powering other circuits. The regulator will handle up to 100 mA. The foil pattern and component layout for the power supply are shown in Fig. 4 on page 62. The printed circuit boards for power supply and preamp are available as mentioned in the Parts Lists.

With only the power supply operating, connect a voltmeter between terminal K and ground. The indicated voltage should be −47 volts. If it is a little higher, connect a 40,000-to-60,000-ohm resistor across R23 to bring the voltage down to −47. If you have a sensitive millivoltmeter, check to see that the noise at this terminal is below 200 μV. There should be no ripple at all when the output voltage of the supply is viewed on a scope.

Before mounting either the power supply or the preamp in the chassis, interconnect the two boards, with terminal L of the supply to terminal C of the preamp, and terminal J of the supply to B on the preamp.

Connect a dc voltmeter between the junction of C5 and R11 (negative) and ground (positive) in one channel. Turn on the power and wait until the voltage being measured reaches a maximum—it will take a minute or more. Temporarily connect a fixed resistor (between 50,000 and 80,000 ohms) where *R6* is supposed to be in this channel. The resistor should be such that the voltage being measured is as close as possible to −21.5 volts. Do the same for the other channel; then recheck the first chan-

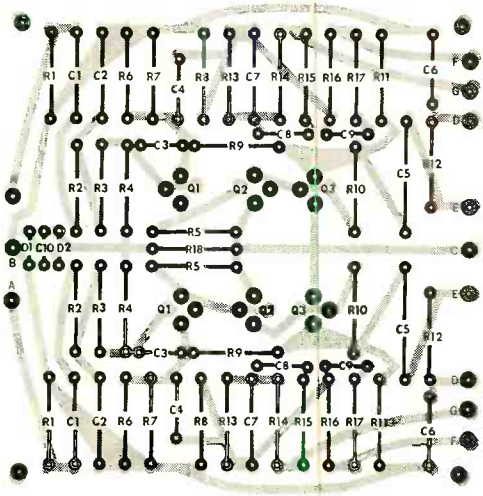
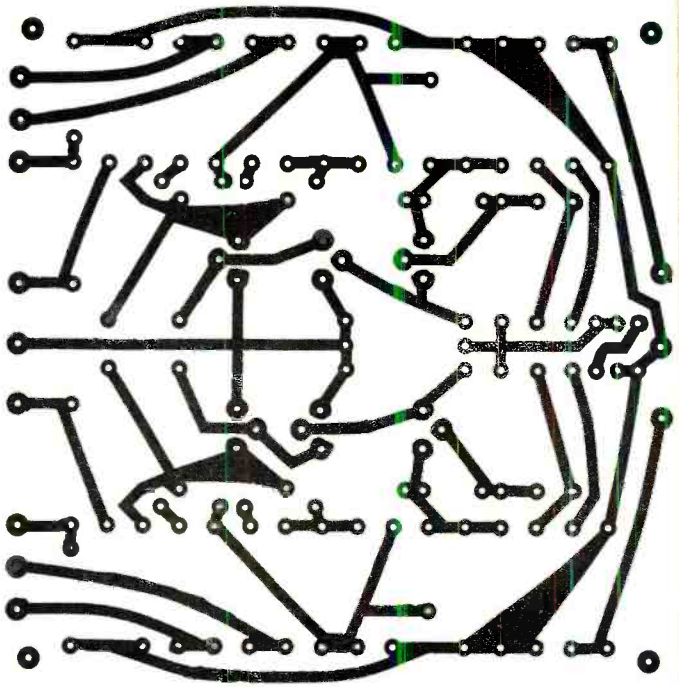


Fig. 2. The foil pattern shown below is for both channels of the preamp. Component layout is shown at right.



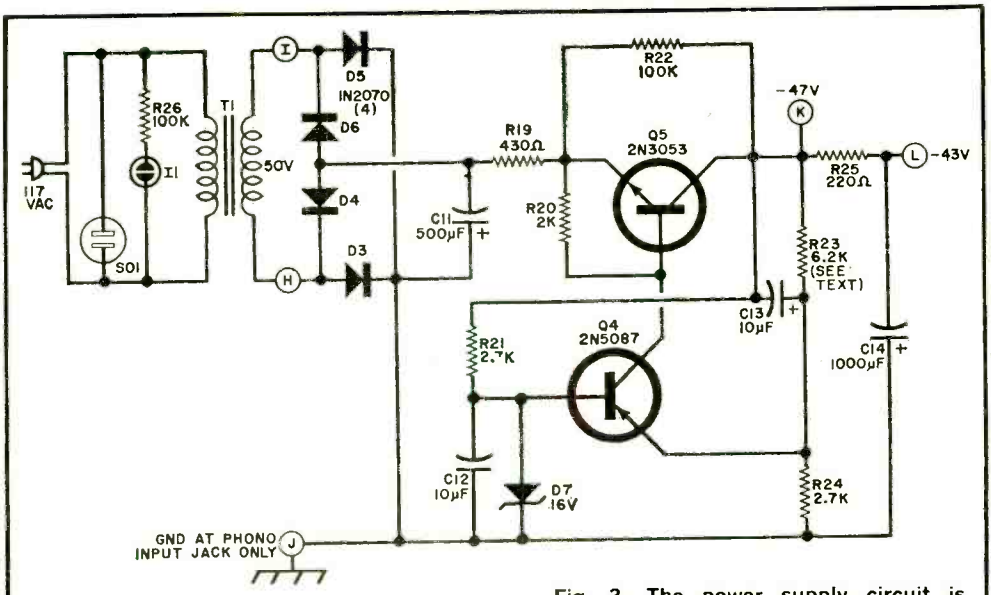
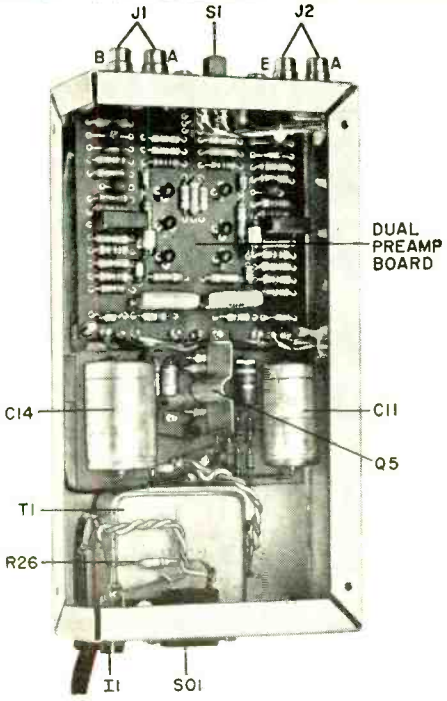


Fig. 3. The power supply circuit is more elaborate than some but this is essential to proper preamp operation.

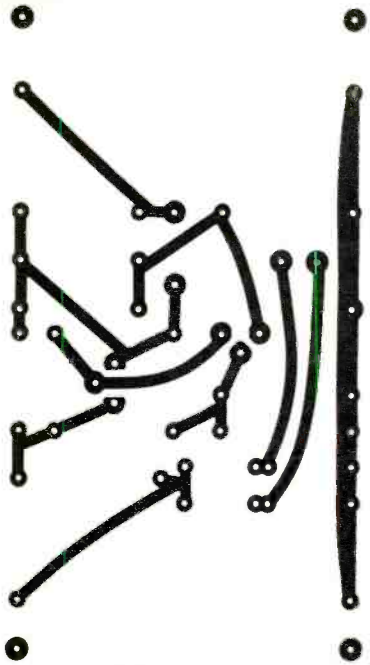
PARTS LIST
POWER SUPPLY

C11—500-μF, 70-volt electrolytic capacitor
C12—10-μF, 16-volt tantalum capacitor
C13—10-μF, 35-volt electrolytic capacitor
C14—1000-μF, 50-volt electrolytic capacitor
D3-D6—1N2070 diode
D7—16-volt, 1-watt, 2% zener diode
I1—117-volt neon lamp
Q4—2N5087 transistor
Q5—2N3053 transistor
R19—430-ohm, 2-watt, 5% resistor
R20—2000-ohm, 10% resistor
R21,R24—2700-ohm, 5% resistor
R22,R26—100,000-ohm, 20% resistor
R23—6200-ohm resistor (see text)
R25—220-ohm resistor
S01—117-volt chassis mount receptacle
T1—Shielded toroid transformer: 50V at 100 mA
Misc.—Pilot lamp holder, line cord, rubber feet, (4), suitable chassis (Bud CU-482), heat sink for Q5 (Wakefield 296-4), terminal strip, mounting hardware, etc.
Note—The following are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216: Transformer T1, #17221-1 for $13.00 plus postage and insurance for 1 lb.: preamplifier PC board, #LL118 for $3.15; power supply PC board, #LL119 for $2.45: complete kit of parts for $39.95, plus postage and insurance for 5 lb.



Preamp board and power supply should not be mounted in chassis before conducting tests as described in text.

nel as the two are slightly interactive. Once both channels have 21.5 volts at the junction of *C5* and *R11*, solder in both *R6's*. When installing the amplifier board, use one of the input jack chassis connections as the common ground, making this the only chassis connection. The ground wire to the power supply should be removed and a ground wire run from the power supply point J to the selected input jack.



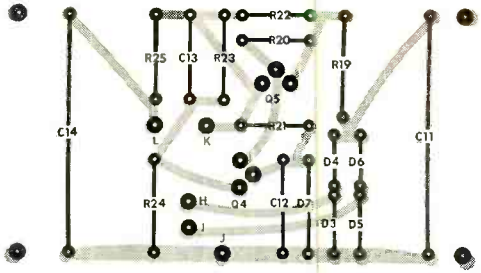
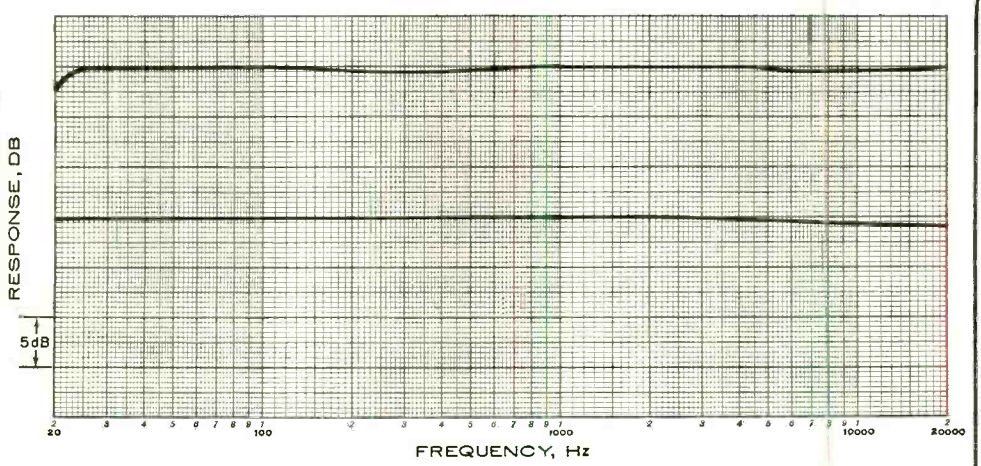


Fig. 4. Except for T1 and components in its primary, power supply is laid out (above right) on the board above.

