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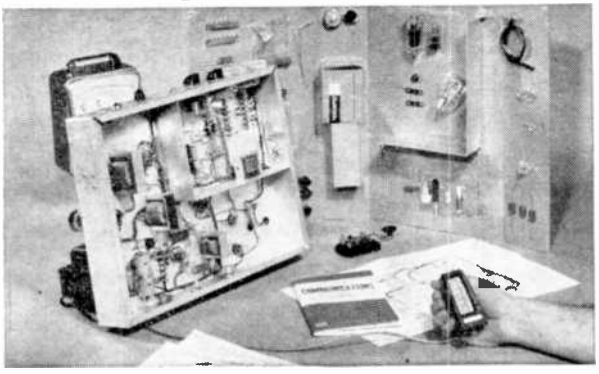

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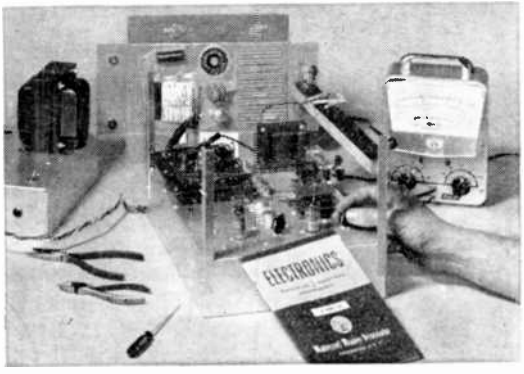

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FEATURE ARTICLES

26 SURVEY OF FOUR-CHANNEL CARTRIDGE TAPE PLAYERS *Julian D. Hirsch*

Tests of seven representative models for the home, including operational details and frequency responses

40 CHASING DX ON THE FM BAND *Richard E. Wood*

Picking up stereo signals is sometimes possible and amazingly long distances can be logged

42 PUBLIC WEATHER BROADCASTS FROM COAST TO COAST *Howard W. Granoff*

The Radio Weather Network broadcasts 24 hours a day for individuals, institutions and service groups

46 THE ORIGIN OF OHM'S LAW *David L. Heiserman*

Story of the man whose name was given to electricity's most basic equation

48 A LOOK AT INDUSTRIAL ROBOTS *Edward A. Lacy*

How they work and the jobs they perform

58 A VERSATILE POCKET CALCULATOR *John T. Frye*

Hewlett-Packard's Model HP-35 holds great promise as a tool in practical engineering computations

84 HAWAII'S TALLEST TOWERS

THE SCENES

10 STEREO SCENE *J. Gordon Holt*

Choosing the stereo system that is right for you

76 TELEVISION SCENE *Forest H. Belt*

All about RCA's new color receivers

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CONSTRUCTION STORIES

32 **FOUR-CHANNEL SYNTHESIZER** *James Bongiorno*
Four channels from two using a novel active-element circuit

35 **INEXPENSIVE TRANSISTOR POWER SUPPLY** *Frank H. Tooker*

45 **A LINEAR-SCALE OHMMETER** *Gerald Beene*
Simple circuit makes VTVM's easier to interpret

51 **ELECTRONIC STEAM WHISTLE** *John S. Simonton, Jr.*
Great addition for model railroads or antique cars

PRODUCT TEST REPORTS

62 **THE SMALLER ADVENT LOUDSPEAKER**

64 **SUPEREX MODEL FF-1 HEADPHONES**

66 **TECHNIQUES 5200 NEGATIVE ART KIT**

68 **SIMPSON MODEL 260 SERIES 6 VOM**

69 **ESTES TRANSROC RADIO CONTROL TRANSMITTER**

DEPARTMENTS

6 **EDITORIAL** *Milton S. Snitzer*
Hearing aids and hi-fi

22 **LETTERS**

24 **NEWS HIGHLIGHTS**

88 **NEW LITERATURE**

94 **NEW PRODUCTS**

96 **ELECTRONICS LIBRARY**

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Editorial

By Milton S. Snitzer, Editor

HEARING AIDS AND HI-FI

The other day we accepted an invitation from Zenith to attend a press showing of a couple of films. One of these films is 5 minutes long, the other is 1 minute long, and they are being offered free to television stations throughout the U.S. and Canada. The films are entitled "The Bridge," and they feature Arthur Fiedler, world-renowned conductor of the Boston Pops Orchestra. The films attempt to bridge the "lack of understanding" gap between those with partial hearing and those with normal hearing.

The films end by offering the public a free educational phonograph record entitled "Getting Through," which simulates how hearing impairment affects a person's ability to hear conversation and music as well as to detect meaningful sounds. The record is designed to show the person with normal hearing what it's like to be hard of hearing. It also shows what a hearing aid can do to bring back some normalcy to the person whose hearing is impaired. The record should be of special interest to anyone who has a hard-of-hearing person in his family, in his circle of friends, or on the job.

The hearing aid is strictly a piece of electronic equipment. It consists of a microphone, an audio amplifier, and an earphone transducer connected to a specially shaped ear piece. The hearing-aid manufacturers were among the first to use transistors in a commercial product and the first to use integrated circuits. The idea is, of course, to achieve miniaturization; some hearing aids are contained completely in the ear, or behind the ear, or in the earpiece of a pair of glasses.

There are over 20 million people in the U.S. that have some hearing problem. Most of these, about 15 million, could be helped with a hearing aid. Most such people have a hearing loss at the higher frequencies. Hence, those wonderful highs that a good hi-fi system produces are lost on such people. To them a modern stereo orchestral record may sound like the "tinny" phonographs of the 1920's. With a properly fitted hearing aid to restore the highs, the loss is compensated for to some extent. Here again is another case where electronics is helping the handicapped.

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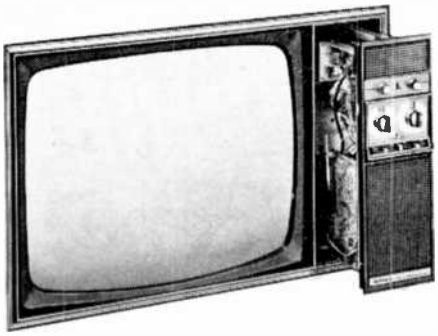

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CIRCLE NO. 47 ON READER SERVICE CARD

Stereo Scene

By J. Gordon Holt

Choosing The Stereo System That's Right For You

EVERY audiophile wants the best hi-fi system his money can buy. For this reason, each of his component purchases is likely to be preceded by months of tortured indecision, while he pores over catalogs and manufacturers' blurb sheets. Meanwhile he reads every equipment report he can find, re-reading them several times to divine what the reviewer really meant when he said, "This is the finest amplifier measuring 8 by 4 by 15 inches and weighing 13 lb that we have ever tested."

Sometimes, the audiophile is even moved to write to magazine editors and ask, "Really and truly, now, what is the *very* best amplifier costing under $300?" The answer, usually, is "There is no very best; it all depends on what you're looking for." If the audiophile is persistent, he may say again, "What I am looking for is the very best amplifier costing under $300." To which the reply is likely to be, "The very best amplifier for under $300 is the one for less than $300 that best suits your needs." This kind of exchange can go on for months; and, indeed, it has been known to. But the magazine editors are not really copping out. They speak words that are very true.

Imagine for a moment that you are a magazine editor, in charge of testing pieces of equipment and writing reports on them. "Ah," you may think, "wouldn't that be nice. *Then* there'd be no secrets kept from me. I could compare them all and *pick* the very best, and you can bet *I'd* tell all my readers which was which." Would you now?

Imagine that, after years of testing, you finally narrowed the loudspeaker field to three contenders for "the best." Loudspeaker A has the smoothest, most extended high end you've ever heard, superb transient response and "snap," and the deepest, tightest bass. However, it has a rather pronounced middle-range "awk" coloration and higher distortion than the other two systems. System B has the lowest distortion and the most transparent over-all sound, but it is inefficient. It has comparatively limited power-handling ability, and it tends to make things sound rather more distant than they are supposed to be. System C has the smoothest, most neutral-sounding middle range, seeming neither distant nor close-up; but it is a bit shy in the deep bass range, and is rather deficient in over-all "snap." Now that there are no secrets being withheld from you, what do *you* tell an eager audiophile who

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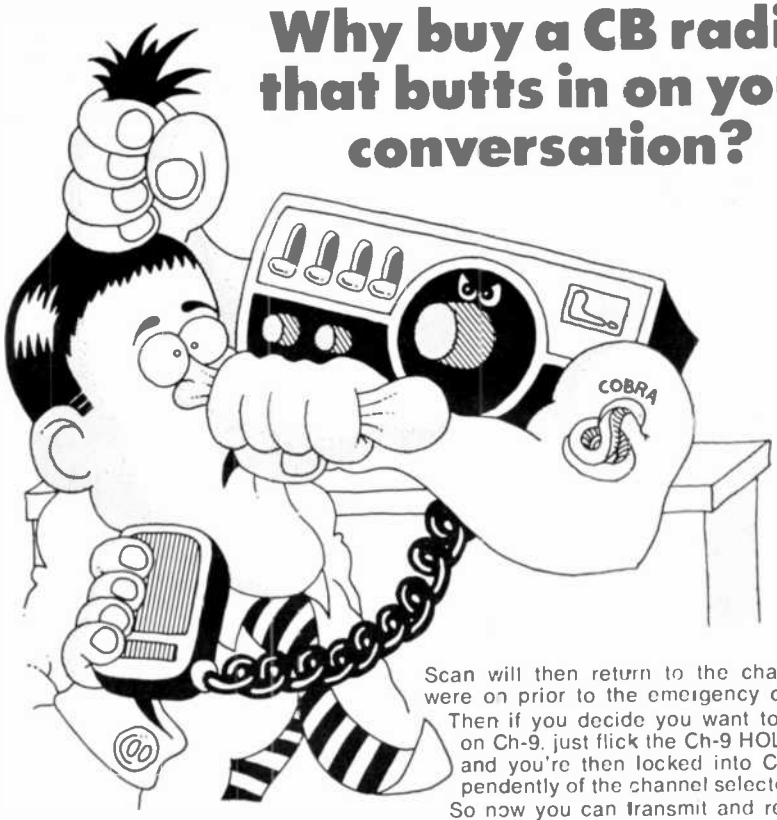

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wants to know which is the best of these three loudspeakers? You try to be honest with him and say, "Well, it all depends on what you want out of your speaker system." Of course he knows you're hedging.

The same goes for other components. The preamp with the best sound is not the one with the most versatile tone controls. The power amplifier with the cleanest sound has too much power for some loudspeakers and over-damps others, causing bass deficiency. The tape recorder with the lowest wow and flutter is difficult to thread and has higher distortion than one with audible flutter. And so it goes.

What's Best For You? It is a platitude—and a truism—that measurements don't tell the whole story. But even if measurements *could* allow us to predict exactly how something will affect the signals passing through a system, no measurements can ever predict how your hearing will react to whatever the system is doing to the sound. Don't hold your breath, but until the age of absolute perfection arrives, every component is going to do *something* to the sound. If the components didn't, your listening room would. And if it didn't, you still might not like what you hear. But rather than sit and decry the impossibility of ever having someone tell you what's best for you, you can find out for yourself. It just takes a bit of planning, with an eye to your own personality and listening habits.

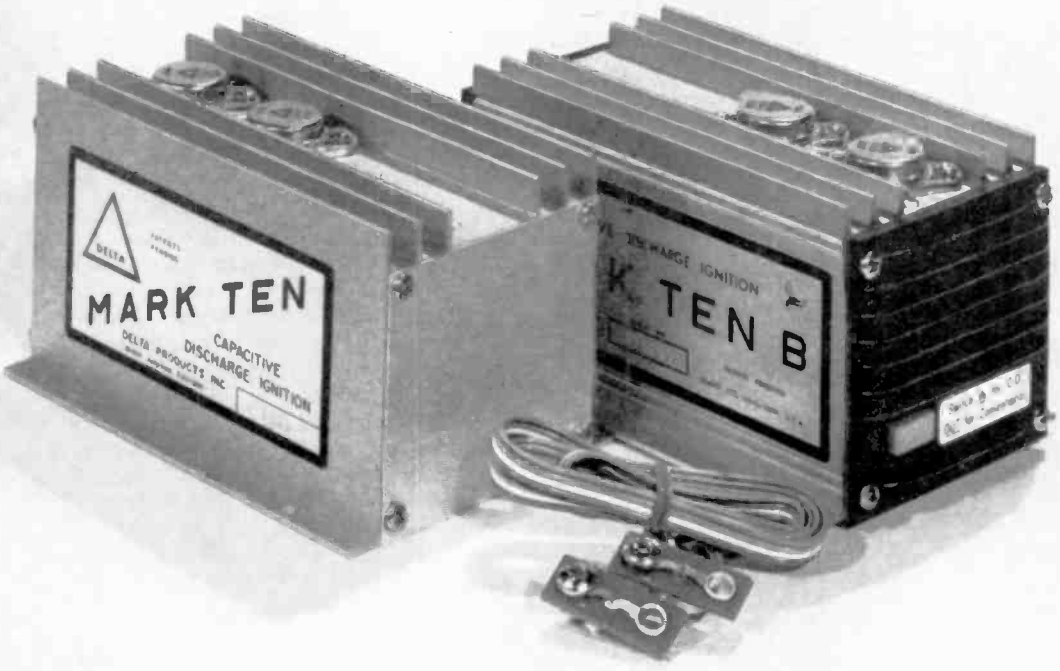
Just as there are some microphones that do a better job than others on certain instruments, there are some hi-fi systems which seem to suit certain kinds of music. And just as recording engineers disagree as to which mikes are best for which instruments, the personal characteristics and habits of hi-fi listeners make them disagree as to which systems are best for which kinds of music. If you can formulate some kind of personality profile of yourself as a listener, you're well on your way to finding a hi-fi system that will please you.

First of all, are you really sure you need a component system at all? Do you spend more time thinking about how impressed your non-hi-fi friends will be with your system than about how it will sound to you? If so, you don't want sound, you want status; and your best bet is to assemble the highest-priced system you can afford from among the components advertised in the mass-circulation magazines and status newspapers. It may even sound very good—certainly not bad—and it will convince all your non-hi-fi friends of your personality and your own good taste.

Do you use music exclusively as a background for other activities? If so, don't waste your money on an expensive component system; all you need is something that sounds pleasant, which means fairly good low-end performance and rather dull highs. A showy high end may sound impressive in a store, but it is a waste of money to pay for super-tweeters and then listen to the system with the treble turned all the way down. A suitable system, however, can be a relatively inexpensive, ready-built, just-connect-the-wires-together-and-plug-in "component" system, or a console in as large and ornate a cabinet as your decor demands. Any money left over can go toward buying some good recordings that you want.

The Bachelor-Pad System. The background-music system that is to provide atmosphere conducive to seductions demands somewhat higher fi; because during the first few minutes after it is turned on it is usually listened to at moderately high volume, and it must be good enough not to offend or it will lose its effectiveness. The system should sound rich and opulent, which means there should be *some* highs, but clean ones, and the bass should be full but not boomy. A modest separate-component system is called for here, although there are some complete, ready-built "component" systems available that will do as well if not better sonically than components you've chosen yourself. However, these do lack that little aura of having been selected individually by their owner.

If you do sit down alone occasionally and listen to music, without doing anything else to occupy or distract your mind, then you are likely to hear what is coming from the speakers and are fair game for a really good reproducing system. But what *kind* of system? This, again, is for you to decide.



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Although it is difficult, and often pointless, to try to stereotype people, it is a help in selecting hi-fi components if you can match them to your "personality type." If you think of yourself as the extroverted, athletic, easygoing, confident type, you will probably prefer reproduced sound that is rather forwardly projected and "authoritarian." Which means you will more than likely be happier with horn-type speakers (covering the upper ranges, anyway) or cone speakers with a high degree of presence. If you are more sensitive, finnicky, reserved, and retiring, you will probably prefer the more distant, "polite" sound of most electrostatic or low-efficiency acoustic-suspension speakers. If you figure your personality is somewhere in between, you'll probably want a fairly "neutral" sound, which can be found among the cone and also the electrostatic speakers.

What Do You Listen To? What kind of music do you listen to most often, when not entertaining guests? If your answer is classical, and you type yourself as more introverted than extroverted, you are going to be harder to please than any other kind of listener. You may have access to the "real thing" from time to time, un-amplified and un-canned, as a standard of comparison, and the sounds of massed violins, high trumpets, or a female chorus are harder to reproduce naturally than just about any other musical sounds. You will want the lowest distortion and the smoothest response from your system, and since you may end up preferring electrostatic speakers, you might well consider them at the outset. You may also wish to investigate tube-type components. (They are still around.) They tend to be more tolerant of electrostatic loads than many solid-state amplifiers.

If classics are your bag, but you are more the robust, outgoing type, you will be less inclined to quibble over such sonic subtleties as sweetness and transparency, and more inclined to value crispness, tautness, and clarity. You may also be inclined to prefer higher levels than the introspective type, so you should consider horn-type speakers or forward-sounding cones, and some of the better solid-state amplifiers.

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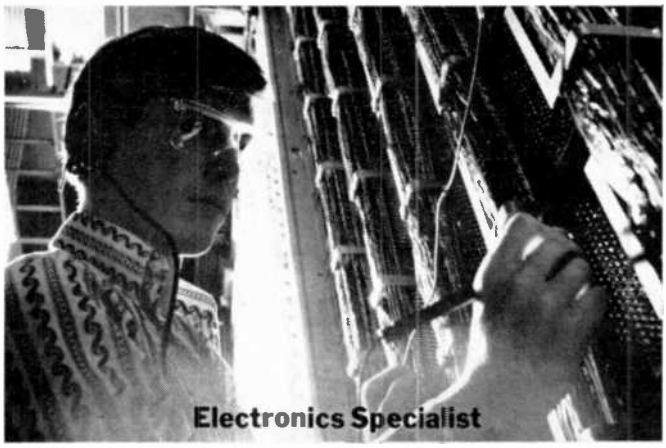
Electronics Specialist

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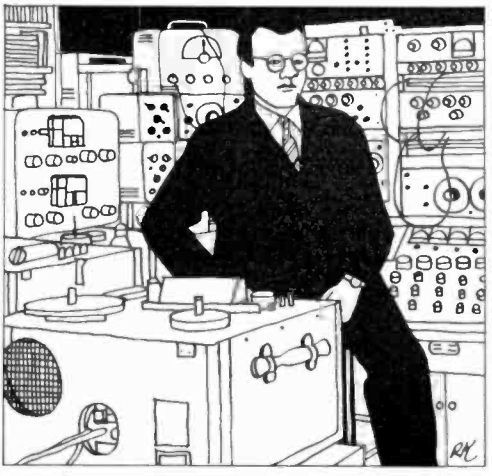
If you're a "hard" or "acid" rock enthusiast, who likes to listen at very high volume levels without incurring the wrath of neighbors, the range of hi-fi equipment available to you is rather limited. Most hi-fi components are not designed to work at extremely high levels, and while there are hi-fi amplifiers available with the necessary power, there are few hi-fi loudspeakers that will take it. Special high-level speaker systems are made specifically for this purpose (as well as for public-address work); but few are as good, in terms of range and smoothness, as the better speakers intended for the usual listening requirements at home. If you want the benefits of the best speakers and also demand high volume levels, get a moderately to highly efficient hi-fi system, and drive it with an amplifier whose capabilities for maximum continuous power output are no greater than the rated program-power capacity of the loudspeaker.