Mount the shielded transformer on the chassis, and place the heat sink on transistor Q5 of the power supply. The physical arrangement of the other chassis components and connectors is not critical.

Operation. To use the preamplifier in your present stereo system, simply plug the turntable signal cables into the input jacks (*J1*) and run the output jacks (*J2*) to the AUX inputs of your amplifier. Don't forget to phase all the ac plugs to get the lowest hum. If you find that you need a ground on the turntable chassis, run a wire from it to the mounting screw closest to the preamplifier input jack that was selected as the common ground. ◈



PROJECT EVALUATION
HIRSCH-HOUCK LABORATORIES

The preamplifier does just about what the designer claims for it. Gain measurements, in general, were within 0.5 dB of the author's claims and show a loss of only 1.4 dB at 20 Hz relative to the extrapolated RIAA curve. Phono overload occurs at a very safe 110 millivolts, and the clipping level from the output is 14.7 volts, something of a record in our experience.

Distortion is really negligible, typically 0.013 to 0.03% over most of the useful range of the amplifier (even up to 10 volts output). The measurement of 0.31% at 125 millivolts output was partly hum and partly noise, but both were extremely low. The combined hum/noise output was about 100 microvolts.

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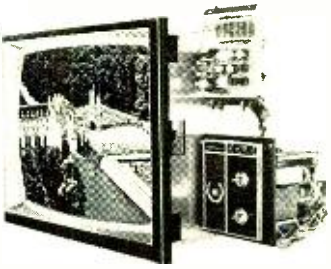

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CIRCLE NO. 23 ON READER SERVICE CARD

MAC'S SERVICE SHOP

Single Sideband for the CB'er

By John T. Frye, W9EGV, KHD4167

"MAC," Barney said to his employer working at the bench beside him, "I want to ask you about the olden days."

"Do tell, Sonny," Mac answered, laying aside the diddle stick he was using to adjust a sound trap on the color chassis in front of him and affecting the cracked falsetto voice of old age; "how come and how 'olden'?"

"While I was eating at Burger Chef this noon, a young guy with a whip on his car noticed my ham call license plates and pulled up beside me and began peppering me with questions about the relative merits of single sideband as compared to amplitude modulation. He was an avid CB'er and was thinking of going SSB."

"Well, you should have been a gusher of information. After all, you're yakking it up on SSB all the time."

"That's just the point. Hams had already switched to SSB when I got my ticket. I've never operated anything but SSB and a little FM on two meters. On the bands I work, you hear very few AM stations. I felt like the man who, when asked how his wife was, answered 'Compared to what?'"

"Did you confess you didn't know?"

"Are you kidding? A ham *never* admits ignorance to a CB'er. I told him I had to get back to work but that I'd see him at the same place tomorrow and give him the scoop. I knew you have been an avid shortwave listener ever since you heard Marconi send his first message, and I figured you could fill me in."

"Thanks a bunch! But aren't you taking a chance in asking a senile old man for information? It just so happens, though, that I was listening during the time the big changeover from AM to SSB occurred on the ham bands, and I heard the pro and con of both systems debated heatedly over and over again. I will not be surprised if CB follows along much the same pattern in the next few years."

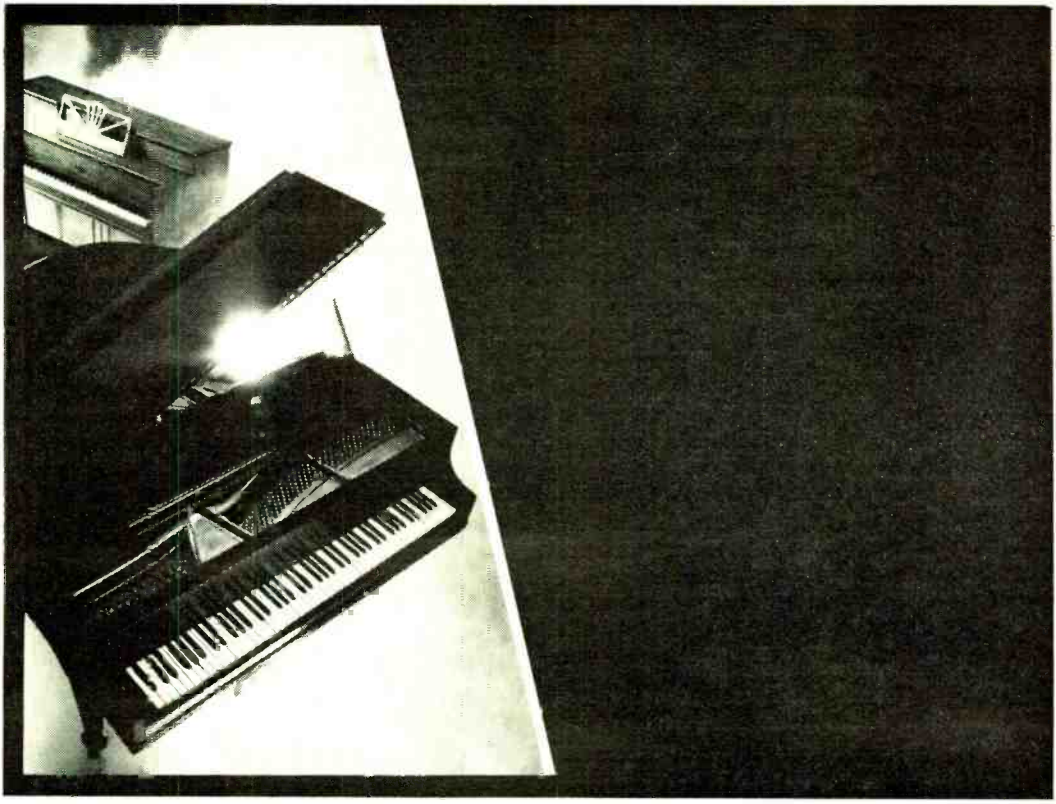
"I gather AM didn't give up easily."

"You gather correctly. There was a great deal of bitterness and name calling when the first few SSB stations came on the air. AM operators sneeringly referred to the new signals as 'Donald Duck' and 'slop bucket' modulation. The SSB boys retaliated with scornful references to 'Ancient Modulation.' Each group accused the other of putting out broad, interfering signals, and each group deliberately interfered with the other."

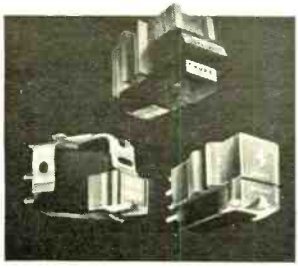
"Then the two types of modulation aren't very compatible."

Advantages of SSB. "Not very—at least not on the ham bands when you're receiving unwanted SSB signals on an AM receiver, and *vice versa*. But before we go into the "why" of that, let's talk about the claimed advantages of single sideband. The first is talk power, and this adds up to a whopping 9 dB. Here's how.

"A very efficient 5-watt AM-CB transceiver might produce a 4-watt carrier without modulation. On a panoramic receiver which displays r-f voltage on the vertical axis of a scope tube and frequency on the horizontal axis, this carrier would be a single vertical line rising from the base line at the carrier frequency. We can adjust this line to a convenient one-unit length with the receiver controls. Now if we modulate this carrier 100% with a 1000-Hz sine wave, we see two other vertical lines, each ½ unit in length, spring up on either side of the carrier signal at a distance of 1 kHz from it. The carrier line remains unchanged. However, if we simultaneously examine the modulated envelope of our signal, we find



To each his own.



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modulating the carrier 100% caused the peak envelope voltage to double on positive peaks and to fall to zero on negative peaks.

"Our peak voltage is now 2 units, and since the power across the fixed antenna resistance is equal to the square of the voltage, the peak modulated power is 2^2 or four times the unmodulated carrier power: 4 x 4 or 16 watts. The final stage and power supply must be able to deliver this amount of power.

"The question is: how much of this 16 watts is actually talk power. Since the only change we saw under 100% modulation was the appearance of the sidebands—the carrier amplitude did not change at all—the talk power must be in these. Each sideband was ½ unit high. That means each contained $(½)^2$ or ¼ the carrier power or 1 watt. Their total was 2 watts.

"Inasmuch as the carrier contributes nothing to the intelligence of the signal and the sidebands do not actually need anything to 'carry' them through the air, suppose we eliminate the carrier and divide the power it wasted between the two sidebands. When half the cannibalized carrier voltage is added to each sideband, each becomes one unit in length and their total power becomes twice the original carrier power, or 8 watts. We now have a double-sideband-suppressed-carrier signal with four times the talk power of the AM signal.

"But hold on! The two sidebands are as identical as the two faces of the god Janus. They repeat, in unison, the same message. So why not eliminate one and use the power saved to amplify the other? When we pick up one sideband and stack it on top of the other, this lone voltage grows to two units in length. That means the power of this single sideband is $(2)^2$ x 4 or 16 watts, and it is all talk power. The two watts of talk power of the AM signal has increased eight times, or 9 dB, with the same power consumption."

"Hey, how about that!" Barney exclaimed.

"That's not all. Remember each sideband is separated from the carrier by a distance equal to its frequency. The width of an AM signal, therefore, is twice the highest modulating frequency. Voice modulation with frequencies up to 3,000 Hz means a 6-kHz wide signal. But SSB, transmitting only one sideband, occupies only half this bandwidth. Two SSB signals fit neatly into the 6 kHz taken up by a single AM signal."

What About the Carrier? "If we don't need the carrier, why did we get tangled up with it in the first place?" Barney asked.

"I never said we didn't need it. I said we didn't have to *transmit* it. We need the carrier for a reference at the receiver to recover the modulating frequencies. You recall a 3000-Hz modulating frequency was converted into a radiated r-f frequency removed from the carrier by ± 3 kHz. Similarly all transmitted sideband components are keyed to the original carrier frequency; that is, the frequency *difference* between any one of them and the carrier indicates the audio frequency producing that particular component. Therefore we must have either the original carrier at the receiver or another carrier of exactly the same frequency. An AM transmitter simply sends along the original carrier. SSB utilizes the 'dried milk' technique: all the water is taken out for shipping and then is replaced by the consumer to reconstitute the original. In the same way the product detector of the SSB receiver produces a carrier that can be inserted into the incoming sideband signal precisely where the original carrier was. Difference beats between the components and this carrier reproduce the original modulating frequencies."