If you consider yourself as being somewhere between the introvert and extrovert, or if your primary musical interests are in "soft" rock, "mood" music, pops, folk music, shows and so on, you will probably not be as demanding of "sweetness" as the classical introvert, nor as demanding in terms of volume as the classical extrovert. You thus have by far the widest range of equipment to choose from, which is a mixed blessing. We'll narrow the field, though, in a subsequent Stereo Scene. ◈



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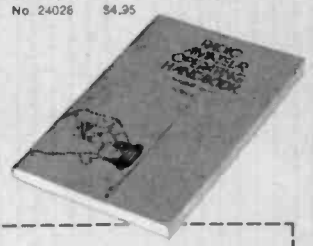

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Letters

A LOOK INTO THE PAST

Your editorial in the February 1972 issue tells about the high-velocity air stream woofer developed by Dr. Harry Olson of RCA. I think it must have been some time in the middle or late 1920's that I first read in *Radio News* about this type of speaker. The first large-scale application used leather valves like vocal cords, and they were operated by solenoids. The valves were kept moist by water spray. The unit was mounted on a boat and taken offshore several miles on a lake and used to "broadcast" to an on-shore resort from recorded programs.

Later on, there were a number of throat assemblies put on the market. These used a slotted strip between two slotted guides and were driven by a balanced-armature magnetic unit. This required only a few watts to get the same power as a 50-watt amplifier connected to a battery of speakers.

E.M. Smith
Mesa, Ariz.

TELLING IT LIKE IT IS

I am the Service Manager of a new quality-oriented stereo store in Des Moines. As a regular reader of J. Gordon Holt's "Stereo Scene," I was again impressed at his ability to "tell it like it is" in his advice on hi-fi equipment troubleshooting.

I didn't have to read very far before realizing that the February column would make an excellent hand-out at my service counter. It could eliminate many unnecessary trips and service bills for my customers—as well as help keep my service shelves and benches open for the real problems.

Richard F. Trump
Audio Labs, Inc.
Des Moines, Iowa

IN REBUTTAL

I read "Cable TV—Where It Is and Where It's Going" with great interest since the photo shown was of the tower and antennas of our Harrisburg, Penn., cable TV system. The article stated that the system belonged to Jerrold, but Sammons Communications, Inc. purchased this system on November 1, 1971.

I question some of the facts that Mr. Belt

stated in his article, particularly those involving monthly operating costs of subscribers, before-tax operating profits, and a return investment of 20 percent. If these facts were true, I believe that every businessman in the U.S. would be attempting to get into the CATV business. Monthly operating costs per subscriber vary from one CATV system to another, and the fact is that they often exceed $2.50 per subscriber. The operating cost per subscriber can vary tremendously, depending upon the given CATV system.

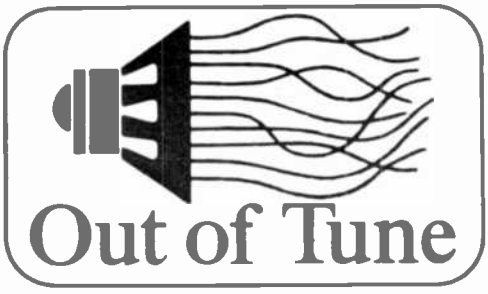
JAMES R. ARNOLD
National Trans-Video, Inc.
Dallas, Texas

TACKLING PROBLEMS IN DIGITAL EQUIPMENT

I enjoyed "Why Triggered Sweep Oscilloscopes?" in the Test Equipment Scene (January 1972) but noted that the needs of the digital troubleshooter and designer were omitted. The digital world certainly consumes a fair proportion of the new oscilloscopes. But it is interesting how most digital problems can be solved not with an oscilloscope but a "Logic Probe."

Various logic probes selling for less than $100—such as our HP 10525A—are available to provide the users with all sorts of troubleshooting information, and they can handle toggle rates faster than 25 MHz. The concept is amazingly simple, usually requiring but 5 volts from the power supply of the circuit under test. A light, merely by glowing, flashing, and extinguishing, tells the user of highs, lows, and activity.

JESSE PIPKIN
Hewlett-Packard
Santa Clara, Calif.



"Build a DVOM Plug-In," March 1972. In the Parts List on page 63, make the following corrections: Add *C10* to the first line (0.01-μF disc capacitor); change Q5 to type 2N4871; change *R6* to 68,000 ohms; change *R14* to 2200 ohms; change *R3* and *R5* to 1000-ohm standard potentiometers; add *R37*—33,000-ohm, ½-watt, 10% resistors. Schematic diagram is correct.

News Highlights

National Bureau of Standards Scores Measurement Breakthrough

A new era in measurement science was inaugurated recently by NBS scientists who successfully achieved the highest frequency measurement ever made. By determining the frequency of an infrared laser whose wavelength was already known, the team of scientists laid the groundwork for linking the international standards of length and time. The speed with which light travels is equal to its wavelength times its frequency. With the frequency and wavelength known with high precision, the speed of light can be calculated more exactly than before. A 30-fold more accurate determination of the speed of light is now possible.

Sony Announces New Color Video Projection System

A color video projection system which produces TV pictures on a specially designed display screen has been announced by Sony. The screen measures more than 4 feet diagonally. The projection is accomplished with the aid of the company's newly developed, highly efficient color cathode ray tube and a projection lens system. The development is primarily designed for consumer use as well as for educational and commercial fields. Price of the system, expected to be put on sale this fall, is anticipated to be about $2000.

Author Cited for His Services

Richard E. Wood, who has written a number of articles for us on shortwave listening, has been awarded a medal and citation by the Vatican. The awards were for his services as technical monitor and advisor to the Vatican Radio in Rome. Wood suggests interference-free frequencies for use by the Vatican Radio in its North American broadcast service to avoid jamming and interference from larger and more powerful stations.

Color TV Sales Up 28.2% Over 1970

Sales of color TV sets to dealers were up 28.2% in 1971 over sales in 1970. An all-time record of 6.18 million unit sales was made, according to figures released by the Electronic Industries Association (EIA). Monochrome television set sales were also up by 7.2% as a result of sales of 4.87 million units. Home radio set sales were also up by 11.2% in 1971 compared to 1970. Auto radio sales were up 27.3% for the same period. So, all in all, manufacturers of consumer electronic products are viewing with cautious optimism their new sales figures and hoping for an even better year in 1972.

Cardiac Pacemaker Checked by Telephone

An electronic system permits physicians to check over the telephone in a couple of seconds an implanted cardiac pacemaker's performance. The system, developed by Monsanto Commercial Products Co., consists of a transmitter, a receiver, and an electronic counter. A magnetic sensor connected to the transmitter converts the pacemaker's rate to an audible tone for telephone transmission. The receiver in the doctor's

office converts the series of tones to an electronic pulse which the counter measures and displays as a rate in beats per minute. Pacemaker performance is checked routinely to prevent failure and determine the time to replace the device's batteries. The patient would be required to come to the doctor's office only when the pulse rate falls by about ten percent—an indication of low battery voltage. The system is being marketed by C & S Biomedical Co., Englewood, N.J.

Cable TV Gets $2.5-million Grant

The Ford Foundation has announced a $2.5-million grant to city and state governments to help them develop the cable-TV medium. The Foundation is already in this area through its sponsorship of a Rand Corp. study to determine cable needs in Dayton, Ohio. Another grant was made by the John and Mary R. Markle Foundation of $500,000 to set up a cable TV information center in Washington.

Low-Cost Rural Radiotelephones for Phone Industry

A new, low-cost rural subscriber radiotelephone system is being marketed to extend phone service to distant locations. The system, developed by Hallicrafters, can be used to provide service to those locations that are distant from the central telephone office and not feasible or economical to connect by open wire, underground cable or high-density radio. By use of vhf radio, the phone line is effectively extended up to a distance of 30 miles from the central telephone office.

Radar to Monitor San Francisco Harbor

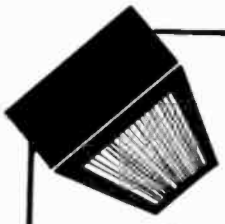
The Coast Guard has awarded a contract for an all-weather high-resolution surveillance radar system to monitor San Francisco's harbor. The system, to be installed during the fall of 1972, will provide the Coast Guard with accurate details of ship and pleasure craft movement in the approach and congested areas of the harbor. The award of the $758,000 contract to Cutler-Hammer's AIL Div. is a continuation of a program that has already seen the installation of a lower resolution radar in the harbor. The new radar has much higher resolution and will significantly enhance the advisory and monitoring services presently being performed. One radar will be installed at Point Bonita overlooking the seaward approach to the Golden Gate Bridge, a second radar is to be installed on Yerba Buena Island to provide surveillance of the central harbor area.

Camera Produces TV Pictures in Total Darkness

A new camera that can produce pictures in total darkness was introduced as a component in a low-light-level TV system for airborne military uses. The camera is ten times more sensitive to light than existing cameras. The camera uses RCA's silicon intensifier target tube which was used in the color TV camera that transmitted live pictures from the moon during the Apollo 15 mission. In addition to its low-light-level capabilities, the tube also performs in bright sunlight and is relatively immune to damage even pointed directly into the sun.

GE to Supply Nearly 3000 Mobile Radios

In what is said to be the largest contract awarded in the communications industry in the past 12 months, General Electric will supply nearly 3000 mobile radios, base stations and portable 2-way radios, to the Imperial Iranian Gendarmerie. The radio equipment will be used in the post-to-company communications network of the Gendarmerie, which provides border patrol, internal security and police services for rural Iranian communities.



Survey of Four-Channel

THE newest development in high-fidelity music reproduction is 4-channel sound. Although the greatest activity is currently in the development of matrix or stereo-compatible disc systems, it is generally recognized that the ultimate in 4-channel reproduction can be achieved only by a discrete-channel system. Presently, only magnetic tape has the capability of recording and reproducing four discrete channels using readily available playback equipment.

Open-reel 4-channel tape recorders are offered by several manufacturers; but the existing repertoire of recorded tapes is limited and relatively expensive. Fortunately, the popular 8-track cartridge can meet most of the basic requirements of the 4-channel medium at modest cost.

The tape cartridge is a sealed plastic case containing an endless closed loop of tape. The tape, wound on a single hub, is driven by a conventional capstan shaft and pressure wheel. It is pulled from inside, over the head, and onto the outside of the tape pack at 3¾ ips.

The cartridge tape is the standard ¼" open-reel width, but it is specially lubricated to permit the required slippage of the tape layers as the tape emerges from the pack. For 2-channel stereo, two of the eight parallel tracks are played back at a time. At the end of the tape, conducting foil trips a head-lifting mechanism which automatically shifts the head so that its gaps contact another pair of tracks, eventually covering, in succession, all four of the track pairs.

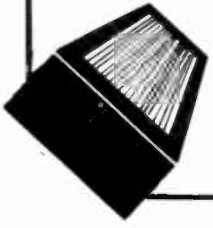
For 4-channel operation, the cartridge has only two programs, each containing four parallel tracks. The head has four sections, the output of each going to its own preamplifier. Each program requires twice as many recorded tracks; so, total playing time is half that of 2-track formats.

Tape cartridge players have switches which are tripped or released simply by the insertion or removal of the cartridge. Some machines have special features, such as continuous repetition of a given track and partial ejection of the cartridge to shut off power after all tracks have been played.

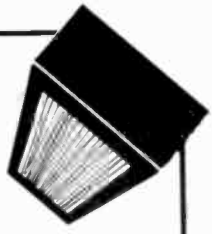
Although the key dimensions of 2- and 4-channel cartridges are identical, the latter have an additional groove which automatically switches the player from 2- to 4-channel operation when the cartridge is inserted into the slot. Virtually all players have lights to indicate the type of program and the tracks being played.

Four-Channel Considerations. The basic 4-channel tape cartridge deck has internal equalizing preamplifiers. The line outputs are at levels of a few tenths of a volt for driving the auxiliary inputs of an external amplifier. There are rarely any level controls. Usually, the only control is a channel or special mode selector.

The most desirable arrangement is to use a 4-channel integrated amplifier and four identical speakers. Adding a 4-channel



RESULTS OF TESTS OF SEVEN REPRESENTATIVE MODELS FOR THE HOME



Cartridge Tape Players

capability to an existing stereo system requires a second amplifier to drive the rear speakers. The rear speakers should be impedance matched to the front speakers, though in the rear they need not be the same type or quality as those in the front. A satisfying 4-channel effect can be derived with inexpensive rear speakers if the front speakers are of reasonably good quality.

A drawback of the add-on system is the need for independent volume controls for the two stereo amplifiers to maintain front-to-rear balance when changing volume levels. To solve this problem, some manufacturers produce 4-channel "converters" which combine a 2-channel amplifier with a 4-channel player. The front channels are played "normal-through" while the rear speakers are driven by the converter. A single volume control on the converter affects all speakers simultaneously.

Advantages and Disadvantages. The tape cartridge is one of the most convenient formats for packaged music. Nothing could be simpler than plugging in a cartridge to turn on and play a music system. And the same cartridge can be used in mobile and home players. The ability to use either 2- or 4-channel cartridges with no switching or other adjustments is an added feature. A considerable number of 4-channel cartridges have been released, principally the RCA "Q-8" types; so there is no lack of available material.

On the other hand, the cartridge format has certain drawbacks. The user has no means of rapid access to any specific part of the program. Some decks have a fast-forward function, but it is still exasperatingly slow at only five times the normal play speed. Reverse operation is impossible, nor is there any external indication, other than the track, of what part of the tape is being played.

The sonic quality of tape cartridges varies widely. In spite of their higher operating speed, the frequency response of most cartridges and players falls short of what has been attained by cassettes operating at only 1⅞ ips. The hiss level of cartridge systems is usually greater than that heard with a good basic cassette system. It is unfortunate that the need for four Dolby noise reduction circuits makes this very effective system uneconomical for 4-channel cartridge systems.

The constant rubbing of tape layers within a cartridge can reduce the useful life of the tape. In the event of breaks, it is rarely possible to splice the tape. All currently manufactured cartridge playing mechanisms have more flutter than do the better cassette decks and low-to-medium priced open-reel tape recorders.

Four-Channel Player Tests. We tested a number of home-type 4-channel players to assess the caliber of performance presently available. Although we have by no means

BY JULIAN D. HIRSCH

Hirsch-Houck Laboratories

covered the entire field, the units are representative of present offerings.

Three of the units were basic 4-channel players without controls or amplifiers; two were converters with built-in rear-channel amplifiers; and one contained a complete AM/stereo FM receiver requiring an external stereo amplifier for driving the rear speakers when playing 4-channel tapes.

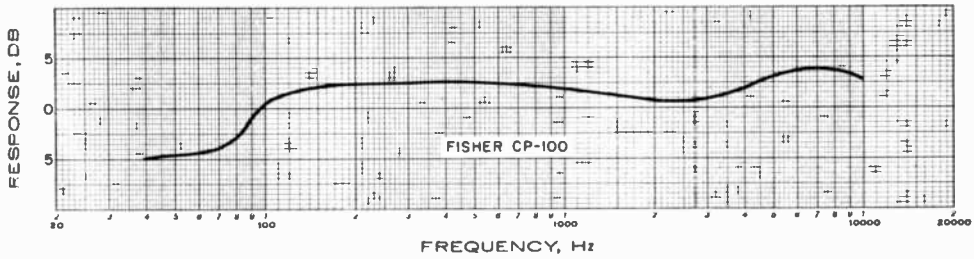
We did not have a test cartridge with the precisely calibrated signals available on professional open-reel test tapes. However, the Audiotex No. 30-213 test cartridge, designed for use by service technicians and hobbyists, provided a suitable source of frequency-response test signals. The tape has recorded voice announcements and tones which range from 40 to 10,000 Hz. Although it is not as accurate a tool as the Ampex alignment tapes used for open-reel tests, it is suitable for obtaining *relative* response readings. After using it with a number of players, we found its performance to be consistent with critical listening tests.

We measured the output voltage from the 1000-Hz reference level tone to compare the output levels of the different players. The unweighted noise output voltage was measured with a blank unrecorded tape cartridge to give an indication of relative signal-to-noise ratios for the various machines.

Lacking a standard flutter test cartridge, wow and flutter were judged only by listening. The exact frequency of the nominal 1000-Hz reference tone reproduced by each deck was measured to evaluate the "spread" of operating speeds. Since the accuracy of the original recorded frequency was not known, we could not determine actual speed accuracies.

On players containing amplifiers or tuners we measured the performances of these items as far as design permitted. Finally, we used a variety of Q-8 cartridges to compare two players at a time. A high-quality 4-channel amplifier and top-notch speaker systems were used.

BASIC TAPE DECKS



● *Fisher CP-100* ($169.95). In its measured performance, Fisher's CP-100 was typical of the test group. Its output—not necessarily the maximum or nominal level—was 120 mV from the reference 1000-Hz tone on the tape. Noise level was −38 dB relative to the 120-mV level.

Beyond 100 Hz, the frequency response was exceptionally uniform, varying less than ±2 dB from 100 to 10,000 Hz. The 40-70-Hz low end of the response curve was about 7 dB below the midrange level.