"'Precisely' is the right word," Barney offered. "If that inserted carrier is off more than 50 Hz from the point the original carrier occupied in the signal, voices do not sound right—and that means maintaining a frequency error of less than two-parts-per-million at 27 MHz. Tuning errors you'd never notice on AM render SSB unintelligible. However, since both transmitter and receiver on CB are crystal controlled, I assume this presents no problem."

"Don't be too sure," Mac warned. "From the heterodynes I hear on a CB channel when skip is coming in, it's evident that not all transmitters on the channel are on the same frequency. CB crystals must be within 0.005% of the specified channel frequency, but that means a permissible error of 1350 Hz at 27 MHz. A transmitter operating at one end of this error limit and a receiver at the other would be 2.7 kHz apart. Some form of fine tuning is obviously a must for the receiver portion of a SSB CB transceiver."

"Since a SSB signal is only half as wide as an AM signal, why does it seem wider to AM operators?"

"Because of the AM receiver's slower

attack type of avc and the wider passband. The powerful pulsing type of signal from a SSB station overloads the front end of these receivers that run at full r-f gain on weak signals. Reducing r-f gain and using a beat frequency oscillator to insert a carrier makes it possible to receive SSB on an AM receiver and gives a much more realistic idea of signal bandwidth."

"Don't forget an AM carrier puts a nasty heterodyne into a SSB receiver unless that carrier is exactly zero beat with the SSB station," Barney pointed out. "No wonder the two get along like cats and dogs. But SSB, with eight times the talk power and taking up only half as much room, has a lot going for it."

"There's more. With stages in the SSB transmitter operating in a linear fashion, there is less distortion to produce TVI-causing harmonics. That does not mean, I hasten to add, that SSB can't cause TVI by front-end overload of the TV receiver. Also, the only time a SSB transmitter consumes appreciable power is when it is actually being modulated. There is no carrier to waste a high percentage of full-modulation power while you're thinking. These makes possible the use of smaller output tubes and lighter power supplies. And there are no high-power audio amplifiers. You never saw any table-top kilowatts until SSB came along. Finally, push-to-talk with full break-in is a natural with the SSB mode of operation."

Any Drawbacks? "Doesn't SSB have any drawbacks? Why hasn't it caught on faster on CB?"

"It has drawbacks. I've already mentioned the much more stringent frequency stability requirements. Circuitry in both transmitter and receiver is more involved. These things add to the expense. But the hobby type of operation of most CB operators is the greatest deterrent. They don't want to talk just to their own units; they want to talk to other CB stations, most of whom can't receive SSB. A SSB station on CB at present is like a frog sending out a mating call in the desert: he doesn't get many answers! Other stations can't understand his Donald Duck squawking. That's the way it was on ham radio at first, but once hams grasped the advantages of single sideband, that mode of operation snowballed." ◈

Communications Scene

By Richard Humphrey

Harbor Police: Communications Afloat

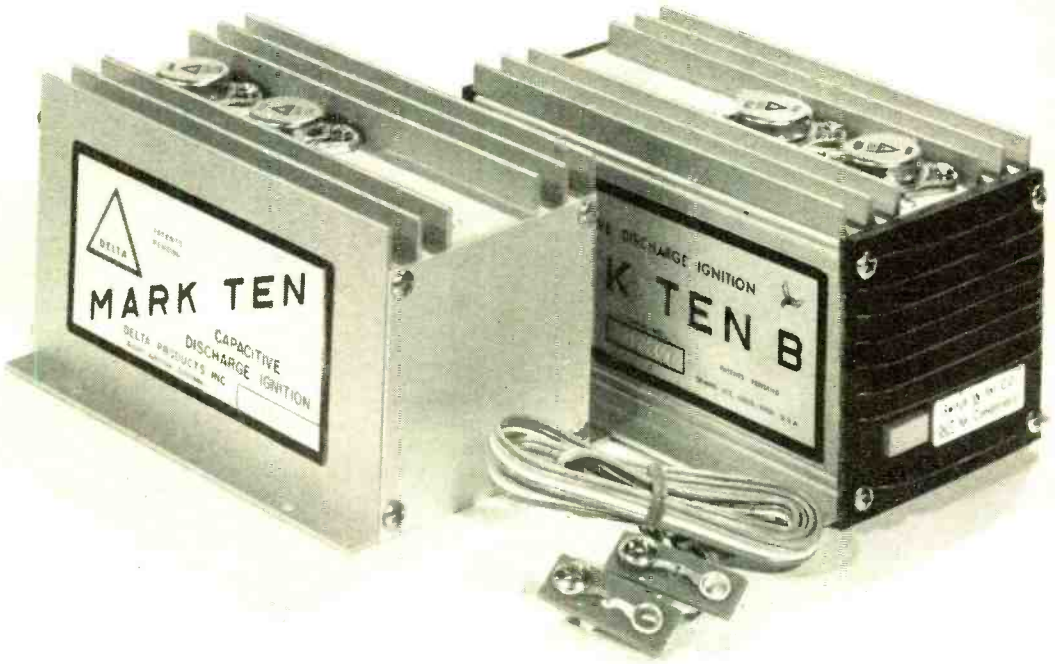
CRUISING the water around New York City from Long Island Sound to New Jersey's Sandy Hook is an elite group of the City's Finest with its own vhf/FM communications system. The system is separate from the New York Police Department's radio network; and that makes the NYPD Harbor Patrol Unit very happy.

Restructuring the Bands. The Harbor Patrol Unit's good fortune came about when the Federal Communications Commission was restructuring the vhf/FM marine band and enlarging it from 18 channels to 39. Fitting those 39 channels into the same space in the radio spectrum formerly occupied by 18 channels was a big problem for the FCC.

Following the guidelines laid down by the International Telecommunication Union's World Administrative Radio Conference held in the fall of 1967 in Geneva, the FCC accomplished its task by reducing the channel-spacing from 50 kHz to 25 kHz. So there'd be no chance of "crosstalk" between channels it cut the FM "swing" from ±15 kHz (the so-called "wide-band FM") to ±5 kHz ("narrow-band FM").

In the process, the two "guard" bands on either side of channel 16 (156.8 MHz), the national distress, safety and calling frequency, became much too large. The low-side guard band was changed from 156.725-156.775 MHz to 156.7625-156.7875 MHz; the high-side from 156.825-156.875 MHz to 156.8125-156.8375 MHz. This meant that channels 15 and 17—not used up to now because of their proximity to channel 16—were available for assignment.

The FCC, therefore, made channel 15 (156.75 MHz) an "environmental" channel to be used for the broadcasting of weather information, notices to mariners, local conditions, hazards to navigation and other items of interest to mariners. This was done with the intention that it would eventually replace the 162.55-MHz Weather Bureau forecasting service as far as the marine community was concerned. Channel 17 (156.85 MHz) was designated the "state control" channel for "communications, other than Port Operations, in the Maritime Mobile Service on very high frequencies (vhf) between coast stations, operated by a government, other than Federal, boating administration and ship stations in which messages are restricted to those of immediate concern and are related directly



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to the regulation and control, or rendering of assistance."

It was this state control channel which NYPD's Harbor Patrol Unit chose as the backbone of its communications system. Being responsible for the enforcement of the New York State Navigation Law, the Federal Boating Act of 1958, marine legislation in the Administrative Code and Park Department regulations and —presumably—the recently enacted Federal Boat Safety Act of 1971, the Harbor Patrol Unit is brought squarely under the FCC requirements. To it they added channel 16 (which they monitor continuously), channel 12 (156.6 MHz) and channel 6 (156.3 MHz).

Before June 1971, when the new system went into operation (the same time, incidentally, that the group was elevated from "precinct" status—the Harbor Precinct—to its present quasi-autonomous position as the Harbor Patrol Unit) the HPU had to make do with a disjointed and frequently unsatisfactory communications set-up. If its Randall's Island headquarters wanted to contact one of its eleven launches patrolling the ten "posts" in the waters under its jurisdiction, it had to call the NYPD Communications Central at 240 Centre Street in Manhattan by telephone, then wait until one of the two police frequencies was free before the message could be relayed.

Besides the drawback of having to use a "third party" which usually wasn't familiar with the Harbor Patrol Unit's operation (leading to fouled-up messages), there was the added disadvantage that the summer boating months, when the HPU's case-load was heavy and effective and fast communications were vital, constituted exactly the same time of year when police activity ashore was at its height. Hence, both "police" frequencies were unavailable to Harbor Patrol Unit traffic for long stretches.

"With our present responsibilities," says Captain John Lowe, the Harbor Patrol Unit's Commanding Officer, "it's extremely important that we be able to talk directly to our patrol craft. There are times when minutes are vital." Lowe went on to cite instances where it was necessary to have a quick interchange of ideas so that a decision could be made as to whether to use some of the Unit's special equipment such as its remote-control underwater television camera used to pinpoint hard-to-find objects on the harbor's murky bottom.

A Solid Coverage Area. To insure coverage area under its jurisdiction —including the waters in Long Island Sound (from the Westchester County Line), New York Harbor, the North River up to Spuyten Duyvil Creek and all navigable waters to the New Jersey shore as well as two miles into the Atlantic Ocean and assorted lakes—the Harbor Patrol Unit has its transmitter/receiver atop one of Manhattan's skyscrapers. The unit is remotely controlled from the Randall's Island station house.

All eleven of the Harbor Patrol Unit's 50′ twin diesel-powered launches are equipped with 4-channel vhf/FM marine radiotelephones as well as two-channel police-frequency transceivers. None of the launches carries 2-3-MHz marine band equipment nor does the Randall's Island base. This might be regarded as a weak point in the HPU's communications system —as can the minimal 4-channel coverage of the 39-channel vhf/FM marine band. However, in view of the Harbor Patrol Unit's specialized operation and the fact that pleasure craft will be gradually disappearing from the 2-3-MHz band during the five-year transition period between January 1, 1972 and January 1, 1977, it should serve at least for the time being.

The need for a separate two-way network is obvious when you consider the Harbor Patrol Unit's work. Law enforcement occupies a small percentage of its case load. In 1970, for instance, the total of out-and-out "police" cases—grand larceny, petit larceny, criminal mischief and the like—came to only 199 while there were 580 search and rescue cases. In addition, there were 107 cases involving the recovery of bodies of which 23 were by grappling and/or scuba divers. During the year the Harbor Patrol Unit rescued 106 persons in distress. The total assignments for 1970 came to 2768.

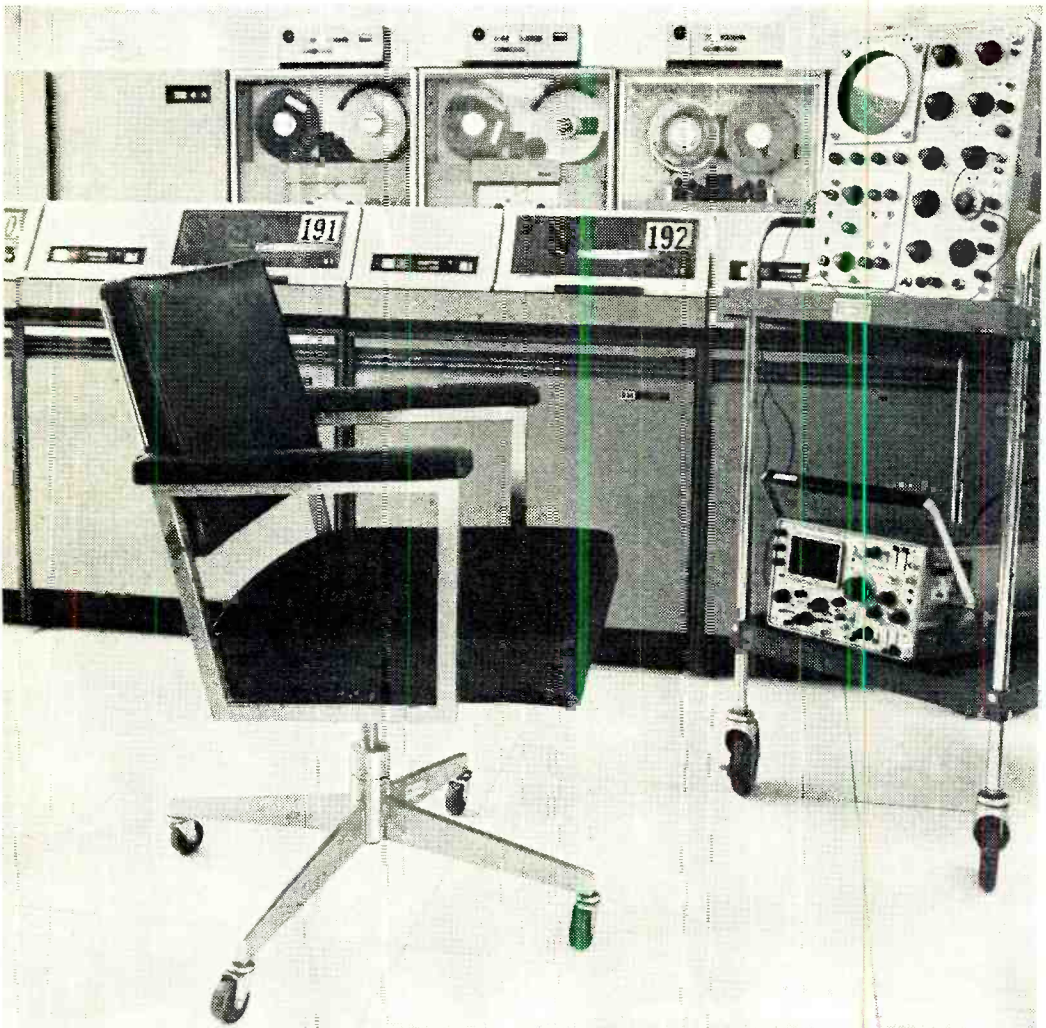
The HPU's involvement with search and rescue promises to be even closer from now on. The first six months of 1971 showed that there were already 495 search and rescue missions among which were 37 rescues and 315 cases of assistance to boats which were disabled, adrift or sinking. In addition, the Unit investigated 36 boating

accidents and was assigned to patrol 32 regattas and other special boating events.

Communications Is the Backbone. Along with another expert in the field, the United States Coast Guard, the Harbor Patrol Unit has found that communications is the backbone of search and rescue. Higher echelon thinking in the NYPD evidently echoes this philosophy. When the HPU's vhf/FM system went into operation in the summer of 1971, it was decided to relieve the group of some time-consuming land duties so that it could focus full-time on the 576 miles of New York City's waterfront, the 146 square miles of water under its jurisdiction and the still-growing pleasure boat population. Its responsibility for the Triboro Bridge was divided between the 114th Precinct (Queens), the 25th Precinct (Manhattan) and the 40th Precinct (Bronx). Randall's and Wards Islands went to the 25th Precinct, Welfare Island to the 114th and Rikers Island to the 40th.

Basically, the Harbor Patrol Unit's use of its vhf/FM communications system goes like this: channel 17 (156.85 MHz) is the one on which the majority of HPU traffic is carried. This is a ship-to-coast *only* channel, incidentally. Channel 16 (156.8 MHz), the national distress, safety and calling frequency, is monitored continuously by both the base station on Randall's Island and all police launches. Channel 12 (156.6 MHz) serves as the Harbor Patrol Unit's link with the Coast Guard for routine (non-distress) traffic as well as with other ship stations for the operational handling, movement and safety of vessels. "Ship", by-the-way, means anything capable of being used as a means of conveyance on the water, including pleasure craft according to the FCC. Channel 6 (156.3 MHz) is used for ship-to-ship *only* safety communications.

By now, the novelty of having its own two-way radio system has worn off although Operations Officer Sgt. John Murphy still occasionally calls the unit farthest from Randall's Island just to impress visitors. It remains for the 1972 pleasure boating season to put the Harbor Patrol Unit's vhf/FM network to the acid test. In any event, it's all a far cry from 1858 when a squad of patrolmen manned a fleet of five rowboats and did a lot of yelling at each other. ◈



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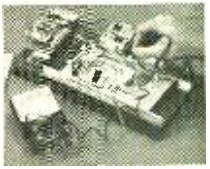

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CIRCLE NO. 12 ON READER SERVICE CARD

Product Test Reports

TELEX MODEL CS-7 COMMUNICATIONS HEADPHONES
(A Hirsch-Houck Lab Report)

THE Telex 1320 series of communication headphones employs highly sensitive drivers which are designed to be impervious to temperature and humidity and to have closely controlled operating characteristics. The earpieces are molded of a high-impact ABS plastic similar to that used in telephones. The Mylar cone drivers are protected by a stainless steel grille. The removable vinyl covered ear cushions are filled with polyurethane foam. The 6′ straight cord is fitted with a molded plastic phone plug and attaches to the earpiece with a molded connector. The connector is locked into place with a pin which can easily be removed to facilitate on-the-spot field replacement of the cord. The adjustable headband is made of vinyl-padded stainless steel.

The series 1320 phones are available with either single or dual earpieces and with or without carbon or dynamic microphones on adjustable booms mounted on the left earpiece. We tested the Model CS-7, a dual earpiece headphone without the microphone attachment.

The nominal impedance of the CS-7 phones is specified as 600 ohms; our measurements revealed a constant impedance of approximately this figure from 20 Hz to 10,000 Hz. It increased to 800 ohms at about 20,000 Hz. The frequency response, measured with our nonstandard "artificial ear" coupler setup, was very similar to that of a number of moderately priced stereo headphones in the $20 to $40 range which we tested in the past. It extended from 20 Hz to 15,000 Hz (the upper limit of our microphone calibration) with the normal irregularities one experiences with coupler measurements of earphone response. We would judge that the manufacturer's specification of usable response of 20 to 20,000 Hz is a justifiable claim.

At a drive level of 3 volts rms (corresponding to 15 milliwatts), the acoustic output had a harmonic distortion content of 3 percent at 400 Hz. Although we did not attempt to measure the actual acoustic output with this drive level, the resulting listening volume was very high—somewhat louder, in fact, than we would normally care to use.

In a rough sense, we can relate the characteristics of the Telex CS-7 phones to those of several popular stereo headphones. In general, its frequency response and smoothness are quite comparable to those of typical medium-priced phones, and its efficiency is higher than average, by as much as 10 dB at middle and low frequencies. It is comfortable to wear, with snug fitting ear cush-

ions and a weight of only one pound. Acoustic isolation from outside noises appears to be about average when compared with stereo headphones which also use padded or liquid-filled ear cushions.

We used the CS-7 phones with two communication receivers. In both cases, the listening volume was more than adequate, and the phones were comfortable over long listening periods. Comparing their sound reproduction quality to that of the military surplus phones we had been using, the improved bass response of the CS-7 was immediately apparent in the form of improved quality on SSB signals. It also made the hitherto unnoticed audio hum in the receiver only too audible. In this case, the hum was not really objectionable, but many receivers have considerable audio hum, relying on the speaker or headphone low-frequency cutoff to attenuate and damp it out. Using the CS-7 phones with such a receiver is akin to using wide-range loudspeakers with a very inexpensive amplifier—the deficiencies of the source are faithfully reproduced!

The list price of the Telex Model CS-7 communication headphones is $29.95.

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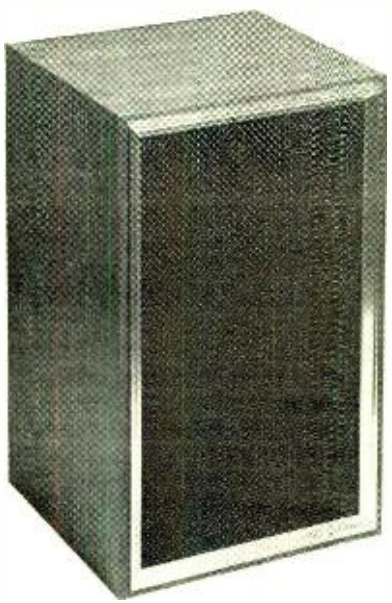
AUDIOTEX MODEL 30-5104 SPEAKER SYSTEM
(A Hirsch-Houck Lab Report)



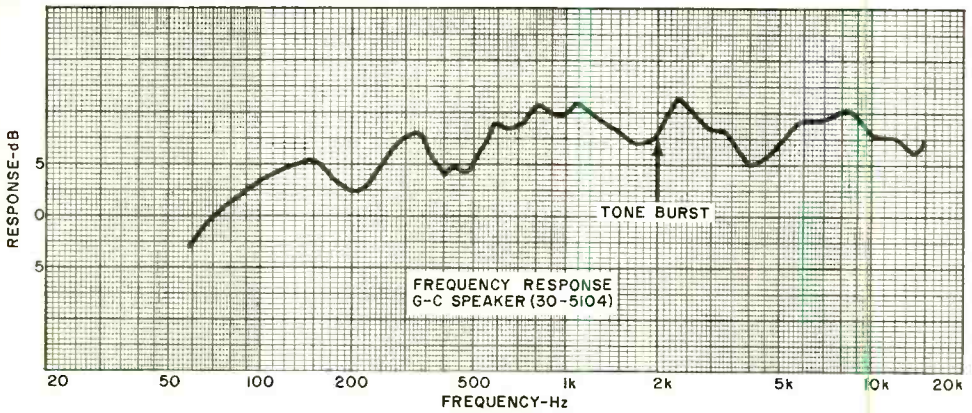
A SPEAKER system designer faces several possible trade-offs between size, weight, efficiency, power-handling ability, frequency response (particularly at the lower bass frequencies), and price when putting together a practical system. No speaker system can excel in all of the above mentioned areas; few are outstanding in more than a couple of them. The Audiotex Model 30-5104 speaker system, manufactured in Japan and marketed in the U.S. by GC Electronics Division of Hydrometals, Inc., is an excellent illustration of one approach to the design problem.