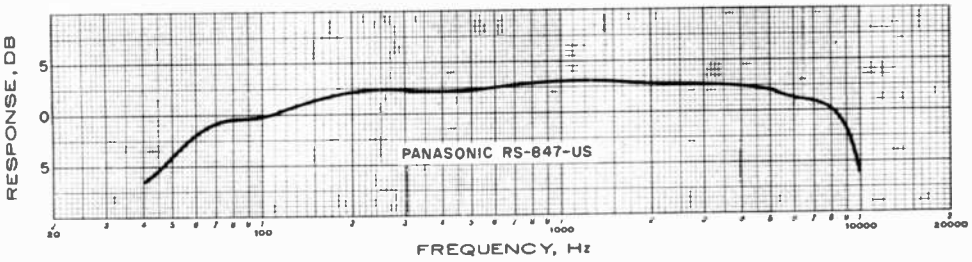
Three program control buttons are provided: CHANGE advances the program to the next track; CONSEC sequentially advances the playback through all program tracks; and REPEAT allows the same track to be played indefinitely.

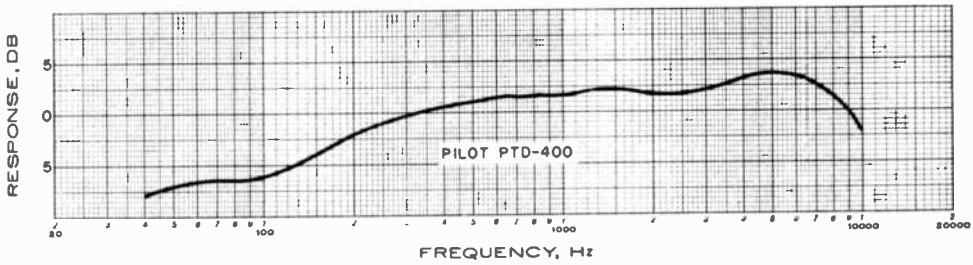
● *Panasonic RS-847-US* ($149.95). This deck had a very smooth frequency response which rolled off slightly below 60 Hz and above 8000 Hz. The output was 145 mV. Noise level was −41 dB—the lowest of the decks tested.

A unique feature of this deck is a switch for selecting continuous play with automatic sequencing of program tracks, or PANAJECT operation. The latter automatically ejects the cartridge and shuts down power after the last track has been played. An EJECT button does the same thing at any desired time, and the cartridge can be removed manually.

The electronics for each channel consist of a single IC plus a few capacitors and resistors. This is the only cartridge deck to our knowledge which takes advantage of IC technology.

● *Pilot PTD-400* ($119.95). This is a basic 2/4-channel deck with a pushbutton for





program advance and four lights which indicate the channel and mode in use. Its 125-mV output and –37-dB noise levels were close to the group average. The uniform frequency response over most of the midrange began to drop off above 8000 Hz and had a gradual downward slope below 500 Hz. The 40-100-Hz level was about 10 dB below the midrange level for this deck.

FOUR-CHANNEL CONVERTERS

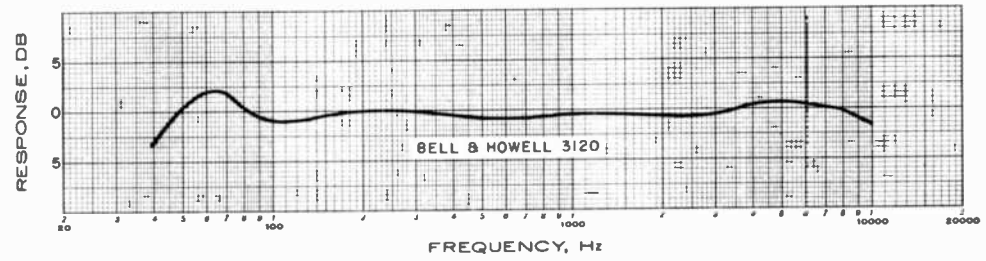
● *Bell & Howell 3120* ($169.95). The Model 3120 provides a convenient, inexpensive way to add 4-channel cartridge capability to an existing 2-channel system. Its tape mechanism has the usual lights to identify the channel and mode in use, and a program advancing lever. The line outputs are for driving an external 4-channel amplifier or two 2-channel amplifiers.

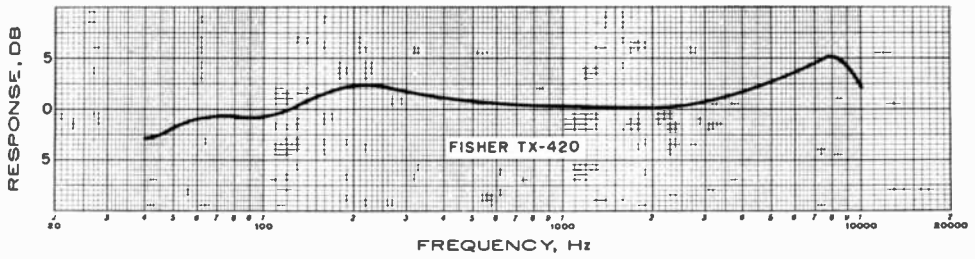
The 3120 contains a low-power stereo amplifier (4.5 watts/channel into 8 ohms) with its own bass and treble, balance, and volume controls. A pair of small speaker systems is supplied as part of the 3120 system, allowing the setup to be used as a complete 2-channel tape playing system.

As a 4-channel converter, the supplied speakers carry only the rear channel signals. The two front channels go to the auxiliary inputs of a separate 2-channel amplifier or receiver. The volume control, together with the main system volume control, sets the front-to-rear balance. A separate master volume control is then used to adjust all four channels simultaneously. A stereo headphone jack on the front panel can be used for private 2-channel stereo listening.

A mode selector switch allows selection of AUTO, 2 CHANNEL, or 4 CHANNEL operation. According to the instructions, the switch is first set to AUTO; when the 2 CHANNEL or 4 CHANNEL lights come on after the cartridge is inserted, it is set to the corresponding position. We could find no reason for this since mode selection is fully automatic; the switch can merely be left in the AUTO position.

The frequency response of the 3120, within ±2.5 dB from 40 to 10,000 Hz, was the flattest of all the players tested. The 300-mV line output was more than twice that





of the basic units. The noise level at -36.5 dB was, by a small margin, the noisiest of the group.

In spite of their small size and the modest output of the built-in amplifier, the supplied speakers operated effectively with a high-quality stereo system consisting of a pair of $300 speaker systems and a high-power amplifier up front.

● *Fisher TX-420* ($299.95). Although also a 4-channel converter, this unit is considerably more versatile than the Bell & Howell 3120. As a cartridge player, it supplies amplification for the rear channels with a true component-quality amplifier which delivers about 12 watts/channel at 8 ohms at the clipping point. At levels of less than 10 watts, distortion over most of the audible frequency range was 0.03 to 0.05%, which is comparable to some of the finest stereo amplifiers.

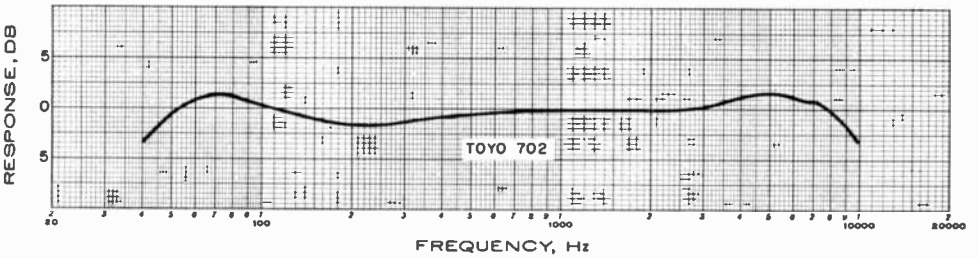
The amplifiers have volume, balance, bass and treble controls and a rear-channel stereo headphone jack. The inputs connect to the tape output jacks of a stereo amplifier or receiver. The front outputs return to the auxiliary inputs of the main amplifier for reproducing cartridge tapes. Pushbutton switches select CARTRIDGE, AUX (for rear channels of another discrete 4-channel program source), and MAIN UNIT inputs.

The amplifiers contain ambiance-extracting circuits to simulate 4-channel sound with 2-channel program sources. In the 2+2 DECODER mode, each rear speaker is driven 180° out of phase with its corresponding front speaker. The opposite rear speaker is driven with a frequency-dependent phase shift, typically over a 90°-180° spread. The frequency response characteristics of the rear channels in this mode can be altered by a CLASSICAL/POPULAR switch to suit the type of music being played.

The tape player has the same operating features as the Fisher CP-100. Its frequency response was one of the best in the group, with a slight emphasis of several dB at 8000 Hz. The 110-mV front channel output level was slightly lower than that of the other units. The -38-dB noise level was about average.

The sound quality and flexibility of the TX-420 were impressive. With a pair of reasonably good rear speakers, it is possible to extract the full potential of existing 4-channel cartridge tapes. The 2+2 DECODER appeared to do a good job of restoring special perspective to 2-channel programs by reproducing ambiance and reverberation through the rear speakers. Our only criticism is that the volume control affects only the rear channels, requiring the setting of two controls for each volume change.

2-/4-CHANNEL TAPE PLAYER



● *Toyo 702* ($169.95). Since this unit was previously tested in the January 1972 Product Test Reviews section, it was not retested for this survey. It is a cartridge player with four built-in amplifier channels, each delivering about 5 watts at 8 ohms. It does not have automatic mode selection; a 2 CHANNEL or a 4 CHANNEL button must

be depressed for the type of cartridge used.

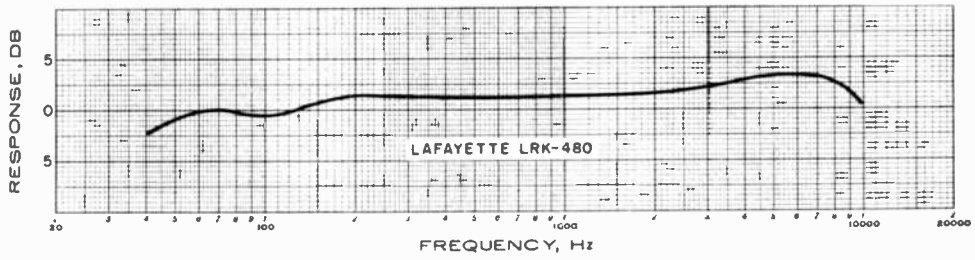
A single volume control with switchable loudness compensation operates on all channels, together with left-right and front-rear balance controls. Similarly, the bass and treble controls affect all channels. Four illuminated VU meters indicate individual channel levels.

The four speaker outputs use standard phono jacks. Switches allow the phases of the rear speakers to be individually reversed. There is no provision for any signal source other than the built-in player.

The frequency response of the system was very good, within +2/−3 dB from 40 to 10,000 Hz. Noise level was 36 dB below 1 watt.

This year, Toyo is introducing two new players. The 707 ($174.95) is identical to the 702 but has switched inputs for phono and auxiliary sources. The 730 ($249.95) has about four times as much audio power, a built-in AM/stereo FM tuner, and a magnetic phono input.

2-/4-CHANNEL PLAYER & RECEIVER



● *Lafayette LRK-480* ($179.95). This offering does not fit neatly into any of our equipment categories. It is basically a low-power AM/stereo FM receiver with a built-in 2-/4-channel player. An external stereo amplifier is required to drive the rear speakers for discrete 4-channel reproduction. It also contains a matrix "Composer" which drives each rear line output with the front signal plus some out-of-phase signal from the opposite channel. With an external amplifier driving the rear speakers, this adds considerable 4-channel effect to 2-channel programs. Finally, there are outputs for two rear speakers driven from what is essentially a "Dynaquad" system, achieving many of the qualities of the Composer system without the need for a second amplifier.

Both of the "derived-4-channel" circuits are usable with 2- and 4-channel tapes and other sources. But the effect is not identical to that obtained with a discrete-channel system.

The frequency response of the LRK-480 player was excellent: +3.5/−2 dB from 40 to 10,000 Hz. The line output was 340 mV, and noise level was one of the lowest at −40 dB. The amplifiers delivered 5 watts/channel. Distortion was less than 0.5%, over most of the frequency range at full power; at lower power, it was typically 0.1%.

The FM tuner had a 3.9-μV IHF usable sensitivity with a distortion level at 100% modulation of 1.4%. Stereo FM separation was better than 30 dB at midrange frequencies and better than 20 dB from 35 to 8500 Hz.

Summary of Tests. The operating speeds of all the units tested fell within an acceptable tolerance of 1% overall. None had objectionable flutter or wow. (With the available cartridges we could not hear any short-term speed fluctuations.) All operated smoothly and according to specifications

There were some audible differences among the units, principally in the high-frequency responses and noise levels. The Fisher, Lafayette, and Bell & Howell units had the best highs. But the hiss level of the Fisher unit was slightly higher than the others, probably due to the slight emphasis in the 8000-9000-Hz region. The Panasonic was the quietest but also had noticeably less "top end" than the others. The Pilot unit fell just behind the Fisher, Lafayette, and Bell & Howell players in noise level. The Toyo unit was not available for comparisons.

We were pleasantly surprised by the quality of the better 4-channel cartridges on these machines. Except for their audible hiss, a few could really qualify as "high fidelity." Other cartridges were listenable, even if they were not up to current disc standards. ◈

FOUR-CHANNEL SYNTHESIZER

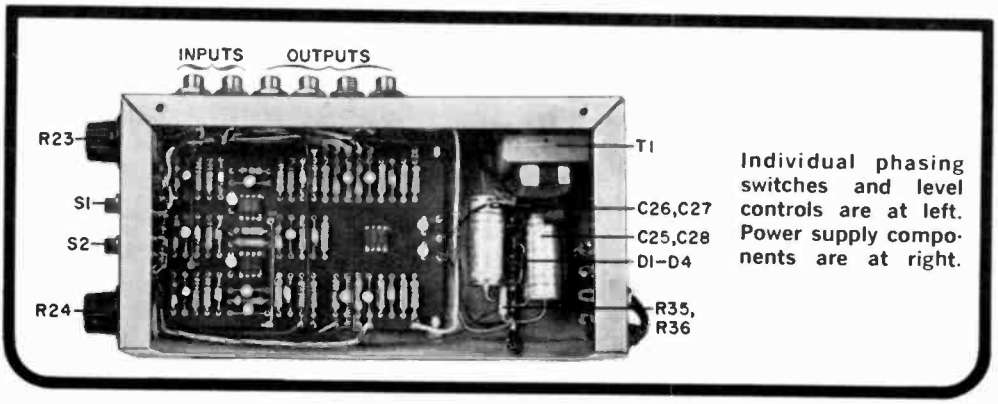
FOUR CHANNELS FROM TWO USING A NOVEL ACTIVE-ELEMENT CIRCUIT

BY JAMES BONGIORNO

THERE are many ways to achieve four-channel sound—from special decoders and special records, to a wide selection of passive four-channel synthesizers that accept a conventional two-channel input and synthesize two more new channels. Here is an opportunity to build a high-quality, low-cost four-channel synthesizer that uses active circuit elements and that, when used with a second stereo amplifier and speakers, will do an impressive job in converting two channels to four. In fact, with E-V processed records (Stereo 4), the sound is very much like an E-V decoder at work. It also does an excellent job on any stereo signal, including FM multiplex.

The synthesizer (whose schematic is shown in Fig. 1) also includes individual level controls and a set of phasing switches for the new channels so that the sound quality can be "tailored" to suit almost any listening environment and musical taste.

The specifications for the synthesizer include a noise level that is 92 dB below 1



Individual phasing switches and level controls are at left. Power supply components are at right.

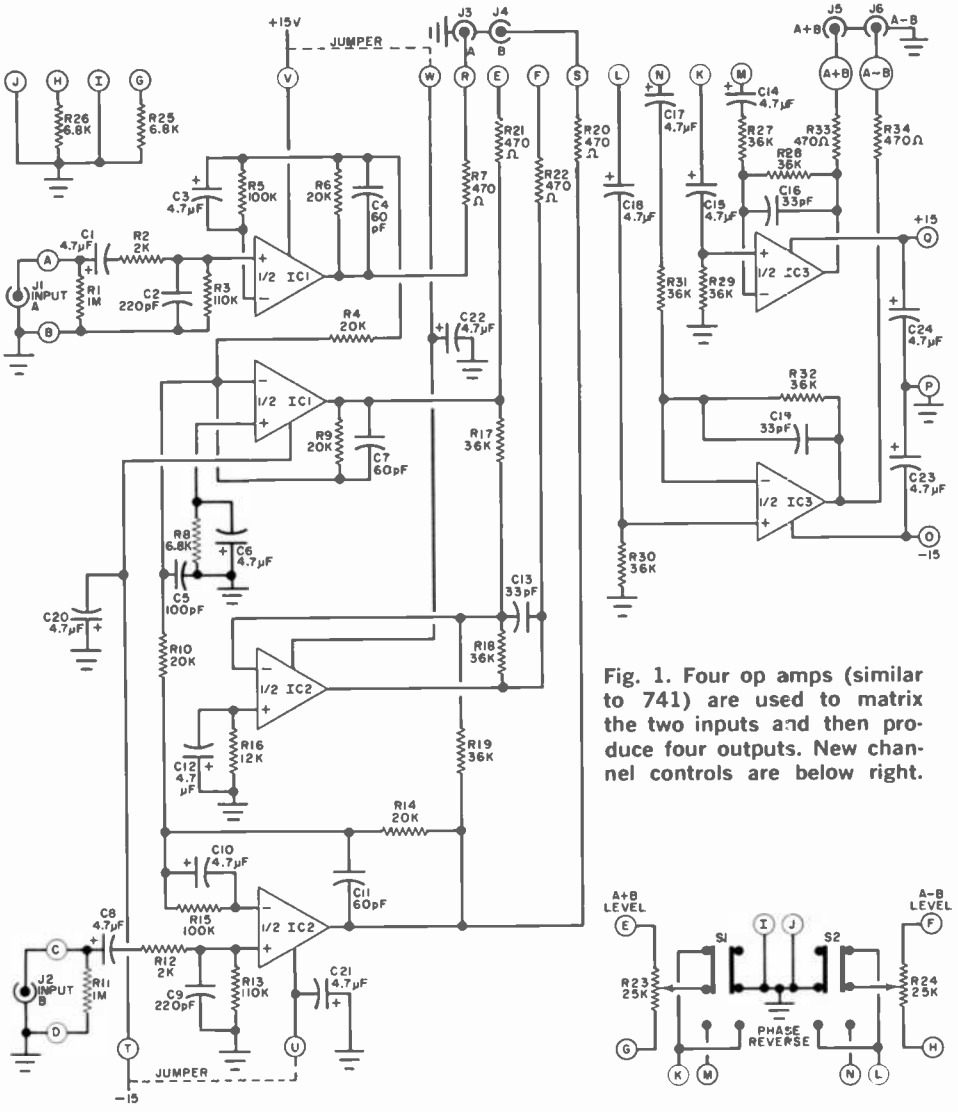


Fig. 1. Four op amps (similar to 741) are used to matrix the two inputs and then produce four outputs. New channel controls are below right.