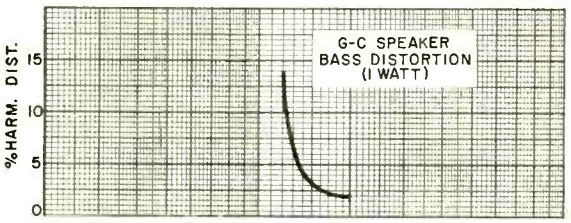
This speaker system, measuring 15½" x 9½" x 9" and weighing only 9 lb 10 oz, is a two-way design employing an 8" woofer and a 3" cone-type tweeter. The crossover frequency is unspecified. The 8-ohm system is designed for a maximum power rating of 25 watts.

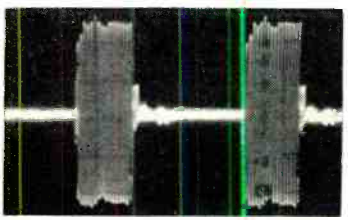
Lab Tests. In our multiple microphone frequency response measurement, the Audiotex speaker system had a surprisingly smooth output over most of the audible frequency range. Between 250 Hz and 15,000 Hz, the output varied by only ±3.5 dB, which would be a creditable achievement for far more expensive speaker systems. However, one of the obvious compromises in the system's design is the sacrifice made in the bass performance. The response of the system fell off below 150 Hz, and was down 10 dB at 70 Hz relative to the midrange level.

The low-frequency power handling ability is also limited. The distortion, normally low beyond 150 Hz, climbed rapidly to 5 percent at 135 Hz and to 14 percent at 120 Hz. These measurements were made at a 1-watt drive level. The impedance of the system was between 7 and 15 ohms over most of the frequency range, rising to a maximum of 22 ohms at the system's resonant frequency of 100 Hz. The tone-burst response was uniformly good over the entire useful range of the speaker system.

Our tests showed which operating parameters had not been sacrificed in the final system design. The efficiency of the Audiotex speaker system, for example, is high compared to many other compact systems. In fact, over most of the useful frequency range, it is about 10 dB more efficient than







Response and distortion curves for Audiotex 30-5104. Photo of tone burst is at right.

are other similarly priced small speaker systems we have tested in the past.

Although the foregoing could be interpreted to mean that the Audiotex speaker system produces 10 dB more volume for a given driving power (which it does), it is more realistic to view it as requiring only one-tenth as much driving power as most other compacts for the same volume level. The Audiotex system is not intended for loud playing, but it will do a fine job at normal listening levels in average sized rooms. Because of its efficiency and limited low-frequency output, it can be driven effectively by some of the least expensive receivers and amplifiers which would be unsuitable for use with the usual inefficient "bookshelf" speaker system.

User Comments. We compared the Audiotex speaker system in an A-B fashion to other small speaker systems selling at or slightly higher in price than the 30-5104. The signal source was a low-cost receiver, selling for less than $175, which delivered about 10 watts per channel and considerably less at very low frequencies. Our immediate impression, once we had compensated for the considerably louder sound from the Audiotex system, was of a clean, somewhat projected sound character with a rather thin bass. The receiver's loudness compensation, however, was able to restore a satisfactory balance, especially at the low-volume control settings made possible by the system's high efficiency. The comparison speaker could play as loud as the Audiotex, but only with the volume control nearly all the way up.

As part of a budget-priced music system or as an extension speaker system, the Audiotex 30-5104 could be a logical and satisfying choice. An excellent application would be for the rear speaker systems in a four-channel stereo setup where their high efficiency can be an advantage and the low frequency and power limitations would be partially offset by the 3-dB lower level drive supplied to the rear speaker systems.

The Audiotex 30-5104 speaker system comes housed in a walnut-finished enclosure. Selling price is $49.95.

Circle No. 66 on Reader Service Card

TRIPLETT MODEL 990 MAINTENANCE IN A CASE

IF YOU lug around a suitcase full of test instruments when going on service calls, only to discover that you are missing an important part or that a delicate piece of equipment has been damaged during transport, take heart. At a cost of $221, *Triplett* is now distributing their "maintenance in a case" Model 990 industrial test instrument

lab which can be used to make fast and accurate measurements of voltage, current, resistance, output level in decibels, rotational speed in rpm, and temperature.

The versatile lab consists of a Model 900 multimeter which has special temperature, dB, and rpm scales in addition to the usual complement of voltage, current, and resistance scales. Complete with its own leather carrying handle, the multimeter also features a fast-acting overload protection circuit.

A Model 901 tachometer/generator is supplied to provide the VOM with the capability of measuring rotational speed between 0 and 500 rpm in one range and between 0 and 5000 rpm in a second range. A rubber tip on the tachometer/generator is held in firm contact with the center of the rotating part; the speed of rotation is then an indication of pointer swing on the special rpm scale of the multimeter. Virtually any type of rotating machinery—including motors and blowers—can provide an rpm indication with this tach/generator-VOM combination.

The temperature probe can be used for air, liquid, or surface temperature measurements in two ranges: −50° F to +100° F and +40° F to +300° F. This probe is used to measure the operating temperature of any type of equipment, inlet and outlet temperatures of furnaces and air conditioners.

A Model 10 clamp-on ammeter adapter

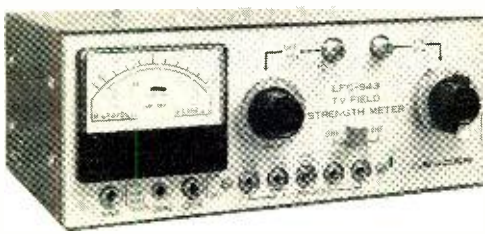
is provided in the Model 990. It is used to measure ac current flowing through a wire without having to break the conductor to insert the meter into the circuit. A Model 101 line separator is also provided to separate one conductor of two-conductor cables so that the Model 10 clamp-on can be used in two-conductor cable systems. Model 611 leads are used to connect the clamp-on ammeter to the multimeter. And a dc current shunt is provided to extend the current measuring capabilities to 100 amperes with only a 250-mV drop.

Having just about all of the test equipment in one padded case (see photo) certainly eases things from a physical viewpoint. As far as use is concerned, we found that the package does a good job. No problems were encountered in using any of the devices supplied nor in interpreting any of the multimeter scales with the specific sensing devices used.

In our bench tests, we used the temperature probe to check warm semiconductors and heat sinks. The ac ammeter section was used to check the rated current (converted to watts) of various electrical appliances, while the dc portion was used for checking the current consumption of several electronic items—among them an audio amplifier and a shortwave receiver. In A-B checks between the Model 990 and several other special-purpose test instruments, we judged that the former provides reasonably good to excellent accuracy in all modes of operation.

Circle No. 67 on Reader Service Card

LEADER INSTRUMENTS MODEL LFC-943 TV FIELD STRENGTH METER



THE things one hooks up to the antenna terminals of a television receiver determine the quality of the picture which will appear on the screen. The list of hookup items includes the orientation and directional characteristics of the antenna, the performance of any boosters used, the level of the incoming signals from MATV and CATV outlets, and the performance of multi-receiver antenna signal splitters. On the other hand, how does one compare the effective "pickup" of the various types and sizes of antennas on the market, assuming that there is a choice to be made? There is, of course, the guess-which-is-better routine in which you change antennas while comparing results. But this means that you have to remember what the previous antennas, boosters, and amplifiers produced in the way of usable signal.

Now there is an easy way out of the selection dilemma for the specialist who handles all types of antennas and signal transmission systems. All he needs is the battery-powdered Model LFC-943 field strength meter available from Leader Instruments. This extremely easy-to-use instrument covers the entire vhf/uhf TV range from channel 2 through channel 83. It indicates signal strength in both decibels and microvolts from −40 to +60 dB (10 μV to 1V) on the vhf channels and from −30 to +40 dB (31.6 μV to 100 mV) on the uhf channels.

The user hooks up the antenna, coupler, or amplifier to be checked to the antenna input terminals on the test set; tunes the channel selector in the test set to the appropriate station (an internal audio system allows the sync buzz to be heard to aid in peaking the tuning); and observes the movement of the meter pointer. A set of attenuators can be switched into the circuit as needed to produce a usable meter indication. The final signal strength is then the meter pointer indication plus the value of the switched-in attenuators.

An earphone is provided for using the LFC-943 in areas where the ambient noise is high. A neck strap, also provided, allows hands-free operation, permitting the user to make mechanical adjustments on the antenna or electrical adjustments on an amplifier or coupler/splitter system. A switch position is provided for testing the internal batteries.

The LFC-943 is essentially a narrow band TV receiver. For the vhf band, the signal is applied through switchable attenuators to the vhf tuner. A four-stage solid-state i-f amplifier then drives a diode

detector whose rectified output current drives the meter movement, calibrated in terms of dB and μV. For audible monitoring, an internal audio system is used to drive either an internal speaker or an earphone, either of which can be switched in as desired.

In the uhf configuration, the input to the uhf terminal drives a conventional solid-state uhf tuner whose output is coupled through the attenuator network to the vhf tuner where it is applied in the conventional uhf position. The remaining circuitry is the same as in the vhf configuration.

Operating power is derived from eight C cells; and a transistorized voltage regulator converts the incoming 12 volts to a constant 9-volt output.

We used the LFC-943 field strength meter to check a number of multi-set splitters and a few antennas. We were surprised to note the differences in output levels between the splitters, with some having surprisingly high losses scattered across the TV band. Other splitters were found to be reasonably flat across the band.