PARTS LIST (Including Power Supply)

C1,C3,C6,C8,C10,C12,C14,C15,C17,C18,C20-C24—4.7-μF, 25-volt electrolytic capacitor
C2,C9—220-pF, 10% polystyrene capacitor
C4,C7,C11—60-pF, 5% polystyrene capacitor
C5—100-pF, 10% polystyrene capacitor
C13,C16,C19—33-pF, 5% polystyrene capacitor
C25,C26—1000-μF, 25-volt electrolytic capacitor
C27,C28—470-μF, 25-volt electrolytic capacitor
D1-D4—1N2070 silicon rectifier
I1—NE-2 neon lamp
IC1-IC3—Dual op amp (Signetics N5558V)
R1,R11—1-megohm, 10% resistor
R2,R12—2000-ohm, 10% resistor
R3,R13—110,000-ohm, 5% resistor
R4,R6,R9,R10,R14—20,000-ohm, 5% resistor
R5,R15—100,000-ohm, 5% resistor
R7,R26,R21,R22,R33,R34—470-ohm, 10% resistor
R8,R25,R26—6300-ohm, 5% resistor
R16—12,000-ohm, 5% resistor
R17-R19, R27-R32—36,000-ohm, 5% resistor
R23,R24—25,000-ohm, linear taper potentiometer
R35,R36—390-ohm, ½-watt resistor
R37—100,000-ohm, 20% resistor
S1,S2—Dpdt slide switch
T1—Power transformer: secondary: 24VCT at 85 mA (Stancor P8394)
Misc.—Suitable chassis (Bud CU-482, 4" x 8" x 2"), rubber feet, knobs, line, etc
Note: Available from Southwest Technical Products, Box 32040, San Antonio, TX 78216. PC board $2.65 pp; complete kit less chassis, $23.90 plus postage for 2 lb.

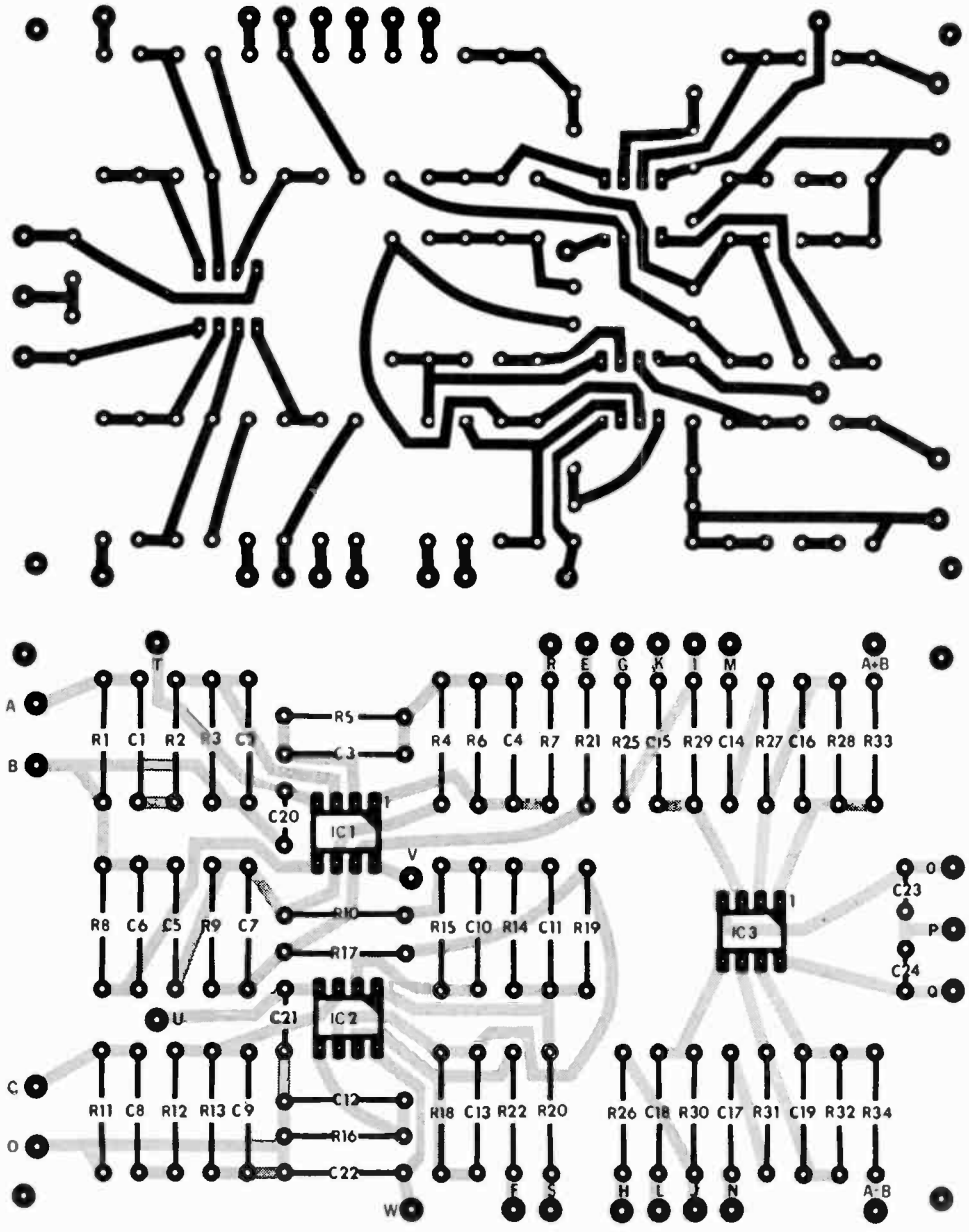


Fig. 2. The actual size foil pattern and components installation diagram for synthesizer. Use a low-power soldering iron and fine solder.

volt on any channel; distortion of 0.05% or less at 1 volt rms output; gain of +6 dB on the two front channels, controllable from −7 to +6 dB on the two new channels; and frequency response of ±0.5 dB from 20 Hz to 20 kHz at 1 volt rms output.

How It Works. The synthesizer recovers the "ambiance" that appears in most stereo recordings and uses it to create the extra channels. Two processes are used: one adding the stereo information to create a third center channel and the other subtracting the two channels to provide a difference signal.

Each of the three IC's contains two identical operational amplifiers. The first two op amps (half of *IC1* and half of *IC2*) are wired as non-inverting amplifiers with a

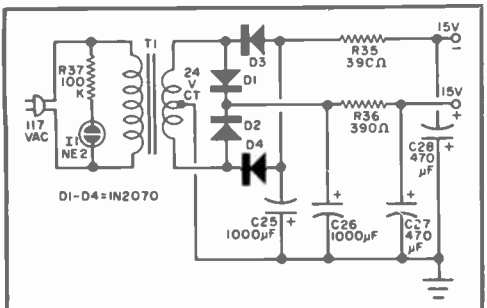


Fig. 3. Conventional power supply is wired point-to-point using terminal strips. See Fig. 1 for Parts List.

gain of two. The outputs for the front channels at *J3* and *J4* are thus twice the A and B inputs.

The second half of *IC1* is a summing amplifier whose output is A + B. The second half of *IC2* is a difference amplifier whose inputs are 2B and A + B so that its output is A − B. Thus the two new channel outputs are A + B and A − B. Level and phase-reversal controls are provided by *R23*, *R24*, *S1*, and *S2*. The signals are then fed to the two halves of *IC3*. With the associated phase-reversal switch in one position, its op amp acts as a unity gain voltage follower; and with the switch in the other position, the op amp acts as an inverting follower. Thus the switch provides a full 180° change in phase of the signal.

Construction. The synthesizer is assembled on a PC board using the foil pattern and component layout shown in Fig. 2. The power supply, whose schematic is shown in Fig. 3, is mounted separately.

The board and power supply can be assembled in a suitable chassis similar to that shown in the photograph of the prototype. The phase-reversal switches, level controls and connectors are mounted on the sides.

Operation. Connect the A and B inputs (*J1* and *J2*, respectively) to the source of conventional two-channel sound and the A and B outputs (*J3* and *J4*) to the inputs of the front-channel stereo amplifier. Connect A + B (*J5*) and A − B (*J6*) to the inputs of the stereo amplifier to be used for the extra speakers.

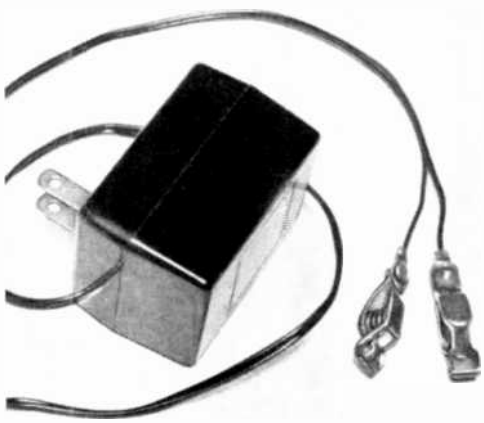
The speaker arrangement used is unique. The two conventional front stereo speakers should be separated a little more than usual with the A + B speaker placed between them. The A − B channel speaker is then placed at the rear of the room.

With a two-channel input turn on the synthesizer and note that the two front channels deliver normal stereo. Adjusting the gain of the two new channels (*R23* and *R24*) should cause a signal to be heard from those speakers. The added stereo amplifier gain controls can be adjusted to obtain the desired volume level. Both the new channel level controls and the phase-reversal switches can now be set for the desired type of four-channel sound for your listening room. ◈

INEXPENSIVE TRANSISTOR POWER SUPPLY

by Frank H. Tooker

HOBBYISTS and experimenters who need a power supply for experimental setups and even finished projects should not overlook the low-cost units sold as battery eliminators for radios and the like. These little power supplies can be obtained in 6-, 9-, and 12-volt models—and they are all electronically voltage regulated. After buying a battery eliminator, fit the ends of the output cable with a pair of clips (see photo). Color code the clips for easy identification of the positive and negative leads. If the clips are equipped with rubber "boots," buy one red and one black and attach them to the positive and negative eliminator leads, respectively. Now, you have a power supply that is inexpensive, compact, and always ready for instant use.



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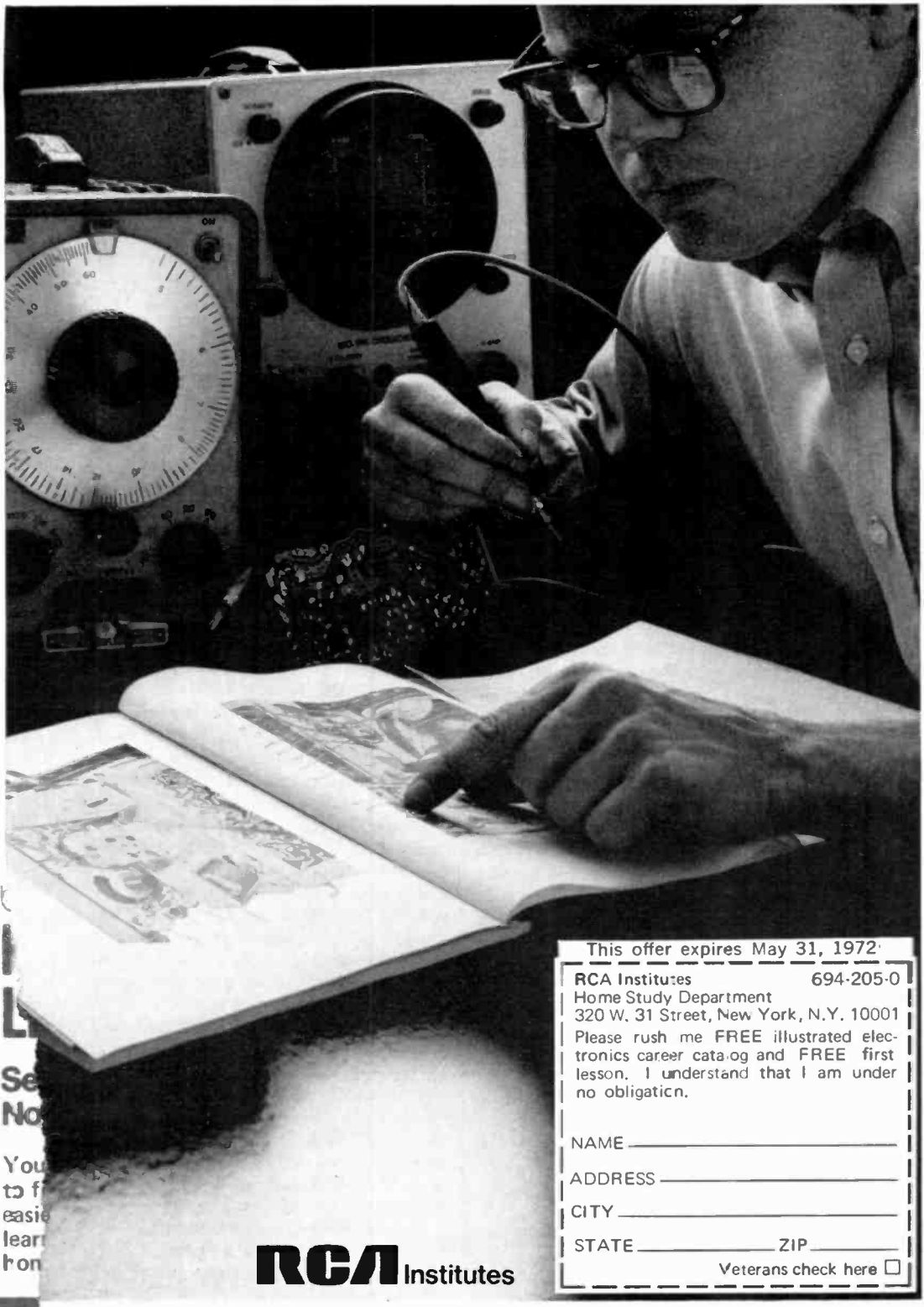

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Chasing DX on the FM Band

LONG-DISTANCE LISTENING ON FM, YOU MAY FIND STEREO OR QUADRAPHONIC SIGNALS

BY RICHARD E. WOOD

MORE than 2500 stations are licensed on the 100 channels that make up the FM broadcast band which extends from 88.1 to 107.9 MHz. For many radio listeners, this is a favorite band for chasing that elusive commodity: DX—rare, low-powered, distant stations. The reasons for this infatuation with FM DX are many. The distances may not be as great as routinely encountered on shortwave or at night on the AM broadcast band; but when it occurs, a good FM DX opening can provide pristine local-quality reception of a kind that simply can't be found on the SW and AM bands. And where else can one DX in stereo and quadraphonic sound?

The FM broadcast band is divided into two parts with the midpoint falling at 92 MHz. On the educational channels, which are in the range from 88.1 to 91.9 MHz, stations are operated by National Public Radio, colleges and universities, religious broadcasters, and some city and county administrations. At present, there are more than 250 such stations in operation.

In the commercial band, from 92.1 to 107.9 MHz, more than 2300 stations are divided up geographically according to an FCC master plan implemented in 1961 which calls for an eventual total of 3075 stations. Not all of the existing stations in this band are commercial. Some are educational, but they must conform to the same power and antenna regulations applicable to the commercial stations.

One difference between the educational and commercial bands is that the commercial stations are non-directional. This makes it easier to predict chances of hearing a particular station once the power and antenna height are known. This contrasts sharply with the situation on the AM band where many clear-channel and almost all regional channel outlets are highly directional.

When there is a directional opening on FM—a duct to a particular city, state, or region—you can consult a list of FM stations and, after judging power and antenna height and possible interference on the frequency, look for other stations in the same location. Chances are that they will be right there. (Perhaps the best aid in tracking down directional openings is the "FM Atlas and Station Guide" published by Bruce F. Elving, Box 24-PE, Adolph, MN 55701, $2.50 per copy.)

The only exception to the non-directional rule is the educational band where some stations can be directed by choice. For example, WSIE, Edwardsville, Ill., a university station on 88.7 MHz located near the southwest corner of the state directs its signal to the northeast to cover Illinois and away from St. Louis which lies nearby but across the state line.

Many FM listeners specialize in the educational band. They like the challenge of the extra complications in directionality, low power (some college and high school stations put out a meager 10 watts), and the lack of identifications on the hour and half-hour. On the other hand, DX listening in the educational band is made easier by the comparatively low frequencies involved. E-layer skip, tropospheric ducting, and other forms of propagation cause the m.u.f. (maximum usable frequency) to rise gradually from TV channel 2 to channel 6 and then up into the FM radio frequencies. But the m.u.f. may hover in the high 80's or low 90's and not rise as far as the commercial FM band.

Bearing this in mind, most FM DX'ers begin their search for stations by checking conditions in the lower half of the educational range. Some also combine their DX'ing with similar work in TV, monitor-

ing TV channel 6 for early warning of DX propagation on FM.

One might well ask where is the best possible location for an FM DX'er in North America? Actually, each part of the continent has its pros and cons. The greatest choice of stations is in the Northeast and Great Lakes region, followed by the South and California. There are fewer stations in the Plains States and Mountain West, but this means that there is less chance of band saturation.