Circle No. 68 on Reader Service Card

MURA "THERMY" TEMPERATURE PROBE

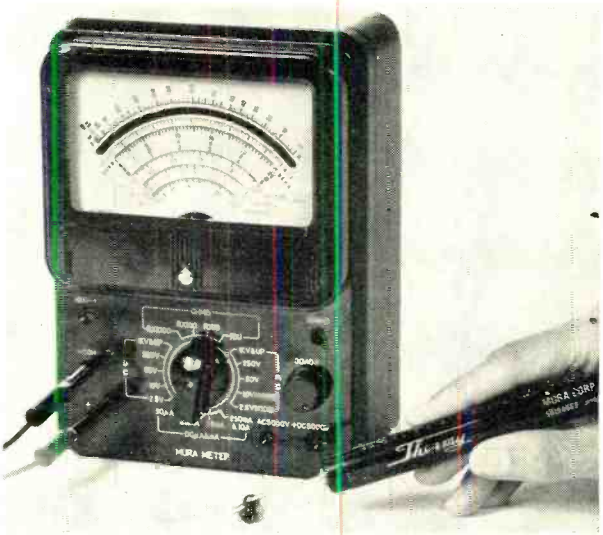
ONE of the more common problems one encounters when working with transistors—especially the medium- and high-power types—is knowing how hot a transistor should get when operated properly and how hot it can get when operated improperly. Most of us merely place a fingertip on the case of the transistor and take a wild guess at how hot it is, basing our guesses on how long we can keep our fingertip there. Most transistor specification sheets supply—in addition to electrical operating parameters—the correct operating and maximum temperatures. Even so, a fingertip is hardly a reliable temperature probe. And who ever heard of a calibrated guess?

Having worked with bulb thermometers and a couple of home-built thermistor temperature sensors, we are fully aware of their shortcomings. Consequently, we welcome the appearance of the Mura "Thermy" temperature sensor adapter. This device is designed to be used in conjunction with virtually any ohmmeter you have. Its temperature measuring range goes from a low end temperature of −60° F to a top end of

400° F; translated into engineering and scientific terms, the temperature range is from −50° C to 200° C.

After plugging the Thermy into the ohmmeter, the user merely touches the 1¼"-long probe-like tip to the surface whose temperature is to be measured. He then notes the resistance indicated on the ohmmeter scale and uses the indication to look up the exact temperature on the chart attached to the probe handle. In essence, the temperatures measured by the Thermy are a function of the ohms scale you are using. Also, the reaction time of the adapter is fairly good, stabilizing quite rapidly after probe-to-surface contact is made. Accuracy of measurement is also pretty good.

The Thermy is supplied with a 3′ cable and a snap-cover case and the price, including case, is $14.95.



Circle No. 69 on Reader Service Card

KURZ-KASCH AUTO-PROBE

WHEN we have to check out the various electrical circuits in our motor vehicles —cars, boats, motorcycles, airplanes, or farm tractors—what usually happens is out comes our trusty VOM and we set to work. Unfortunately, in some cases while undergoing the inevitable acrobatics under the dashboard or under the hood and balancing the meter in precarious places, most of which are not level, tragedy strikes as the VOM takes a dive for the hard concrete pavement. Scratch one once-useful meter.

If you have to make a number of electrical checks in and around your vehicle or trailer, Kurz-Kasch, Inc., would like you to know about their handy "Auto-Probe" tester which they sell for $4.99. Looking like a shirtpocket pencil flashlight, the Auto-Probe has a sharp test tip (for getting through wire insulation without having to break the circuit) at one end. Out of the other end comes a 40" flexible wire terminated in an alligator clip.

Two Indicator Lamps. Behind the translucent cap at the test tip end of the Auto-Probe is a pair of small incandescent lamps, one white and the other red. When the lead is clipped onto chassis ground via the metal vehicle frame, touching the probe tip to a "hot" lead causes the red lamp to light. If the probe tip is touched to any point at chassis ground, however, the white lamp comes on. On the other hand, if contact is made to a disconnected wire, neither lamp comes on.

The Auto-Probe's circuitry is contained in a sturdy chrome steel case measuring ⅝" in diameter and 6" long. Also contained inside the housing is a pair of AA cells which provide power to the tester.

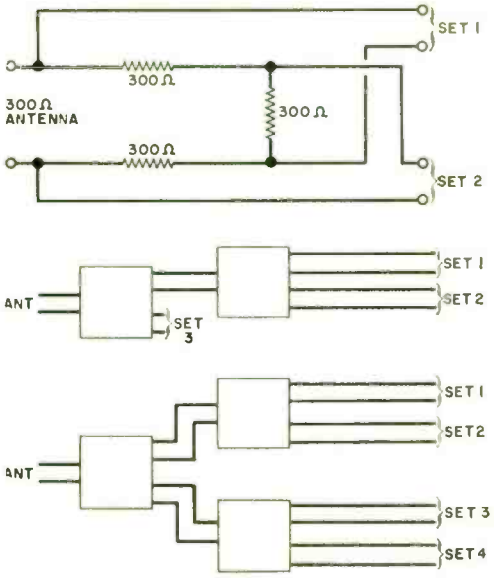
The Auto-Probe is available in a 12-volt negative or positive ground model.

Circle No. 70 on Reader Service Card

TV SIGNAL SPLITTER

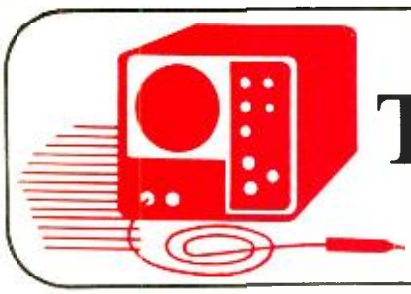
BY C. R. LEWART

THE circuit shown here provides a simple means of connecting two or more TV sets to a common antenna. Besides providing excellent separation, and a good terminating impedance to the antenna lead-in, the circuit may also be used for mixing or distributing r-f signals at other than TV frequencies.



The two-set splitter consists of three equal-valued resistors, each selected to match the impedance of the lead-in. The three resistors, together with the impedance of the lead-in, form a Wheatstone bridge. Each TV set will "see" a 300-ohm impedance, and will be isolated from the other sets. Assuming that the input impedance of the TV sets is close to 300 ohms, the lead-in cable will see an impedance of 300 ohms, and thus be perfectly terminated. The electrical loss in the circuit is 6 dB.

To supply three, four, or more TV sets, the diagram also shows how a number of splitters may be interconnected. For four TV sets, losses will be 12 dB, for eight sets 18 dB, etc. For three TV sets, one will have only 6 dB with 12 dB for the other two. These losses compare with the approximate 4½ dB for a coil-type TV signal splitter. ◈



Test Equipment Scene

By Leslie Solomon, Technical Editor

Digital Instruments: What, Why and Who

THE backbone of all instruments used for measuring voltage, current, and resistance always used to be the familiar analog or moving-pointer meter, usually having a number of different scales. With the development of the gas-discharge readout tube, a new breed of test instrument came into being. Gone was the need for scale interpolations, and gone were the nonlinear and crowded meter scales that made accurate reading difficult. The readout tube also led to the creation of an easy-to-use frequency measuring device or counter.

In the early days, the gas-discharge readouts were driven by vacuum-tube circuits. Thus, the first digital instruments were rather bulky and expensive and were found only in research labs. With the introduction of the transistor, these instruments came down both in size and price, and were more commonly available. Then along came the digital IC. It was this event that rapidly led to the many various new types of digital instruments we see in present catalogs. The single-plane 7-segment display was soon developed. With more advanced semiconductor techniques, especially in light-emitting diodes, the complete solid-state 7-segment readout came into being. With their lower power requirements and small size, they have led to the development of really portable, high-quality, and reasonably priced instruments.

In the not-too-distant future, we shall most likely see the use of liquid crystal readouts with an even greater reduction in power requirements.

There are, at present, two types of digital-readout instruments: the multi-meter that, in various configurations, measures ac and dc voltage, current, and resistance; and the frequency meter (which may also include event counting).

Two methods of creating time bases for digital instruments are used. The first has the commercial power line as the frequency reference, and the other has a crystal-controlled oscillator used as a clock. Because the power line frequency can wander somewhat from the nominal 60 Hz, accuracy beyond 2½ or 3 digits is always in doubt. With a crystal oscillator approach, the clock frequency is always very close so that the timing interval is excellent and accuracy can be maintained to many decimal places.

The accuracy of most digital instruments is expressed as a percentage of the indication and usually ranges from 0.1% to 0.001%. In most cases, the last digit in frequency counters is always in doubt by ±1 count.

The DVM. Digital voltmeters are essentially special-purpose frequency counters because the input voltage is converted into a proportional number of pulses which are counted. This can be done in a number of ways: direct voltage-to-frequency conversion is the simplest. In this approach, the input voltage

controls the frequency of a voltage-controlled oscillator. The oscillator is gated on and off with a known gate time, and the number of pulses passed during this period is displayed on the readouts.

Another approach is to start up a known-frequency oscillator and when the unknown input voltage is at the same level as an internally generated ramp, the oscillator is stopped. The number of oscillator pulses fed to the readouts is arranged to represent the actual value of the input voltage.

Digital multimeters are usually specified in terms of strange numbers like "2½" or "3½" digits. A 2½-digit instrument has two complete decades (0-9) and a single "1" on the left side. This type of instrument can indicate to 1.99, 19.9, or 199 units; while the 3½-digit type can indicate 1.999, 19.99, 199.9, or 1999 units. All digital instruments are equipped with an "overrange" indicator to signal when the capacity of the display has been exceeded. When this indicator comes on, it is a signal to reset the instrument to the next higher range. Many instruments also include automatic polarity indication, and automatically adjust the decimal point to the correct place depending on the range.

As with analog multimeters, always make sure that the DVM you select has a high input impedance to avoid loading the circuit under test. To have a negligible effect on circuit loading, the input impedance must exceed the measured load impedance by at least a factor of 10^n where n is the number of digits in the display. Of course, the sensitivity of the instrument must be such that it will work with the expected signal level.

Frequency Counter. An electronic frequency counter compares (gates) an unknown frequency against a known time interval and presents the results on the digital readouts. In some instruments, provisions are also made for period measurements. In this approach, an unknown time period gates on a known frequency oscillator, with the results displayed.

Most frequency counters come with whole-digit display and include an overrange indicator. Frequency ranges are from about 1 Hz to about 35 MHz. However, front-end scalers are available to enable the counter to reach about 175 MHz.

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There are three main sources of errors in a frequency counter. These are a ±1 count ambiguity, time-base instability, and trigger error noise. The ±1 count ambiguity occurs because the input pulses and the time base are normally not synchronized. The larger the number of events counted, the less the error, and this explains why long gate times result in higher accuracy in frequency measurements. Time base instability is usually due to power line frequency fluctuations (when this method of gating is used), or crystal drift when using this type of oscillator as the gate time source. Trigger error is due to the fact that the counter cannot tell the difference between a real signal and noise mixed with the signal.

Who Makes What. Following are some examples of the less expensive digital instruments: Heath Company IM-102 digital multimeter ($229.95 in kit form) is a 3½-digit instrument using a dual-slope integrator that does not depend on a stable clock for accuracy. With an input impedance in excess of 1 megohm on ac and 100 megohms on dc, this unit has 5 ac and 5 dc voltage ranges from 200 mV to 1000 V; 5 ac and 5 dc current ranges from 200 μA to 2 amperes; and 6 resistance ranges to 20 megohms. Accuracy is 0.2% (0.1% with "tweaking"), and all circuits are overload protected. The instrument also has automatic polarity indication.

Heath also produces the IB-101 frequency counter ($199.95 in kit form) that indicates from 1 Hz to 15 MHz. Having a 5-digit display that can be switched to 8 digits via a front-panel control, the input impedance is 1 megohm and a 1-MHz crystal-controlled oscillator provides an accurate time base. If you have to go higher in frequency, the Heath IB-102 frequency scaler ($99.50 in kit form) can be used. Performing accurate scaling from 2 to 175 MHz, this "front end" can extend the capability of the IB-101 (or any other comparable counter) to 175 MHz. Division ratio is 10:1 or 100:1 at the touch of a switch.

The Triplett Model 6028 ($275) is a 2¾-digit (a conventional 2½-digit display with an added readout that indicates whether the result is above or below ½) portable multimeter having an input impedance of 10 megohms on ac and dc voltage ranges and 5 ac and 5 dc ranges from 100 mV to 1000 V; 5 ac and dc current ranges from 100 μA to 1 ampere; and six resistance ranges to 10 megohms. All ranges are overload protected. Besides an overrange indicator, this instrument also has automatic polarity indication, and is one of the few digital instruments that can operate from built-in batteries.

The Weston Model 1250 frequency counter ($395) uses a full five-digit, solid-state display and has a frequency response from 5 Hz to over 32 MHz in four ranges. Sensitivity is 250 mV rms, and input impedance is 1 megohm. It uses a 1-MHz crystal-controlled oscillator as the clock. This bench instrument also provides a 1-MHz pulse output at TTL levels for use in testing external logic circuits. It also has leading zero suppression.

Weston's Model 4440 digital multimeter ($285) has 3½ digits of readout, is line or battery operated, and weighs less than 2½ pounds. Some features are: automatic polarity indication, leading zero suppression, and complete overload protection. It covers ac and dc voltages from 200 mV to 1000 V with a 10-megohm input impedance, ac and dc current to 199.9 μA, and resistance from 200 ohms to 2 megohms. A battery position is also included. The unit can be operated from rechargeable or conventional "C" cells.

Simpson makes several digital instruments. Their latest, the Model 460 portable, digital VOM ($395) is a 3½-digit instrument with 26 ranges. Among these are ac and dc voltages from 200 mV to 1000 V; ac and dc current from 200 μA to 1 ampere; and resistance to 200 megohms. Input impedance for voltage is 1 megohm for ac and a minimum of 10 megohms for dc. Among other features are automatic polarity indication, built-in line supply and battery power, and the unique use of an analog meter to indicate nulls or peaks when doing alignment. Full overload protection is provided for each range, and the display is non-blinking.

The Hickok Model 3301 ($385) uses a 3½-digit non-blinking display and has 27 ranges. These include 5 ac and dc voltage ranges from 100 mV to 1000 V, 5 ac and dc current ranges from 100 μA to 1 ampere, and 7 resistance ranges to 100 megohms. Full overload protection is provided on all ranges and an optional battery power supply is available. You can also specify BCD output for interfacing with data acquisition system. ◈

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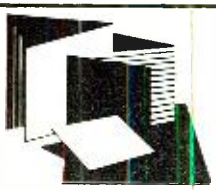

New Literature

RAYTHEON MARINE EQUIPMENT CATALOG

Raytheon's full line of marine electronic equipment for navigation, communication, and safety is featured in a new 16-page catalog. Two dozen radars, radiotelephones, radio direction finders, loud hailers, loran receivers, and Fathometer depth sounders are illustrated and described in detail. Prices are not quoted. Address: Raytheon Marine Products, 676 Island Pond Rd., Manchester, NH 03103.

STANCOR TRANSFORMER CATALOG

The new *Stancor* Transformer Catalog (No. 207) lists more than 1900 standard transformers for design engineers. Included in the listings are full technical data, mounting dimensions, photos, and other specifications for audio and power transformers, chokes, and inductors. Address: Essex Int'l., Inc., Controls Div., Stancor Prods., 3501 W. Addison St., Chicago, IL 60618.

BROOKSTONE HARD-TO-FIND TOOLS CATALOG

The Second 1972 Edition A catalog of hard-to-find tools and accessories available from *Brookstone* is a goldmine for anyone who has ever needed a non-standard tool and couldn't find it anywhere. In addition to tools, the catalog lists such items as a hand-held searchlight which puts out a blazing 200,000-candlepower beam, a professional resistance soldering machine, an automatic wire stripper, and a sophisticated fire alarm system. Tools listed are all finest quality. Address: Brookstone Co., Dept. C, 10 Brookstone Bldg., Peterborough, NH 03458.

SCIENTIFIC MEASUREMENTS LITERATURE

Currently available from *Scientific Measurements* is a five-sheet handout. The Data Sheet contains information on the 16 possible 2-input, 1-output binary combinatorial circuits on one side and the rules of Boolean algebra on the other side. Three other sheets provide information on the company's Comp-U-Kit Logic Lab 1, Analog Computer 1, and Pulse Generator. The final sheet lists the prices for the various Comp-U-Kit modules. Address: Scientific Measurements, Inc., 2945 Central, Wilmette, IL 60091.

Electronics Library

MODERN OPERATIONAL CIRCUIT DESIGN
by John T. Smith

This book presents the body of circuit design techniques and information which have applications in a wide range of scientific disciplines. Until now, the use of such knowledge has been the province of the highly trained designer of military systems. This book, however, provides the non-specialist with ample information for assembling his own circuits and solving his own problems. Especially important, all circuits illustrated have been successfully built and tested by the author.

Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Hard cover. 256 pages. $14.95.

ELECTRONIC CIRCUITS MANUAL
by John Markus

Engineers, experimenters, and hobbyists—in fact, anyone requiring complete, up-to-date information on electronic circuitry—will appreciate this encyclopedic compendium of more than 3000 advanced circuit designs, each complete with component values. The circuit diagrams are organized into 99 logical chapters and indexed for fast, efficient retrieval of schematics and circuit data for every need.

Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 987 pages. $19.75.

CITIZENS BAND RADIO SERVICE MANUAL
by R. F. Burns & L. G. Sands

As an all-in-one troubleshooting and maintenance guide for all types of CB radio transceivers, this new book contains a helpful 36-page fold-out section which contains complete schematic diagrams of popular late-model 2-way radios. Represented in the diagrams are the Courier CCT4, Cobra 25, Hallicrafters CB-21, Johnson Personal Messenger and Messenger III, Lafayette Dynacom 12A and HB-23A, Midland 13-880, Rustler, SCB-6CB Sidebander, Sonar T-2, and Telsat 924.

Published by Tab Books, Blue Ridge Summit, PA 17214. 192 pages + 36-page foldout. $7.95 hard cover, $4.95 soft cover.

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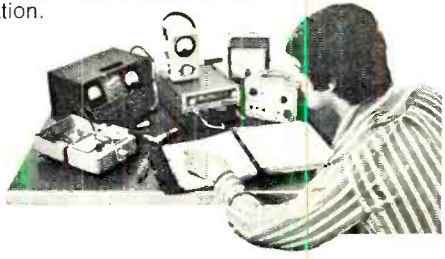


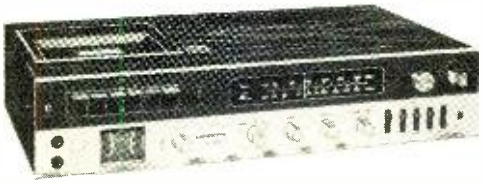
PACE SSB AND CB TRANSCEIVER

The *Pace Division* of *Pathcom Inc.* has introduced a new SSB and AM Citizens Band Radio, called the Sidetalk 23. The combination 46 channel SSB and 23 channel AM transceiver is all solid state with 15 watts PEP. It has adjustable squelch with fine tuning control of each channel (clarifier). A noise blanker circuit has front control switch, and a crystal-lattice filter provides proper band-pass with over 60 dB suppression on unwanted side bands.

Circle No. 71 on Reader Service Card

LAFAYETTE RADIO STEREO SYSTEM COMBO

The Model LRK-900 combination stereo receiver and cassette recorder available from *Lafayette Radio Electronics Corp.* incorporates



special circuits which reproduce regular stereo records, tapes, and FM broadcasts with 4-dimensional effects. The sensitive FM tuner utilizes "Acritune" for instant center-station tuning. The cassette deck features switchable standard/Cr02 tape bias equalization, large recording meters, sound-with-sound mixing, and automatic mechanical/electrical shutoff.

Circle No. 72 on Reader Service Card

MOSLEY 5-ELEMENT CB BEAM ANTENNA

The Deluxe *Mosley* CB Mini-Beam Model GA-5D antenna is designed to deliver full-size beam performance in a compact package. Ten deluxe high-Q coils molded onto the element extensions reduce size without limiting electrical capability. A new swaging technique seals both ends of all coil sections to prevent moisture accumulation and assure reliable all-weather performance. The compact GA-5D was designed to reduce the area exposed to wind so that the antenna can be mounted, without a tower, on a TV antenna mount and turned with an inexpensive TV rotor.

Circle No. 73 on Reader Service Card

TRIPLETT MICRO-POWER FET VOM

The Model 603 battery-powered FET VOM developed by *Triplett* can be left on continuously without appreciably wearing down the batteries. It draws only 10 μA as a result of an exclusive "TMP" (Triplett Micro Power) circuit. Current drain is so low, in fact, that carbon-zinc batteries should last as long as they do on a shelf. Besides TMP, the meter features Low Power Ohms which permits safe testing of transistors and IC's, an Auto Polarity circuit, and an amplifier circuit which incorporates a high degree of feedback for making both ac and dc scales linear. On both dc and ac, measurements can be made out to 1000 volts and 1000 mA (1 ampere) with 3% accuracy. Ohmmeter ranges cover from RX1 through RX1 meg. The output ranges go from –30 dB to +62 dB with 3% accuracy.

Circle No. 74 on Reader Service Card

DUOTONE DELUXE STEREO HEADPHONES

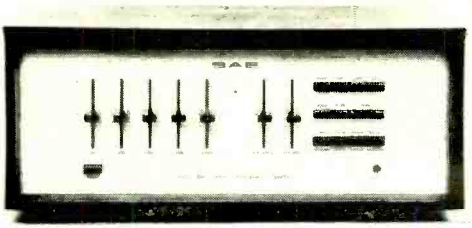
The *Duotone Co., Inc.*, has announced the availability of their new top-of-the-line Model VCH-100 stereo headphone set. The VCH-100 reproduces sound over the range of from 15 Hz to 25,000 Hz and has a power-handling capacity of 1 watt. Impedance is 4-16 ohms.