A New Jersey DX'er can quickly run up a goodly station and state count by tuning the many groundwave (GW) and extended groundwave (EGW) signals which he can hear daily. But if his FM dial is filled with GW signals and splatter from local outlets, he may miss such DX-producing phenomena as E-layer skip (Es), tropospheric ducting (Tr), and meteor scatter (Ms). A California DX'er may achieve a total of 175 home-state stations, but his total of states logged is likely to be less than that of the New Jersey listener.

All things considered, the best location for an FM DX'er is generally agreed to be in the South where FM broadcasting is really lively. There are many interesting targets to aim for. And there is also a natural advantage, especially for listeners in the Gulf South. Here there is more Tr than in any other part of the country, especially in winter which tends to be an off-season for FM DX in the North. "Gulf trops"—tropo propagation across and around the Gulf of Mexico—is a byword among southern FM DX hounds. Skip from the E layer is also more frequently encountered in southern latitudes.

FM listeners tend to have a strong interest in propagation. They learn to distinguish the different modes as they hear them. Tr, for example, shows great directionality, allowing an experienced DX'er to zero in on a duct that is so directional that only those stations operating from a single transmitter site or narrowly circumscribed section of a city are audible.

Tropospheric reception is often strong and steady. It may last for hours or days and provide excellent stereo signals at average distances of 300 to 600 miles. At a distance of 1094 miles, Tr of WBEN-FM Buffalo, N.Y., 102.5 MHz, was heard in Baton Rouge, La.—maybe a record for this mode of propagation at FM broadcast frequencies.

Perhaps the most exciting mode of FM propagation is Ms. Meteors and meteorites constantly rain down from space; as they fall, they interpose themselves between transmitter and receiver and reflect the FM signal. Ms is very brief, lasting only seconds, and at the most, minutes. The majority of stations heard will remain unidentified since only music or other non-distinctive program material will be heard. But there is always the possibility that the scatter may occur just when an identification or a local commercial is being aired. If enough is heard, a report can be sent off. For example, from Baton Rouge, WIFI Philadelphia, 92.5 MHz, was positively identified and subsequently verified. The distance of 1112 miles is typical for Ms.

A more regular source of reception in the 750-2000 mile range is Es, chiefly in summer around midday but irregularly observed throughout the year. Like Tr, it is directional but generally less steady, with the focus darting around, and lasting only minutes. As with Tr and Ms, signals propagated by Es are generally quite loud, but at times they may fade deeply. Es is quite unpredictable, more so than Ms which cannot be predicted in detail for specific stations.

International activity in FM DX (as well as in utility vhf and TV) is organized by Worldwide TV-FM DX Association, 1203 Kenton Rd., Deerfield, IL 60015. Annual membership which includes the monthly "VHF-UHF Digest" is $8.50; a sample copy of the Digest is 50¢. The Digest regularly carries the latest FCC, Canadian, and foreign station license news; news on Mexican, Central American, and Caribbean stations; regional FM reports which give latest member loggings; and a QSL section. For international FM DX'ers, there is a regular "European Scene."

FM stations tend to be friendlier and better verifiers of QSL's than are stations on the AM broadcast band. The reasons for this are the relatively few FM reports received, the newness of many FM stations (which makes them genuinely interested in reports), and the high quality of FM reception reports sent in. This last is due to the almost total lack of casual FM DX'ers. Too, it is recognized that the FM DX'er must have better equipment than his counterpart working DX on SW and AM BCB, and that he must take more care in tuning and have a nodding acquaintance with propagation. ◈

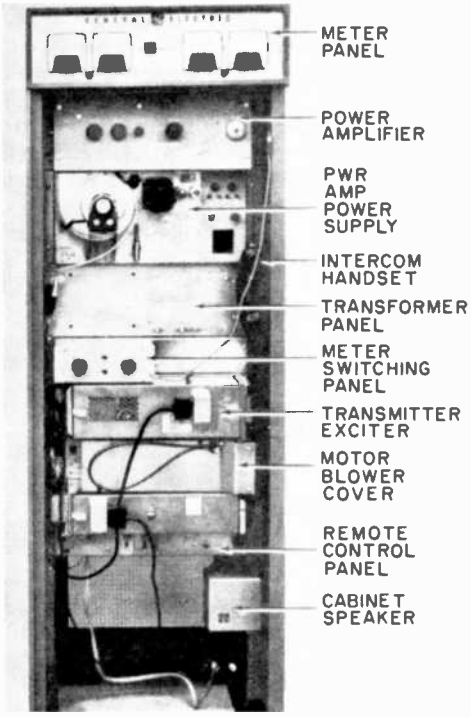
Public Weather Broadcasts from Coast to Coast

A DETAILED LOOK AT THE EQUIPMENT THAT PROVIDES 24-HOUR-A-DAY WEATHER INFORMATION

BY HOWARD W. GRANOFF

THE first station of the nationwide Radio Weather Service was installed in Chicago, Ill., in the early 1950's. Now there are nearly 60 of these vhf-FM stations operating in various critical storm areas and disseminating general weather information and disaster warnings on a 24-hour-a-day basis.

Fig. 1. Base station with front open.



The Network, operated by the National Oceanic and Atmospheric Administration, provides advance warnings of severe weather conditions to permit the public to take adequate precautions against thunderstorms, tornados, blizzards, hurricanes, and floods. It also transmits such information as temperature, humidity, rainfall and snowfall accumulations, wind speed and direction, marine conditions, and general forecasting.

Two frequencies are used by the NOAA Radio Weather Network. The primary frequency is 162.55 MHz. The secondary frequency of 162.40 MHz is used when the primary frequency would create interference at certain locations. Since radio propagation can be tricky, the National Weather Service plans to use a third frequency when absolutely necessary at locations where adjacent sites are unusually close. The use of this third frequency, it is hoped, can be minimized by employing every technical method available—antenna alignment, height, relocation, etc.

Following the establishment of the first station in Chicago, similar systems were in operation by 1962 in Kansas City, Mo., and New York, N. Y. In 1966 and 1967, the vhf-FM Radio Weather Service was expanded to cover 16 additional cities.

Typical Station. The station serving the Washington, D. C., area is known as a Type B100 system and is typical of the early in-

stallations. Its transmitter, located at Davidsonville, Md., operates on 162.55 MHz. The transmission range reaches a maximum of 40 miles, depending on terrain. Station equipment consists of a 300-watt base station vhf-FM narrow-band transmitter (Fig. 1), a 35-watt desk-top vhf-FM narrow-band transceiver (Fig. 2), and a control console (Fig. 3) with a record/playback tape deck, two playback decks, a remote control console, and a speaker amplifier. A VOX monitor alarm receiver is installed near the control console.

The 300-watt transmitter is usually located in an area favorable to the installation of the antenna. Telephone lines are generally used to link the transmitter/antenna site with the Weather Service office. The control console, 35-watt transceiver, and VOX monitor alarm receiver are located in the Weather Service office.

The control console provides facilities for making recordings, playing them back for transmission by the 300-watt transmitter, and monitoring of the recordings before they are aired. The remote control panel provides a signal of constant level to the transmitter, nullifying signal variations which may occur. It also makes it possible for the operator to turn on and off the 300-watt transmitter carrier. Finally, the remote control panel contains a tone-alert function, the purpose of which is to supply a precision 1050-Hz audio tone for a predetermined period of time (2-5 seconds) when momentarily activated. A receiver equipped for tone-alert is activated when a 1050-Hz tone modulated FM carrier signal is received. Receivers of this type are used by police and fire departments, and other agencies concerned with the public welfare.

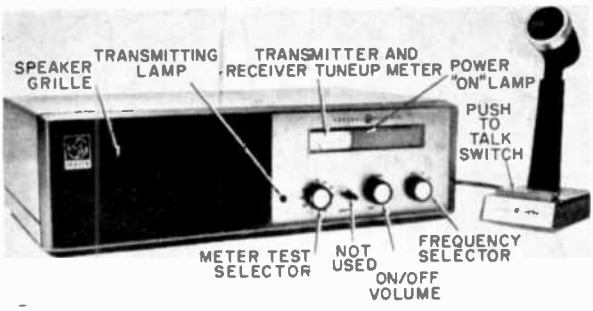


Fig. 2. The 35-W desk-top transceiver.

The 35-watt transceiver is used by NWS office personnel to maintain communications with a designated local radio station in the event of telephone line failure during a disaster. The transceiver allows the NWS office to provide the radio station with alerts and all details concerning an emergency for rebroadcast to the general public. The VOX monitor alarm receiver, installed in the NWS office, is used to monitor transmissions originating at the 300-watt transmitter and sounds an alert when

RADIO WEATHER NETWORK

Location	Frequency
Akron, Ohio	162.55 MHz
Anchorage, Alas.	162.55
Astoria, Ore.	na
Atlanta, Ga.	162.55
Atlantic City, N.J.	162.40
Brownsville, Texas	162.55
Boston, Mass.	162.40
Buffalo, N.Y.	162.55
Charleston, S.C.	162.55
Chicago, Ill.	162.55
Cleveland, Ohio	162.55
Corpus Christi, Texas	162.55
Dallas, Texas	162.40
Denver, Colo.	162.55
Des Moines, Iowa	162.55
Detroit, Mich.	162.55
Erie, Penna.	162.40
Eugene, Ore.	162.40
Eureka, Calif.	162.55
Ft. Worth, Texas	162.55
Galveston, Texas	162.55
Hilo, Hawaii	162.55
Honolulu, Hawaii	162.55
Hyannis, Mass.	162.55
Indianapolis, Ind.	162.55
Jacksonville, Fla.	162.55
Kansas City, Mo.	162.55
Lake Charles, La.	162.55
Los Angeles, Calif.	162.55
Miami, Fla.	162.55
Milwaukee, Wis.	162.40
Minneapolis, Minn.	162.55
Mobile, Ala.	162.55
Monterey, Calif.	162.40
Morehead City, N.C.	162.55
Mt. Huleakala, Hawaii	169.075*
New London, Conn.	162.40
New Orleans, La.	162.55
New York, N.Y.	162.55
Norfolk, Va.	162.55
Oxnard, Calif.	162.40
Pensacola, Fla.	na
Portland, Maine	162.55
Portland, Ore.	162.55
Rockland, Maine	162.40
Sacramento, Calif.	162.40
Salt Lake City, Utah	162.50
San Diego, Calif.	162.40
Sandusky, Ohio	162.55
San Francisco, Calif.	162.55
Savannah, Ga.	162.40
Seattle, Wash.	162.55
Seward, Alas.	162.55
St. Joseph, Mo.	162.40
St. Louis, Mo.	162.55
Tampa, Fla.	162.55
Washington, D.C.	162.55
West Palm Beach, Fla.	162.40
Wichita, Kansas	162.55
Wilmington, N.C.	162.55

na—not available
*—temporary

interruptions of audio or r-f signals occur.

The 300-watt transmitter employs a vertically polarized omnidirectional antenna with a gain of 6 dB. The 35-watt transceiver's antenna is a horizontally polarized directional affair with 5 dB of gain.

New Advances. During 1969, five stations of the advanced Type B101 were added to the NWS vhf-FM network. They are located in Portland, Maine; Buffalo, N.Y.; Portland, Ore.; Seattle, Wash.; and Brownsville, Texas. The design of the control console has additional capability and more flexibility than does the B100 system. It has two record/playback tape decks, a 5-channel playback deck, and an audio sequencer designed by NWS. The audio sequencer makes it possible to select, through numbered pushbuttons, the tape playback channels—either singularly, sequentially, or in any combination in ascending order to provide continuous cycling between them to a maximum of seven units. The B101 remote

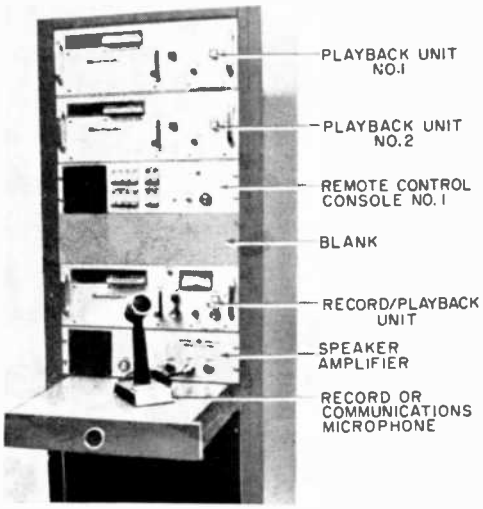


Fig. 3. Front view of control console.

control panel incorporates the B100's speaker amplifier function and is the same in all other respects to its forerunner. A VOX monitor alarm receiver used with the B101 system is utilized in the same manner as in the B100 system.

In parallel with the development of the B101 system was that of a Type B102 system which was installed at Cleveland, Ohio, in early 1970. This system contains a newly designed automatic audio system

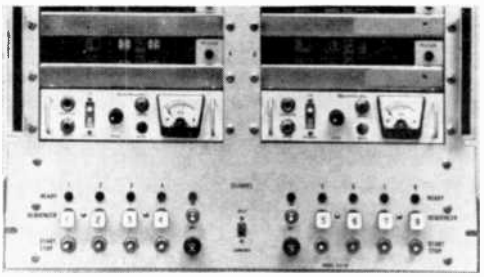


Fig. 4. New automatic audio system.

(Fig. 4) having two record/play and six playback channels and an audio sequencer. The automatic audio system has a split-combined audio mode to permit operation either as an integral system having two record/playback channels, or as two independent systems, each with one record/playback and three playback channels. This permits the distribution of the same message or two independent messages simultaneously over two separate circuits.

In the combined mode, it is possible to cycle all eight playback channels sequentially in a continuous repeatable loop. In the split mode, the automatic audio system's eight playback channels are split into two separate and independent sections; each has four channels capable of sequentially cycling in a continuous repetitious loop. A B102 system can deliver the same audio signal or two independent signals to two separately located vhf-FM 300-watt transmitters. The development of the automatic audio system laid the groundwork for the B103 system which has become the standard in the NWS vhf-FM network.

The B103 differs from the older systems only in the design of the control console which now contains the automatic audio system and the remote control panel developed for the B101 system. This design has resulted in a more economical, highly flexible, and more compact console with greatly increased capability. The NWS is procuring B103 systems for ten new locations.

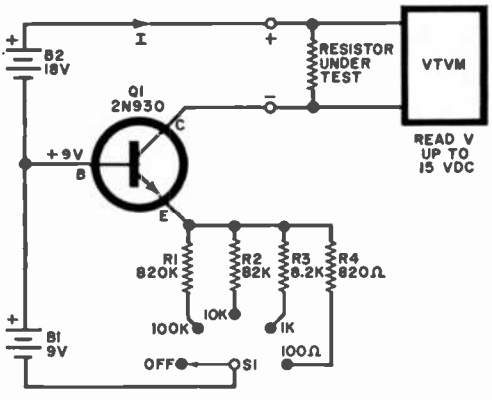
For those readers who wish to tune in on NWS forecasts, the list of station locations and frequencies given in the table should be of interest. Receivers with the capability of tuning in NWS forecasts are available from many sources. They can be divided into two categories: inexpensive units which sell for $17 (or less) to $70 with sensitivities of 2 to 10 μV/meter, and tone-alert models for $150 to $300. The latter have sensitivities ranging from 0.35 to 1 μV. ◈

OUTBOARD CONSTANT-CURRENT SOURCE
CONVERTS VTVM's DC FUNCTION TO

A LINEAR-SCALE OHMMETER

BY GERALD BEENE

WHEN you use a VTVM to measure resistance, the conventional logarithmic scale can present interpretation difficulties that lead to gross inaccuracies if the meter pointer should fall in the crowded upper one-third of the scale. However, if the scale could be made linear, and thus easier to interpret, your reading accuracies will benefit greatly.



Test resistance value is equal to voltage drop across resistor times range multiplier of current source.

The constant-current circuit, shown here schematically, can be used with your VTVM to provide a linear-scale feature with ranges of 100, 1k, 10k, and 100k ohms. The ranges are interpreted on the linear scale of the dc voltage ranges and not on the usual log-type resistance scale. Nor do you need a conversion chart, nomograph, or formula to figure out the ohmic value of a resistor under test. You simply read the voltage indicated by the meter pointer and observe the range position of the switch in the constant-current circuit.

An example shows how this works. If you measure 4.8 volts across a test resistor and the add-on's range switch is in the 10k position, the resistance is 48,000 ohms (4.8 × 10,000 = 48,000). It's as simple as that.

Since the add-on allows measurements and comparisons at several current levels, diodes can be accurately matched with the constant-current source. You can even get a rough measurement of capacitance values (greater than 0.1 μF). To do this, apply the formula C = (IT/V), where C is in farads, I is supply current in amperes (see table for multiplication factor to use), T is charging time in seconds, and V is measured voltage in volts. For example, if the constant-current source is set to 100k, the capacitance in microfarads is equal to the number of seconds required for the voltmeter to indicate 10 volts after the capacitor is connected. This is only a rough estimate of the capacitance value which will allow you to determine if a capacitor's value is "in the ballpark" of the stamped value.

MULTIPLICATION FACTORS

SCALE FACTOR (OHMS/VOLT)	RANGE CURRENT
100	10 mA
1k	1 mA
10k	0.1 mA
100k	0.01 mA

If you look at the circuit again, you will note that *S1* is set up so that you can connect a capacitor to the circuit before the circuit is switched on. Once the capacitor to be tested is connected to the constant-current source, use the sweep second hand on your watch to count ten seconds from the time the range switch is set into any appropriate operating position for the current source. ◈

The Origin of Ohm's Law

TODAY, Ohm's Law stands as one of the most powerful and commonly used laws of electricity and electronics. It states that the amount of current flowing through a conductor (or resistor) is equal to the applied voltage divided by the resistance of the conducting material. In mathematical terms, the equation generally reads I=E/R. What seems simple and obvious today, however, took a great deal of genius, courage and effort to propose for the first time in 1825. Georg Simon Ohm, a German physicist and mathematician, was a man who had the right kind of genius and courage.

BY DAVID L. HEISERMAN

Scientists were aware of a "galvanic fluid" (electrical current) that played some mysterious role in their studies; but the elusive and short-lived nature of currents in static electricity made them a difficult subject for any kind of meaningful study.

Alessandro Volta completely changed all this in the early months of 1800 when he formally announced the discovery of his electric generating cell. His "hydro-electric battery," forerunner of modern wet-cell batteries, gave scientists their first source of current that could flow continuously. For nearly twenty years, however, all the studies of galvanic currents suffered from one serious disadvantage—there was no way to measure the amount of current flow.

The breakthrough came in 1820 when Oersted showed that a current passing through a wire produces a magnetic field. A year later, Schweigger and Poggendorff used Oersted's findings to invent the galvanoscope—a crude sort of galvanometer made of hundreds of turns of wire wrapped around an ordinary compass. Current flowing through the wire produced a magnetic field that deflected the compass needle by a proportional amount.

Georg Ohm, then a high school mathematics and physics teacher in Cologne, saw the possibility of combining Volta's hydro-electric battery with a galvanoscope to study the nature of electrical current flow.

Using equipment he constructed himself, Ohm set out to find the exact relationship between applied potential, the length of a conductor, and the amount of deflection of the needle in a galvanoscope. His procedure was to connect the galvanoscope directly to the battery and carefully note the position of the compass needle. This gave him a reference reading. He then inserted a wire of known composition and length into the circuit and noted the new position of the needle. This was his experimental reading. Of course, the resistance of the test wire made the needle show a smaller amount of deflection in the experimental condition.

In 1825, Ohm reported his first findings in a paper titled "Preliminary Notice of the Law Accordng to which Metals Conduct Contact Electricity." Publishing this paper turned out to be a mistake that plagued Ohm for the next sixteen years.

Technically speaking, the equation Ohm

presented in the paper was incorrect. It stated that $v=m \log(1+x/r)$; where v was the decrease in the needle's deflection, x represented the length of the conductor, r represented the resistivity of the conducting material, and m stood for the amount of applied potential.

Just before his paper was scheduled to appear in print, Ohm repeated a few of his experiments using a different kind of power source. The results didn't agree with his original findings, and Ohm immediately saw he could develop a much simpler equation that didn't contain a logarithmic term. By the time he contacted the publisher, however, the paper was already in print; and the best he could do was publish a short letter promising to run a new series of experiments. Ohm stated he would show that the amount of current flowing through a circuit goes to zero as the length of the conductor approaches infinity. This bit of mathematical talk constituted his second mistake—a political one in this case. His letter infuriated most scientists of the time because they firmly believed the only proper scientific procedure was to gather mountains of data before playing with any kind of equation.

Ohm's incorrect equation was the result of a widespread lack of knowledge about the basic theory of batteries. After it was too late to stop publication of his paper, Ohm realized he had used an unstable power source—one whose output voltage varied with the amount of loading.

Poggendorff, one of Ohm's few allies in the scientific community, suggested he use a Seebeck thermoelectric battery rather than Volta's hydro-electric battery.

The thermoelectric battery was the first practical device to take advantage of the thermoelectric effect discovered by Seebeck in 1821. The Seebeck effect makes two unlike, tightly bonded conductors produce an electrical potential when one of them is heated. The output voltage is small, but so is the internal resistance. So, Ohm repeated all his experiments using the stable thermoelectric battery and galvanoscope. The equation we now know as Ohm's Law fit the data from his new series of experiments.

In 1826, Ohm was ready to show the world he knew what he was talking about. His second paper was entitled "Determination of the Law According to which Metals Conduct Contact Electricity, Together with the Outlines of a Theory of Volta's Apparatus and the Schweigger Galvanoscope." The corrected equation read, $X=a/(b+x)$; where X represents the amount of current flow through the conductor, a stands for the exciting voltage, x is the resistance of the conductor under test, and b is the combined internal resistance of the power source and galvanoscope.

In the early part of 1827, Ohm published yet a third milestone paper in the history of science called "The Galvanic Battery Treated Mathematically." He then believed he had completely vindicated himself for proposing an incorrect equation and was confident that his colleagues would finally accept his law of electrical conduction.

The scientific community, however, was still not ready to accept Ohm and his works. For one thing, the equation seemed too simple—far too simple to explain a phenomenon that had been challenging the best minds of Europe and America for nearly thirty years. Then, of course, there was Ohm's widely misunderstood statements in the letter following his first paper. Most reputable scientists still considered Ohm a quack. Bitter and disappointed, Ohm returned to his teaching profession.

Six years passed before a few influential scientists began taking serious looks at Ohm's work. The incident that touched off this mild renewal of interest was a paper published by Pouillet in 1831. Pouillet had unwittingly repeated Ohm's work, and he had arrived at exactly the same results. Pouillet believed he was the founder of the law of electrical conduction, and so did most of the scientists of the time. Several scientists, however, noted a strong similarity between Ohm's work and Pouillet's paper.

In 1841, sixteen years after Ohm announced his law of electrical conduction, the British Royal Society presented him the Coply gold medal for "the most conspicuous discovery in the domain of exact investigation." Ohm thus received proper credit for his work, a formal apology for the delay, and a well-deserved round of applause from his peers.

Ohm died in 1854; and, exactly ten years later, the British Association for the Advancement of Science adopted the ohm as the unit of measure for electrical resistance. Thus Ohm (like Ampere and Volta) is now immortalized in the everyday language of modern electrical engineers and technicians everywhere. ◈

A LOOK AT INDUSTRIAL ROBOTS

HOW THEY WORK AND THE JOBS THEY PERFORM

BY EDWARD A. LACY

AT LAST COUNT, there were some 500 industrial robots at work in the U.S. They are performing such dangerous, unpleasant, and boring jobs that no one has complained about job losses to them. Robots are currently being used to load and unload diecasting machines, forging presses, and hot furnaces, to operate spot welders, etc. In the process, the robots are doing these jobs more reliably and economically than could the human workers they replaced.

While it is true that a robot lacks the dexterity of a human, it can learn its job quickly and operate without human attendance, make simple decisions, and communicate with other machines. The robot is also stronger than man and can repeat a process indefinitely without error or failure. And as multipurpose automation, robots are more versatile than special- and single-purpose automation. If a product is discontinued or a manufacturing operation is altered, a robot can be retrained to perform a new job—just like a human—instead of going onto the scrap heap where specialized automation equipment often ends up.

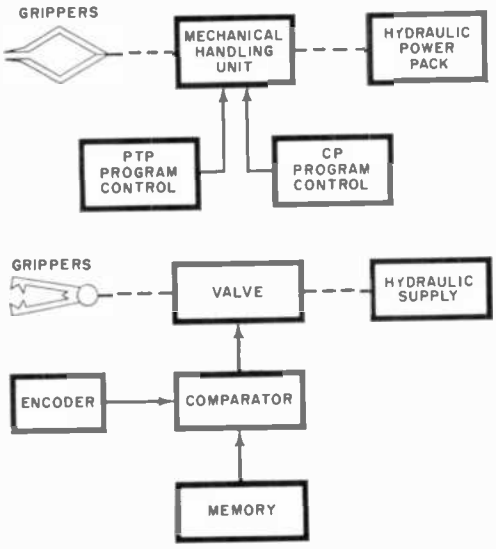
Presently, there are only two companies engaged in building robots for industrial use (while developmental work continues at such universities as Stanford and MIT to give robots artificial intelligence). The companies are Unimation Inc., owned by Pullman Inc. and Condec Corp, and AMF's Versatran® Division. Both companies put their first industrial robots into operation in the early 1960's. AMF calls theirs the Versatran (VERSAtile TRANsfer), while Unimation's goes by the name Unimate® (UNIversal AutoMATion). Versatran and Unimate have some noticeable similarities, such as only one hydraulically powered and electronic-memory controlled arm. Both can be trained on the job and can use a variety of "fingers" which include grippers, suction cups, magnetic pickups, and hand tools.

The Unimate Robot. Unimate's arm and hand are hydraulically powered; the fingers are pneumatically powered. The robot usually operates from a stationary position (it weighs 3500 lb). With an arm reach of 7½ ft, it has a 350 cu ft working area. It can pick up and move an object to any location within a 220° work arc, position the object with 0.05″ accuracy, wait a predetermined interval, transmit signals to other control equipment, and respond to other signals.

In moving an object, the arm can move fore, aft, up, down, or to left or right. The hand can twist or bend independently. The fingers or grippers can deliver up to 300 lb of compressive force; yet, they can be gentle enough to package delicate glass tubing.

Unimate follows a predetermined program of up to 180 sequential operations recorded in its memory. It automatically recycles itself or shuts itself off, and, on signal, starts itself up again. For programming or teaching, a "teach" control with manual switches is used to operate the different drives at low speeds. When the arm and hand assemblies have been raised, twisted, and turned to the position desired and the hand clamp has been opened or closed, this position is recorded on the memory drum by pressing a "record" button on the teach control. (The newest Unimates employ electronically-alterable read-only memories instead of the magnetic drum.) Any position into which the arm and hand can be placed is represented by five groups of numbers in binary code, one group for each degree of freedom.

Five position indicators or encoders on the arm tell the memory the location of



These block diagrams show basic elements that make up Versatran (top) and Unimate (immediately above) robots.

the arm at all times. In operation, the memory tells the arm where it should be. The arm then moves until the encoder and memory codes are the same, at which time the motion or step is completed and the robot goes to the next position indicated by the program. This process is repeated until the entire program is completed.

In early Unimates, each action in a program sequence was initiated upon completion of the previous action. This was a waste of cycle time. So, the Unimate was reprogrammed to anticipate time lags, using judicious overlapping of program steps. This permitted much faster production rates.

Operationally, Unimate moves directly to the position recorded, regardless of the path taken during teaching to reach this position. Since the robot can neither see nor think, if an obstacle exists between the two positions, additional positions defining a path around it must be recorded to avoid collisions.

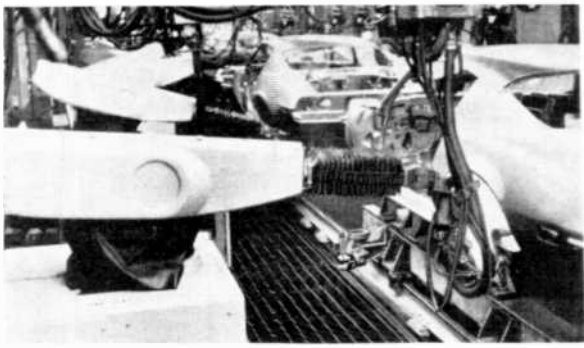
Parts handled by Unimate must not only be in the proper place at the proper time, they must also be properly oriented since the robot lacks the intelligence to search for them.

Interlock circuits keep Unimate in step with other production equipment and protect personnel, equipment, and Unimate itself.

The Versatran Robot. Versatran robots are available in models with two- to six-axes of primary and secondary motions, different mounting configurations, and other options. The "standard" robot offers five degrees of freedom: arm vertical, arm horizontal, arm swing, wrist rotate, and wrist sweep. Traverse of the entire unit, an additional freedom, is available with all robots. Movements can take place in all axes simultaneously.

Two types of programmer controllers are available: point-to-point (PTP) for put-and-take tasks, and continuous path (CP) or contouring controls for tracking or smooth contouring type of motions.

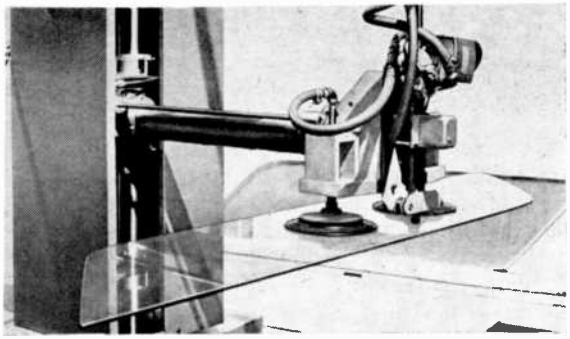
The PTP programmer is used for applications where the arm of the mechanical handler can move in the shortest time path between any pair of three-dimensional points in the work space. The control for a typical five-axis unit provides up to 4000 (some to 14,000) points of program capability. The PTP programmer has plug-in design and contains only the control elements needed. It may consist of six-potentiometer modules, ten-step ring counters, counter logic modules, and servo amplifier modules for each arm movement axis. It



On assembly lines such as this at an automobile plant, monotonous jobs like spot welding of bodies are performed by battery of Unimate robots.

may have a removable program patchboard or be "screwdriver" programmed. Additional modules permit manual alteration of arm positions without changing program pot settings and provide control over gripper wrist sweep and rotate, as well as jaw movements.

When required by the job, a module can



Versatran robot, with vacuum grippers, locates sheet of glass in a stack, picks it up and transfers it automatically to manufacturing station.

be added for separate velocity control in the arm horizontal, vertical, and swing area. Servo amplifiers can be added for applications requiring servo wrist movement.

Programming is done on the job. Vertical, horizontal, and swing arm position pots are patched into the program steps. A similar procedure establishes wrist-rotate-and-sweep and gripper sequences, dwells, interlocks with external equipment, etc.

In programming, manual and dwell console controls are set. The stepping counter automatically resets to the first program position patched in. A manual control pot for each of the three arm axes is adjusted to null out any error between programmed and actual arm positions before the program start button is pressed.

After the desired arm position for that step is reached, one or more of the three program command pots patched into that specific program step is adjusted, if required, until position error lights extinguish. The pots are then locked to memorize that arm position. This procedure is repeated at each step in the program until all patched-in command pots have been set to the desired arm positions for each program step.

Versatran robots have recently been given adaptive control ability to "feel" for and pick up individual objects from a group of many, even when the pickup position is continually changing. This seek-and-find capability in a single axis is the first step toward providing adaptive control capability in up to six axes of movement. Possible uses of the new adaptive control include stacking, unstacking, and machining operations as well as unloading active conveyors.

Before the development of the adaptive control, it was necessary to program a separate pickup point in space for each of the scores of objects in a stack. Holding pallets also had to be very accurately positioned each time. With the Versatran now able to feel for the nearest surface, the user needs to program only a single point for the entire stack.

In operation, the Versatran is positioned between a stack and the work stations to which the sheets will be transferred. Sheets in the stack must be picked up one at a time, but changes in sheet size, transfer routes or speeds, or other requirements can be readily accommodated by adjustment of control panel knobs. The adaptive control feature can function in any of the axes or arm and gripper movement.

The PTP control permits a series of routines to be set in the program with the robot choosing the appropriate ones to suit the task.

In CP operation, the arm of the mechanical handling unit must move through an infinitely controlled smooth path, with speed and acceleration variable over a wide range. At normal work speeds, more than 60 position points/sec are tracked, with programs up to 15 and 30 minutes possible. Typical uses include spray painting and tracking parts on moving conveyors.

The digital memory for the CP programmer consists of two separate magnetic tapes which run alternately to permit the robot to operate without interruption. A separate control matrix board is used for wrist, gripper, and other functions as well as program interfacing with external equipment.

In the "program" mode, the arm of the mechanical handler is manually led through the work movements, using an auxiliary control. Arm motions and other functions, such as wrist and gripper commands and signals to and from external equipment, are recorded simultaneously on the tapes.

After the handler has been taught and a program is established, the tapes control arm movement according to contours, velocities, and accelerations established during manual leading and programming. The tapes also provide commands to external equipment, wrist and gripper functions, and other actions, as well as for stops at predetermined points to await receipt of incoming signals. The program continues on a repetitive basis in the automatic mode under failsafe conditions for as long as necessary to complete the job. ◈

ELECTRONIC STEAM WHISTLE

GREAT FOR MODEL TRAIN BUFFS—

OR MAKING WILD AUTO HORNS

BY JOHN S. SIMONTON, JR.

IF MODEL railroading is one of your hobbies, you probably have at least one problem in common with every other railroad buff—finding a steam whistle sound for your layout. Since you may not be inclined to invest the money necessary to install boilers and pipes for a real whistle, this design for an $8.00 electronic substitute could be just what you need.

If you're adventurous, you might also want to try the steam whistle as a really different auto horn. (*Or how about a chromatic scale of whistles to make a steam calliope?*—Ed.)

Theory of Circuit Design. A whistle is basically nothing more than a resonant chamber which produces a tone when excited by the steam flowing over a turbulence producing orifice. However, there are other factors involved. There is the sound of the steam which can be heard as a faint hiss as the whistle is blown. Also, like other "musical" instruments, a whistle has its own peculiar attack and decay characteristics. That is, it takes a short time for the sound to build up to a maximum and the vibrations persist for some short time after the exciting force (steam) is removed. Finally, there is a slight lowering of pitch as the vibrating medium in the cavity changes from air to a denser air/water combination.

In this electronic whistle, whose schematic is shown in Fig. 1, there are three essentially independent sections which produce the necessary effects to make it sound like a real steam whistle. They are a tone oscillator, a noise source, and a gating amplifier.

The oscillator is a conventional phase shift circuit with *Q1* in a common-emitter configuration for gain and also to provide 180° of the required 360° of phase shift. The remaining 180° is provided by the frequency determining components, *C1*, *C2*, *C3*, *R1*, *R2*, and *R3*.

The steam sound is provided by a white noise generator, *Q2*, which has its base-emitter junction biased above the breakdown potential. The noise of the resulting avalanche breakdown mechanism appears across *R8* and is used to simulate the sound of steam.