Individual volume controls are provided for each earcup. The earcups are cushion padded for user comfort, and the phones come with a 15-ft coil cord to which is attached a standard three-conductor phone plug.

Circle No. 75 on Reader Service Card

SCIENTIFIC AUDIO PREAMP EQUALIZER

The Mark IX Preamplifier Equalizer recently announced by *Scientific Audio Electronics, Inc.*, has operational characteristics similar to those used in recording studios. The equalizers can be used to compensate for poorly equalized records, to modify the tonal quality of loud-



speakers, and, in some instances, to compensate for room characteristics. The equalizer section uses five frequencies instead of tone controls. Toroidal LC bandpass filters with 12 dB/octave slopes are used. The equalizers are variable to ±16 or ±8 dB. A defeat switch is provided for electrically removing the equalizers from the audio system, and a tape copy facility is provided to eliminate patching to the rear of the chassis.

Circle No. 76 on Reader Service Card

HEATHKIT 25" VHF/UHF COLOR TV KIT

The Model GR-900 solid-state color TV with a 25" diagonal measurement, uhf detent tuning, and ultra-rectangular picture tube has now taken its place at the top of the *Heath Company's* color TV receiver kit line. The user can preset up to 12 uhf channels in his area to take advantage of the detent tuning. Push-button power tuning scans both vhf and uhf stations in either direction. An angular tint switch selects either normal or wide-angle color demodulation to reduce tint and flesh tone changes when switching channels. Instant-on operation with override, pushbutton aft and automatic tint control, and adjustable tone control are also included. The ultra-rectangular picture tube design gives the viewer 315 sq in. of viewing area. As usual in Heathkit TV's, the GR-900 has built-in service features and comes with a volt-ohmmeter for easy servicing setup, and troubleshooting.

Circle No. 77 on Reader Service Card

SHURE IMPEDANCE-MATCHING TRANSFORMER

Owners of transistorized tape recorders equipped with medium-impedance inputs can now get superior performance from their recordings

through the use of a new *Shure* Model A97A line-matching transformer and a high-quality, low-impedance microphone. Usually, the mike that comes with home and portable recorders is a utility unit which cannot take advantage of the full performance potential of the recorder. Use of a Model A97A and a high-quality microphone (such as Shure's 575SB or 585SB) not only improves the audio input signal, it also permits the use of long cables without loss of high frequencies and without hum and noise pickup.

Circle No. 78 on Reader Service Card

ONKYO LINEAR SUSPENSION SPEAKER SYSTEM

A three-way "linear suspension" speaker system (Model 20) featuring a 12" woofer, a 2" hemispheric dome midrange speaker, and a 1" hemispheric dome tweeter is being marketed by *Onyko*. The drivers are specially designed and manufactured to minimize undesirable resonances. A unique integrated crossover network with exclusive filter circuitry helps provide smooth, clean transitions. The crossover control panel located on the rear of the enclosure contains 5-position midrange and high-frequency switches which allow the listener to adjust driver levels in 2-dB steps to suit his listening tastes. Frequency range is 35-20,000 Hz; maximum power handling capacity is 50 watts, with 10 watts rms minimum required.

Circle No. 79 on Reader Service Card

TOYO 4-CHANNEL DECODER

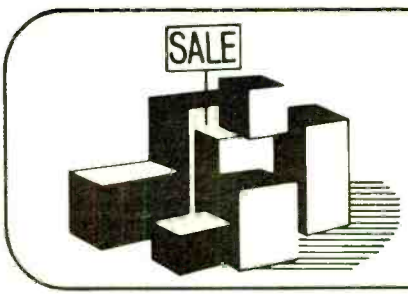
The new Model QC-002 4-channel decoder made by *Toyo Radio Co. of America, Inc.*, recovers both the "hidden ambiance" contained in ordinary 3-channel programs *and* the four original channels from encoded (matrixed) programs. The decoder is designed to feed into any 4-channel amplifier or any pair of 2-channel amplifiers. The all pushbutton controls include Effect Selectors which allow the user to choose between solo effect, simulating the ambiance of a small concert hall with a single performer; concert hall ambiance; or surround sound, which gives the listener the sensation of being located in the middle of the orchestra.

Circle No. 80 on Reader Service Card

SBE DIGITAL READOUT HAM TRANSCEIVER

Linear Systems, Inc., has announced the introduction of the SBE Model SB-36 amateur radio transceiver which incorporates a digital counter to provide a six-digit direct frequency readout on all ham bands. The SB-36 has a power output of 500 watts PEP on SSB, full frequency coverage of all ham bands from 80 to 10 meters, built-in VOX capability, semibreak-in operation on CW, and a deluxe sideband generating system featuring separate crystal lattice filters for USB and LSB.

Circle No. 81 on Reader Service Card



Surplus Scene

By Alexander W. Burawa, Associate Editor

THE SMALL-PARTS MARKET

The Surplus Scene dealers can hardly qualify as small-parts suppliers in the same sense as the big industrial mail-order houses. Nevertheless, they do offer some fantastic buys in some standard and many hard-to-find components. Typical of Surplus Scene offerings are such items as computer-grade and standard types of electrolytic capacitors, pulse and power transformers, toroids, relays and switches, power resistors and potentiometers, etc.

Starting with G & G Radio Supply Co. (45 Warren St., New York, NY 10007), look for great buys in receiving and special-purpose vacuum tubes, crystals in the 75¢ to $1.60 price range, and panel meters.

Baynton Electronics Corp. (2709 North Broad St., Philadelphia, PA 19132) has a lot to offer the bargain hunter in the way of test equipment for all areas of electronics, plus a very good selection of coaxial cable connectors and cable assemblies. They also have some good buys in low-pass interstage and line filters, hard-to-find multi-turn miniature trimming potentiometers made by Bourns, crystal can relays, and solid-state components.

Looking for special types of power transformers, filter reactors, and filter capacitors? Then look to Surplus Center (P.O. Box 82209, Lincoln, NB 68501). While you're at it, look into rectifiers such as a 50-ampere, 50-PIV stud-type which they have for only $2.49 and an IBM rectifier that normally lists for $10.50 but is on sale for $2.69. (It contains two 12-ampere, 50-PIV silicon rectifiers already mounted on a heavy-duty aluminum heat sink).

Poly Paks (P.O. Box 942, S. Lynfield, MA 01940) is a bonanza for small parts such as resistor and capacitor assortments, miniature reed switches, coils and chokes, tape heads, motors, and microminiature relays. Good buys can also be had on fiber optics and loudspeakers.

Small parts occupy the lion's share of the Delta Electronics Co. (Box 1, Lynn, MA 01903) catalog. Listed is everything from potentiometers to capacitors to switches. A special buy is a 7-gang pushbutton switch assembly containing six dpdt and one 4pdt switches made by Centralab; it goes for $1.35. Computer-grade capacitors are listed for $2-$7 for lots of five.

For coaxial connectors, variable capacitors and noise filters, John Meshna Jr. (P.O. Box 62, Lynn, MA 01904) has "knockouts for thin wallets" as they state. There are other goodies as well—like insulated sleeving, rubber feet, thermistors, terminal strips, and Teflon press-fit standoffs.

Herbach & Rademan, Inc. (401 East Erie Ave., Philadelphia, PA 19134) offers many specialized components. Their listings include stepping and rotary relays, heat detectors, toggle switches, and Ledex rotary solenoids. The company's catalog flyer is a monthly—titled, appropriately, "This Month"—and offerings change accordingly. Past catalog listings featured fantastic buys on numeric readouts (always in demand), transformers, solenoids, and relays.

For our last entry, we have Edmund Scientific Co. (380 Edscorp Bldg., Barrington, NJ 08007). They have such diverse items as an electronic desk-top calculator with an 8-position, seven-segment display readout for $199.50; psychedelic lighting displays; numeric indicator tubes; a batch of $50 worth of transistors for only $2.50; and an infrared sensor alarm kit for $6.95. Send for their latest catalog and see how diverse their offerings are. ◈

ELECTRONICS MARKET PLACE

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ROCKETS: Ideal for miniature transmitter tests. New illustrated catalog. 25¢. Single and multistage kits, cones, engines, launchers, trackers, rocket aerial cameras, technical information. Fast service. Estes Industries, Dept. 18-K, Penrose, Colorado 81240.

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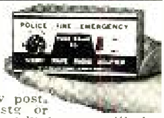

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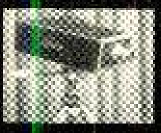

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7402	.26	.25	.23	.22	.21	.20
7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.64	1.55	1.46	1.37	1.27
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7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7483	1.63	1.55	1.46	1.38	1.29	1.20
7486	.58	.55	.52	.49	.46	.44
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7494	1.18	1.12	1.05	.99	.93	.87
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74100	1.52	1.44	1.36	1.28	1.20	1.12
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74145	1.41	1.33	1.26	1.18	1.11	1.04
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74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.08
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74157	1.56	1.48	1.39	1.31	1.23	1.15
74158	1.56	1.48	1.39	1.31	1.23	1.15
74160	1.89	1.79	1.68	1.58	1.47	1.37
74161	1.89	1.79	1.68	1.58	1.47	1.37
74162	1.89	1.79	1.68	1.58	1.47	1.37
74163	1.89	1.79	1.68	1.58	1.47	1.37
74180	1.20	1.13	1.07	1.01	.95	.88
74181	5.20	4.90	4.59	4.28	3.98	3.67
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.43
74193	1.98	1.87	1.76	1.65	1.54	1.43
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NE536	7.31	6.88	6.45	6.02	5.59	5.16
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NE550	1.24	1.17	1.11	1.04	.98	.91
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE565	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
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MS556	1.87	1.77	1.66	1.56	1.46	1.35
MS558	.80	.76	.72	.68	.64	.60
MS595	3.40	3.20	3.00	2.80	2.60	2.40
MS596	1.87	1.77	1.66	1.56	1.46	1.35
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
741	.44	.42	.40	.37	.35	.33
748	.48	.46	.43	.41	.38	.36
1N270	.15	.14	.13	.12	.11	.10
1N751A	.30	.28	.26	.24	.22	.20
1N914	.10	.09	.08	.07	.06	.05
1N4002	.15	.14	.13	.12	.11	.10
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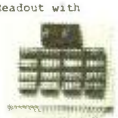

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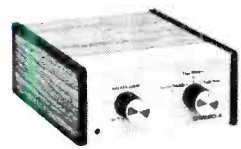

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