The outputs of the oscillator and the noise source are mixed by resistors *R7* and

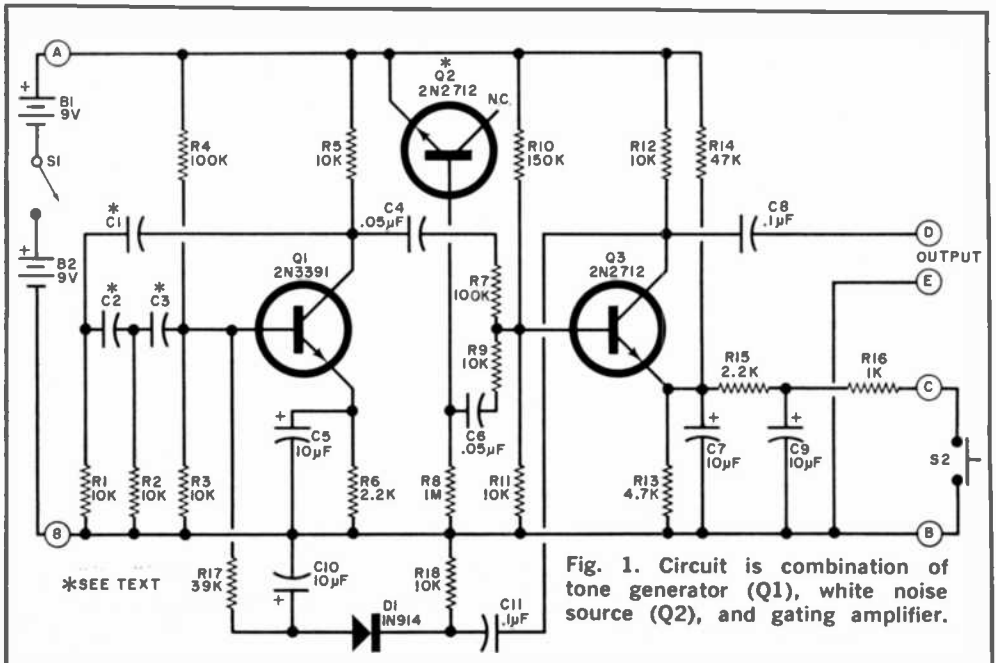
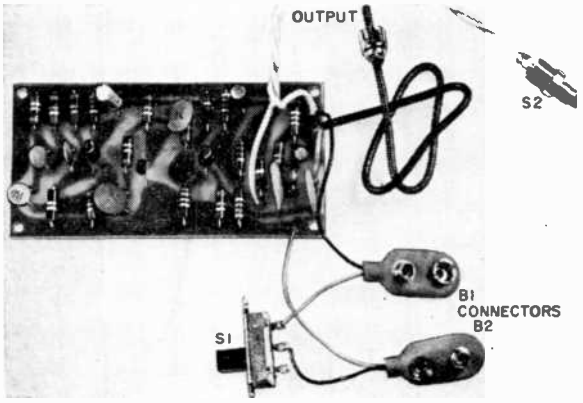


Fig. 1. Circuit is combination of tone generator (Q1), white noise source (Q2), and gating amplifier.

PARTS LIST

B1,B2—9-volt battery
C1-C3—0.005 to 0.05-μF disc capacitor (see text)
C4,C6—0.05-μF disc capacitor
C5,C7,C9,C10—10-μF, 6-volt electrolytic capacitor
C8,C11—0.1-μF disc capacitor
D1—Diode (1N914 or similar)
Q1—2N3391 transistor
Q2,Q3—2N2712 transistor (see text)
R1-R3,R5,R9,R11,R12,R18—10,000-ohm, ½W, 10% resistor
R4,R7—100,000-ohm, ½W, 10% resistor
R6,R15—2200-ohm, ½W, 10% resistor
R8—1-megohm, ½W, 10% resistor
R10—150,000-ohm, ½W, 10% resistor
R13—4700-ohm, ½W, 10% resistor
R14—47,000-ohm, ½W, 10% resistor
R16—1000-ohm, ½W, 10% resistor
R17—39,000-ohm, ½W, 10% resistor
S1—Spst slide or toggle switch
S2—Spst, normally open, pushbutton switch
Misc.—Battery clips, coax, phono plug, wire, solder, etc.
Note—The following are available from PAIA Electronics, Inc., Box 14359, Oklahoma City, OK 73114: etched and drilled PC board #6710 at $2.00, postpaid in U.S.; complete kit of all parts including PC board and selected Q2 and two sets of C1, C2, and C3, but less batteries, at $7.95, postpaid in U.S.

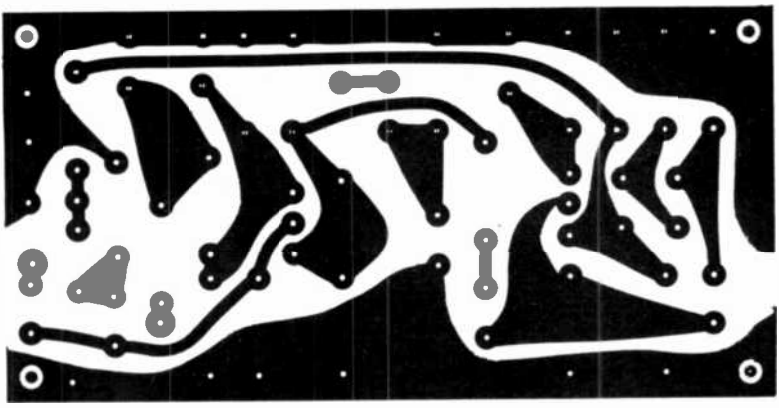
Note how components are connected to board with S1 between the batteries.



R9 and applied to the common emitter gain stage, *Q3*. When pushbutton *S2* is open, *Q3* cannot pass audio because its emitter is held at a slightly higher voltage than its base by the voltage divider *R14* and *R13*. When *S2* is closed, the voltage at *Q3*'s emitter begins to drop as *C9* discharges through *R16*.

As *Q3*'s emitter voltage drops, its base-emitter junction becomes more and more forward biased and thereby increases the gain of *Q3*. When *S2* is opened, a reverse action occurs as *C9* charges up through *R15*. These two time constants are chosen to simulate the attack and decay characteristics of the steam whistle.

Part of the output signal is tapped off of *Q3*'s collector and rectified and filtered



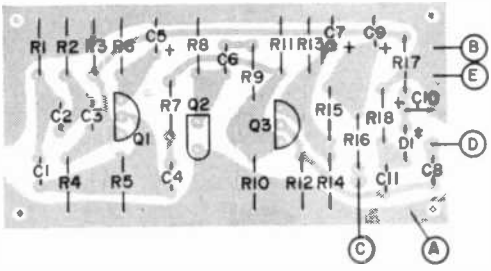


Fig. 2. The actual size foil pattern and component layout. Observe the polarities carefully during assembly.

by *D1* and *C10*. The resulting dc voltage is applied to *Q1's* base, where it gradually lowers the pitch of the oscillator slightly as the whistle is blown.

Construction. As with any project, an etched circuit board provides ruggedness and contributes to the appearance; but since there are no high frequencies involved here, the PC board is not essential. A foil pattern and component placement diagram are shown in Fig. 2.

Solder in place the resistors and disc capacitors first; then the electrolytics and semiconductors, being sure to observe the polarities. Use heat sinks on the semiconductor leads while soldering.

Selecting a transistor for *Q2* may present a problem, but the prospect is unlikely. Samples of test lots of 2N2712 transistors indicate that only a small percentage will not function properly as a noise source when driven from an 18-volt supply. Since two 2N2712's are required for the unit, the chances that neither will work for the noise source are remote. If you wish, check the performance of the noise source by putting a high-impedance crystal earphone directly across resistor *R8* and listen for the hiss. The volume of the noise at this point in the circuit is very low but you should be able to hear it.

Complete the assembly by soldering in place the positive lead from one battery connector and the negative lead from the other, the wires to the pushbutton and the audio output lead. Note that one of the pushbutton leads and the negative battery connector lead share a circuit board connection point and that a short length of small coax (RG-174/U) is used for the audio output. The remaining battery connector leads are used as a switch leg and soldered to power switch S1.

Operation. There are no adjustments which must be made to the whistle to make it operate, but there are some component values you may want to trim to get the sound the way you want it.

The values of *C1*, *C2*, and *C3* determine the pitch. Using 0.005 microfarads for all three of these capacitors produces the high-pitched screech of European trains, while 0.05-microfarad units give the throaty roar of American freight trains. The three capacitors need not be of equal value to sustain oscillation; and pitches between the two extremes can be obtained by changing individual capacitors.

The amount of "steam" can be varied by altering the value of *R9*. For more noise, decrease the resistance; for less hiss, increase the resistance.

Operation of the whistle is simply a matter of snapping two 9-volt batteries in place and plugging the output into a suitable amplifier. The type of amplifier used is not important, but the better it is (in terms of fidelity), the better will be the sound. ◈

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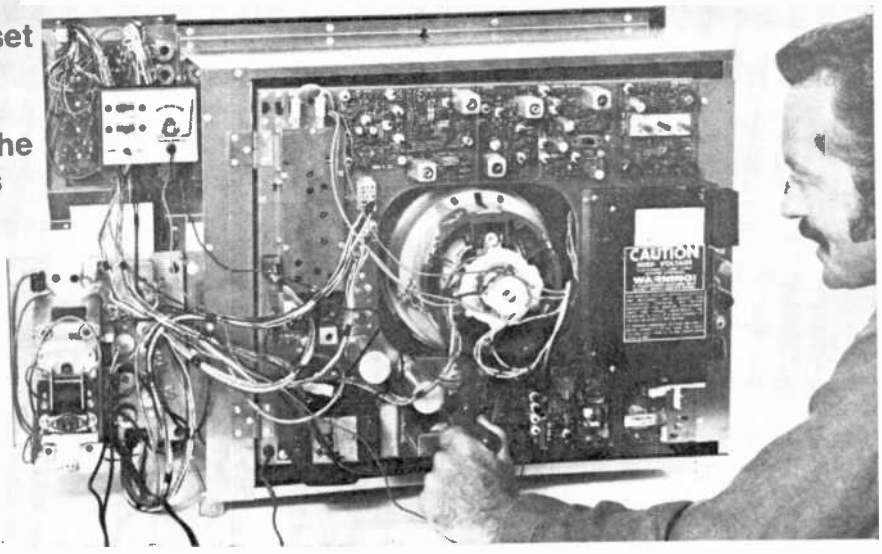

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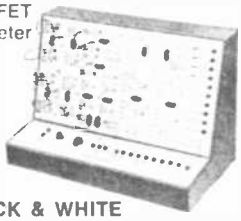

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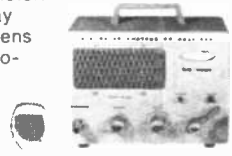

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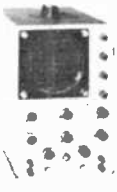

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A Versatile Pocket Calculator

By John T. Frye, W9EGV, KHD4167

FROM back in the service department Mac heard the front door screen of the service shop slam behind Matilda and Barney as they returned from their lunch hour. "I'm *glad* I forget each winter how lovely the first really warm day of May can be," Matilda was declaring. "It's wonderful and exciting to be able to discover this over and over again each year."

"Yeah, it's not bad out there," Barney admitted gruffly as he pushed through the swinging door of the service department. He found his employer seated at the service bench staring down at the varicolored keyboard of a little object lying on the bench in front of him. The object was flanked by a couple of open books and a scratch pad.

"Hey, what are you doing?" Barney demanded.

"Checking out a graduation gift for my favorite nephew who finishes high school next month—no, that's not quite true," he broke off. "Actually I'm having a ball playing with this fascinating bunch of integrated circuits."

"What is it? Looks a lot like the minicalculator Matilda has out on her desk except it has more keys."

"It's Hewlett-Packard's new HP-35 Pocket Calculator," Mac answered, "and you're right about the number of keys. Matilda's has fifteen; this one has thirty-five. You may have also noticed her calculator displays eight digits while this one displays ten, but these are only superficial differences. There are other more important ones."

"I've got the feeling I'm going to hear about them," Barney said resignedly, heaving himself up on the bench. "But do you think the kid is going to appreciate something to work math with just after getting out of school? I'll bet he'd rather have a portable stereo or TV set."

"If he doesn't appreciate this thing now, he will when he starts to Purdue in the fall and begins four years of studying electronic engineering," Mac promised. "Believe me, this thing can be worth much more than its nine-ounce weight in gold to an engineering student or to any other student seriously involved with math."

"Yeah?" Barney questioned skeptically. "What can it do that Matilda's calculator can't?"

"The one Matilda has is known in the trade as a 'four-banger' because it performs the four basic arithmetic functions: addition, subtraction, multiplication, and division. However it does these with far greater accuracy and speed than is possible with a slide rule and also keeps track of the decimal point. Used in connection with a good set of logarithm and trig tables, it can sharpen the accuracy and shorten the time of performing more complicated functions and would be of great help to any college student.

"But now listen to what this little jewel, the Cadillac of the miniature calculators, can do. In addition to the four arithmetic functions mentioned, it can also extract the square root of a displayed number at the stroke of this key. Separate keys are provided to yield almost instantly the trigonometric functions of sin x, cos x, tan x, arc sin x, arc cos x, and arc tan x. Another key gives the common logarithm of any displayed number, while still another key yields the natural logarithm. This key marked x is used to find e to any power without having to punch in the value of e. This one marked π allows you to punch that constant, correct to ten places, into an equa-

tion with a single key stroke. This 1/x key gives you the reciprocal of any displayed number, and this one (x^y) is used to raise a displayed number to any power within the range of the instrument—all this with an accuracy of 10 significant digits."

"Whew!" Barney gasped. "You weren't just beating your gums when you said that little gadget could do a lot of things. How big a number will it handle?"

"It has a dynamic range of two hundred decades from 10^{-99} to 10^{99}. It displays ten significant digits with the decimal point automatically positioned. Answers larger than 10^{-2} and smaller than 10^{10} are automatically displayed in floating point. Outside this range, numbers are expressed in scientific notation, with the exponent of 10 shown in the extreme right. For example, the answer to an equation yielding Boltzmann's Constant in joule/K°, which is 1.38 x 10^{-23} would display 1.38 on the left and −23 on the right."

"What does this key marked x⇄y do?" Barney asked.

"That brings up another feature of the HP-35. It has a four-register stack plus one storage memory. Let me see if I can explain: suppose we want to multiply 3 by 4. I punch the 3 and 3 appears on the LED display, called register X. Next I punch the Enter key, and the 3 remains displayed but is also entered in unseen storage register Y. Then I punch 4 and 4 appears in register X while 3 disappears from there but remains in register Y. Finally I punch the multiplication key, and any numbers in X and Y are multiplied together and the product appears in register X. Had I punched the key you asked about before punching the multiplication key, contents of the X and Y registers would have swapped places, and we would have seen the 3 again instead of the 4. Being able to do this is a help with some problems."

"How about the other two registers?"

"These are called the Z and T registers. When you punch the Enter key, anything in register X is entered in register Y, anything in register Y moves to register Z, and anything in register Z moves to register T. The key marked R↓ permits 'rolling down' the registers like a rotary desk calendar for viewing what they contain. The CLx key clears any entry in X, while the CLR key clears all registers including memory."

"What do you mean by 'memory'?"

"That is a separate register in which you

can store a constant used repeatedly in a problem you're working with and recall it whenever needed with a single key stroke. A displayed number is entered in the memory by pushing the STO key and is recalled to register X by pushing the RCL key."

"I think I understand," Barney said slowly. "When working with an equation that contains parentheses and brackets, it is often necessary to solve a portion of the problem and then hold that answer until you solve another part to put with it. With the HP-35 you don't have to resort to a scratch pad to do this. You simply poke the partial answer up into the register stack and it drops back into the solution when you need it. Okay; so that leaves only these CH S and E EX keys to be explained."

"The CH S key changes the sign of a displayed number," Mac said. "The E EX key means the next entries after it is punched are exponent digits. CH S must immediately follow E EX for negative exponents. For example, to enter $-.0123 \times 10^{-7}$, you press CH S, .0123, E EX, CH S, and 7 in that order."

"How do they get all those smarts into that little bitty case?"

"With five especially designed MOS/LSI circuits using a new low-power, high-performance ion-implant process. Each is equivalent to 6,000 transistors, making a total of 30,000 transistor functions in a case 5.8" long, 3.2" wide, and tapering from a height of 1.3" at the display end to 0.7" at the other. And don't forget this case that slips easily into your shirt pocket also contains a Ni-Cad rechargeable battery pack that will operate the instrument for at least five hours before it needs recharging from the 5-oz charger furnished with the HP-35."

"How much time can you really save by using it?"

"That's what Hewlett-Packard wanted to know; so they ran a capability study in which engineers proficient in slide rule calculation and also familiar with the operation of the HP-35 worked the same problems on the slide rule and the calculator. In calculating the great circle distance between two points on the earth for which the latitudes and longitudes were given, the time on the HP-35 was 65 seconds with the answer to ten significant figures. On the slide rule it took five minutes to get an answer to four significant figures. In working out the pH of a buffer solution, the calculator again required 65 seconds to get an answer to ten significant digits while the slide rule required five minutes to get an answer to three significant digits.

"But time saved is not the whole story, although it certainly is important to a college student loaded down with heavy assignments in all his subjects. Because of tolerances in manipulation when several settings are involved, repeating a solution on the slide rule rarely produces precisely the same answer. This is not true on the calculator. If you feed in the same information, you get precisely the same answer. And don't overlook the much greater accuracy with the calculator, plus the great advantage of not having to keep track of the decimal point."

"You really are excited about this thing, aren't you?"

"That I am," Mac admitted. "For one thing, I'm glad to see an American company coming out with a really outstanding calculator. I had begun to believe that only the Japanese knew how to make minicalculators. But my enthusiasm goes deeper than that. Man's relationship with numbers has always been a love/hate affair. On the one hand he is fascinated with the mystery and power of numerical calculations, but he dislikes the drudgery of making involved calculations involving large numbers with pencil and paper.

"Down through the ages there have been breakthroughs in freeing him from this drudgery in the way of easily carried calculating aids. First, probably, was the Chinese abacus; then came tables of logarithms; next was the slide rule; and now we have this shirt-pocket computer that can perform all these calculations we've mentioned with lightning speed. Personally, I honestly feel the advent of the HP-35 marks an exciting event in the history of practical engineering."

"Okay, you're not going to get an argument out of me about that," Barney said. "I yield to no man in hating to do long-winded calculations with a pencil. But now the Big Question: How much does it cost?"

"Three hundred and ninety-five dollars, including recharger, soft leather carrying case, a safety travel case of molded plastic that holds both calculator and recharger, and an operating manual. While that's not exactly peanuts, it's only a fraction of what a non-portable desk-top scientific calculator capable of doing the same things would cost."

"I only see one problem," Barney said, sliding from the bench and dusting off the seat of his trousers.

"What's that?"

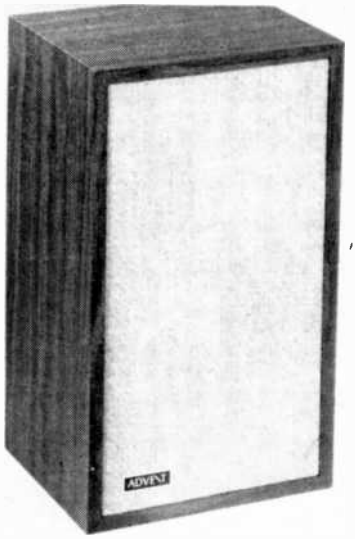
"How are you going to be able to surrender that little jewel to your nephew?"

"That's what's worrying me," Mac admitted as he reached out and patted the little calculator fondly. ◈

We hate to see you go, Joe. Your designs have given us many hilarious moments!

Product Test Reports

THE SMALLER ADVENT LOUDSPEAKER
(A Hirsch-Houck Lab Report)



THE Advent Loudspeaker, a bookshelf-size speaker system with exceptional performance for its price has been joined by a junior partner: the Smaller Advent Loudspeaker. The new system is smaller in size, lighter in weight, lower in price, and virtually identical in performance to its bigger cousin. The Smaller Advent, measuring 20" x 11½" x 9¼" and weighing 27 pounds, is exactly half the volume and 15 pounds lighter than the Advent Loudspeaker. Its impedance has been halved to a nominal 4 ohms, and efficiency is 3 dB less than that of the original Advent speaker system.

The impedance curve, dispersion, frequency response, and general sound quality of the Smaller Advent are identical to those of the Advent Loudspeaker. Its 8½" woofer which has a free-air resonance of 18 Hz resonates at 43 Hz when mounted in the fully sealed enclosure. These resonant frequencies are also shared by the Advent Loudspeaker and some of the most expensive and highly regarded acoustic suspension speaker systems.

The tweeter in the Smaller Advent is a 2" cone type which contains a ¾" dome at its center to provide improved dispersion. The tweeter is identical to the one in the larger system with the exception that its 4-ohm voice coil and lighter magnet structure reduce its efficiency to that of the woofer.

The Smaller Advent system has no level controls since the efficiencies of its two drivers are matched to provide a uniform response. It is intended for use primarily with low-to-medium priced amplifiers and receivers whose power outputs are limited to the 15-29-watt/channel range. Although efficiency is very low (about as low as the least efficient acoustic suspension systems), this is partially offset by the 4-ohm impedance which enables the Smaller Advent to use the maximum power capabilities of an amplifier since most solid-state amplifiers deliver 25-50 percent more power into 4-ohm loads than they do into 8-ohm loads. Furthermore, the Smaller Advent is not designed to fill an auditorium or even an unusually large listening room with sound at the ear-splitting levels favored by some people. It is best suited to normal home use, and although its low-frequency power handling ability has been limited—a necessary step in obtaining the frequency response of a "big" speaker from a small one—it nevertheless can play loud enough to belie its small size.

Test Results. When we measured the frequency response of the Smaller Advent Loudspeaker in our live room, averaging the output of eight microphones, we found it to be exceptionally smooth and uniform,

within ±3 dB from 120 Hz to 13,000 Hz. The output rose slightly at low frequencies, with a maximum in the 60-70-Hz range of about +5 dB. At 32 Hz, it had returned to the midrange level. Obviously, this is remarkable performance for almost any speaker system used in the home, let alone a miniature one.

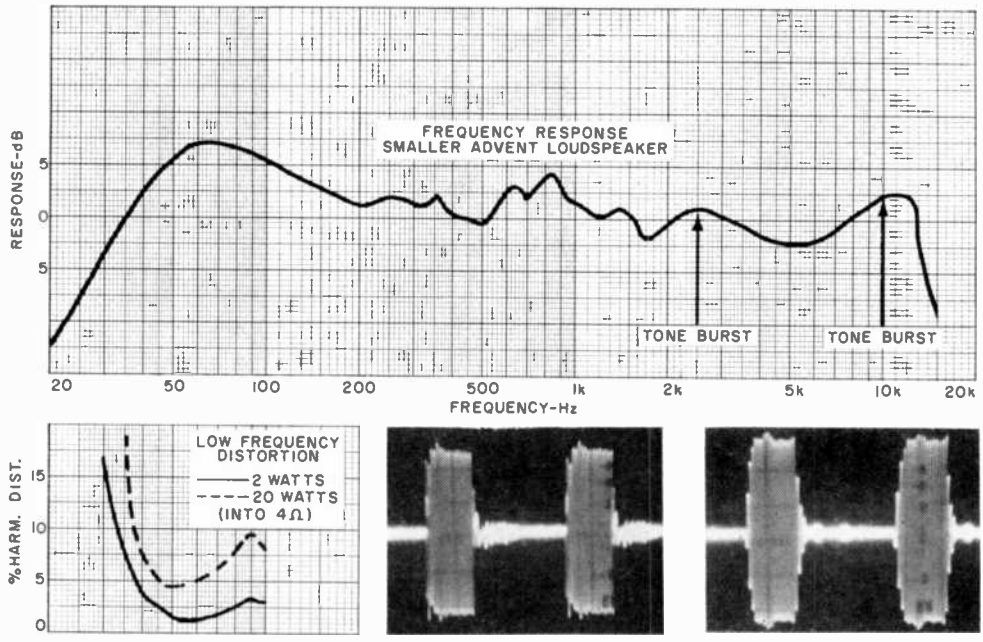
Driving the speaker system at 2 watts (based on the 4-ohm impedance), the low-frequency distortion began to rise below 40 Hz, reaching 5 percent at 38 Hz and 10 percent at 33 Hz. These figures are typical measurements we have made on some very fine acoustic suspension systems which were considerably larger and more costly than the Smaller Advent Loudspeaker. Its restricted power handling ability was evidenced by the considerable increase in distortion when we drove the speaker system at a 20-watt level. However, even under this severe condition, the distortion was only 10 percent at 38 Hz.

The tone-burst response of the Smaller Advent Loudspeaker was very good, displaying no signs of ringing or spurious frequencies in its output. The impedance was 4 ohms at about 100 Hz and between 5000 and 11,000 Hz, rising to 15 ohms at 850 Hz and to between 20 and 25 ohms at about 45 Hz.

Listening Tests. We subjected the Smaller Advent, as we do all speaker systems, to the simulated "live-versus-recorded" test in which its ability to imitate accurately a live musical program can be judged side-by-side with the original sound. It did a very fine job, often so good that we could not hear any difference between the two. Where differences could be heard, they were in the form of a very subtle midrange balance shift and on such instruments as wire brushes where the drop-off in response beyond 13,000 Hz could be detected.

This test also showed that the polar dispersion of the Smaller Advent, though reasonably good, was not enough to sustain its "facsimile" reproduction of the original sound over angles of 45° or more from its axis.

We also did considerable A-B comparing of the Smaller Advent Loudspeaker against several other speaker systems, all far larger and more expensive. To our amazement, the Smaller Advent proved to be just as good as many of them and better than others under practically any listening situa-



At top is shown frequency response curve and points at which tone burst tests were made. Photos of tone burst reproduced are shown above right. Above left is graph of low-frequency distortion of the speaker at 2- and 20-watt levels.

tion we could devise. The Smaller Advent can deliver a room-filling 30-Hz fundamental which must be heard to be believed!

One of the most attractive features of the Smaller Advent Loudspeaker, besides its handsome cabinet, is its price: $69.95.

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SUPEREX MODEL FF-1 HEADPHONES
(A Hirsch-Houck Lab Report)

THE Superex Model FF-1 "Freedom Fone" resembles many headphones which have molded earcups, removable cushioned vinyl ear pads, and a spring-steel headband with vinyl covering. Here, however, is where the resemblance ends since the FF-1 has no external connecting cord!

In the FF-1, one earcup contains a magnetic induction pickup coil whose output drives it and the other earpiece through a built-in battery-powered transistor amplifier. By installing a wire loop around the listening area and passing audio frequency currents through it, the program is heard in the earphones throughout the area enclosed by the loop. The earcup containing the pickup coil has a small knob which provides the user with an on-off/volume control.

The Superex FF-1 phones supplied to us for testing included a demonstration loop consisting of a multi-turn coil approximately 12" in diameter and an amplifier coupler. These items are not manufactured by Superex and are not normally supplied with the FF-1 phones. We made our frequency response measurements with the phones mounted on our microphone coupler

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* Copies of the Audio Engineering Society paper, 'ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS', by Dr. A. G. Bose, are available from the Bose Corp. for fifty cents.

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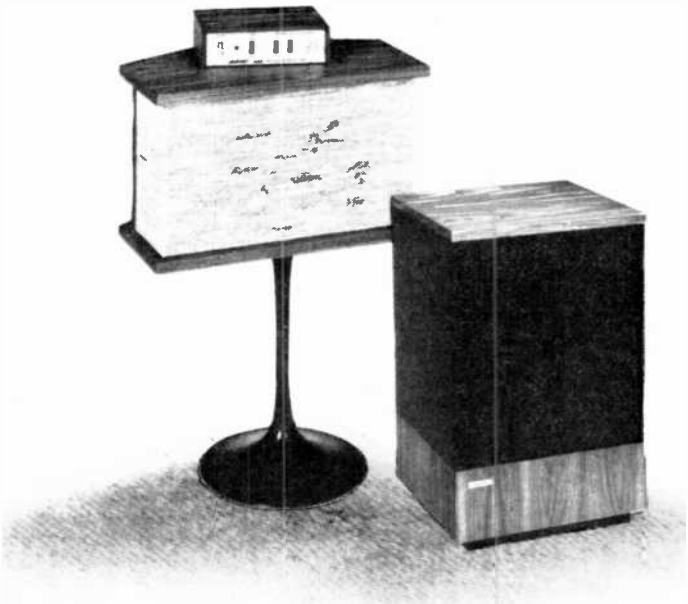

The BOSE 901 and BOSE 501 are covered by patent rights issued and pending.

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and the loop positioned about 18" from the pickup earcup. The demonstrator had a resistor in series with the loop to present a safe load to the amplifier. The driving voltage in our tests was the recommended 3 volts rms.

The acoustic output from the FF-1 phones was quite low—adequate for most purposes, but certainly not for high-level serious music listening. On the other hand, these are monophonic phones, clearly designed for applications outside the usual hi-fi market. The frequency response, with the usual response irregularities associated with a coupler measurement, was relatively uniform from 300 Hz to beyond our microphone's upper limit of 15,000 Hz. However, below 700 Hz, the output fell off at a 6-dB/octave rate and was lost in our ambient noise level below 200 Hz.

Use Tests. To judge the Superex FF-1 phones under more realistic conditions, we mounted a loop of No. 18 zip-cord on the ceiling, covering an area of about 10 feet square. The two conductors were connected in series to form a two-turn loop. An 8-ohm resistor was connected in series with the loop; then the whole was driven from one channel output of a stereo receiver.

The volume level anywhere within the loop was adequate for listening to radio programs. It fell off rapidly outside the loop area. Although there were some directional effects, causing sharp reductions in output under certain conditions of headphone orientation within the loop, these were not troublesome in practice, and the average volume level was essentially constant anywhere within the loop area.

The "thin" bass, which could be inferred from the measured response, was very apparent. Applying bass boost in the amplifier corrected much of this, however. Overall, we would describe the sound as good "AM" quality; in fact, when listening to AM broadcasts, we were not aware of any significant loss or coloration of response. We also tried a single-turn loop and found, as expected, a significant reduction in sound level. The ease of installing a two-conductor wire and connecting it in series to make a two-turn loop is very practical.

One side effect of the inductive coupling system used for the FF-1 phones was the system's susceptibility to ac hum pickup from power wiring. Most of the time, the hum was clearly audible, although it varied somewhat with listening location and headphone orientation.

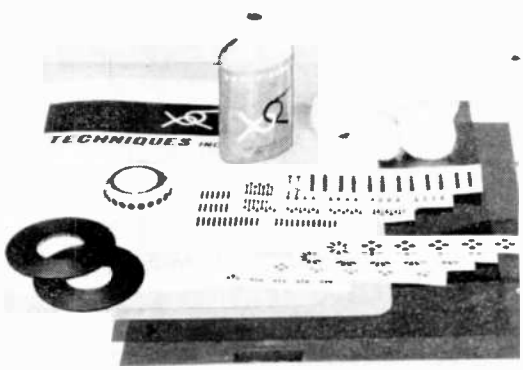
The possible applications of the FF-1 are too numerous to list. For example, one can listen to radio broadcasts or other programs without disturbing others in the listening area and without being distracted by outside noises while still retaining mobility and freedom from trailing cords. The very light 12-ounce weight made the FF-1 phones comfortable, and the ear cushions provided for comfortable wear for extended periods of time. We also found them convenient in communications service with our amateur radio station. In this case, the low-frequency cutoff is a distinct advantage because of the improvement in clarity of CW and SSB reception. The available volume level was also satisfactory for ham use, and any distortion caused by turning up the volume was not significant.

The price of the Freedom Fones is $29.95.

Circle No. 61 on Reader Service Card

TECHNIQUES 5200 NEGATIVE ART KIT

LET'S face it, printed circuit boards have become a way of life for assembling electronic projects at home. We at POPULAR ELECTRONICS Including ELECTRONICS WORLD often have to make the PC boards featured in the construction articles. Consequently, we have more than a nodding acquaintance with most of the commercially available printed circuit kits. Although most such kits—especially the professional or "lab" types—turn out fine examples of PC boards when the instructions are followed to the letter, most boards made at home still do not look like the ones made by commer-



cial processes. Too, if we have to make more than one of the same type board, no two look alike.

In our experience, we have learned that the photosensitive systems which require the preparation of a film negative etching and drilling exposure guide offer the best approach to making PC boards at home with near-commercial quality. This process is neat to perform and fully capable of providing the intricate patterns in modern IC projects. In working with the photosensitive system, the film negative is prepared with the aid of a sheet of transparent Mylar or acetate, paste-down solder pad patterns, and opaque flexible tapes in various narrow widths. Unfortunately, before you can use the negative with most photosensitized boards, it must be reversed to provide a transparent wiring pattern on an opaque black field, an expensive process since the reversing of the negative must be done by a professional photolab.

Now it looks like the negative reversing problem has been licked by Techniques, Inc., who are making available a 1:1 negative artwork kit which can be used directly without going to a photolab. The kit contains an assortment of transistor and IC (both dual-in-line and round) solder pad patterns, edge connector patterns, dots, and tape, all pressure-sensitive stick-ons. Also included are two large sheets of transparent clear Mylar to be used as the base for making the etching guide, two large sheets of presensitized film for making the exposure negative, a bottle of developer, and some cotton balls.

Easy Layout. Working with the kit requires no special training. You start out by laying out the etching guide in the conventional manner, laying down on the Mylar sheet the various solder pad patterns, dots, and tape. This done, you have a positive which is virtually useless to you unless you have a photolab setup or are willing to invest in having it photographically processed at your local photolab. This positive, however, is then used as an exposure mask for making the film exposure negative which will ultimately be used in making the board.

Sandwiching your hand-made negative with the presensitized film supplied, the two are next exposed to a photoflood or ultraviolet light for a short period of time. When the time is up, you separate the sandwich and pour a small puddle of the developer solution onto the sensitized and exposed film.

Using one of the cotton balls supplied, you swirl around the developer until the pattern appears and is sharply in focus without any discontinuances.

After allowing the newly made negative to dry, you are ready to use it to expose any presensitized board, carefully following the instructions supplied with the board. What you will end up with, after the board blank is exposed, etched, and drilled, is a printed circuit board that looks as good as the original positive and the equal of any you could obtain from commercial suppliers.

We used the Techniques 5200 kit to fabricate a readout/decoder board for our frequency counter. The conductor patterns on the board were intricate and as closely spaced as you would expect from a modern digital test instrument; so, it was a severe test to put any PC kit through. Needless to say, the 5200 kit came through with flying colors. Nor could we detect any differences in quality between it and another board made with an exposure negative produced through the expensive photolab route.

Techniques, Inc., has set a suggested retail price of $12.95 for the No. 5200 Negative Art Kit.

Circle No. 62 on Reader Service Card

SIMPSON MODEL 260 SERIES 6 VOM

PHYSICALLY, the new Simpson Electric Co. Model 260 Series 6 volt-ohm-milliammeter bears a close resemblance to the trusty 260 which has served so many electronics users well for so long a time. But there are some basic differences between the old 260 and the new Series 6.

Now, dc voltage ranges go from 0 to 250 mV and 1, 2, 5, 10, 50, 250, 500, and 1000 volts full-scale. Ac voltages go from 2.5 to 1000 volts full-scale. Both ac and dc voltage measuring capability can be extended with the aid of a slip-on probe to yield 5000 volts full-scale. Dc current goes to 50 μA and 1, 10, 100, 500, and 10,000 mA (10 amperes) full-scale. In the resistance mode, the Series 6 has three ranges covering 2k, 200k, and 20 megohms. The scale also has calibration to indicate from —20 to +50 dB in four output ranges.

Sensitivity of the Series 6 is 20,000 ohms/volt in the dc modes and 5000 ohms/volt on ac. Accuracy is ± 2 percent of full scale on dc and ± 3 percent of full scale on ac.

In place of the plastic "bumps" used on the old 260, the Series 6 has four rubber feet which prevent the meter from skidding around on smooth work surfaces. The multipurpose screw-on test leads have a combination of probe and alligator clip test ends for maximum flexibility. To provide more accuracy and greater inherent ruggedness, the meter movement is of the taut-band type. Accidental overloads which could damage an unprotected meter movement are greatly minimized in the Series 6 by a varistor overload protection circuit.

Another welcome feature is the TRANSIT position on the function switch. With the

function switch set to TRANSIT, the meter's pointer movement is damped during its travel, thus preventing G forces from bending the pointer.

User Tests. Having had extensive use (and abuse) of an old Model 260 VOM for more years than this reviewer cares to count, we could honestly judge the performance and flexibility of the Series 6 on a comparison basis. The Series 6 seems to fall into the same reliability slot that its predecessor has established over the years. During our less than gentle comparisons, we noted that the instrument case and meter movement of the Series 6 appear to be more rugged.

The basic Model 260 Series 6 VOM car-

ries a suggested retail price of $65. Several options are available, however. Among them are an antiparallax mirrored scale version (Model 260-6M) at $67; a roll-top safety case version (Model 260-6RT) for $71; and a version with circuit breaker protection (Model 260-6PO) for $97. You can get various combinations of these functions and features as desired. The 5000-volt safety probe sells for $4.50. Finally, there is an assortment of carrying cases from $14 to $20.

Circle No. 63 on Reader Service Card

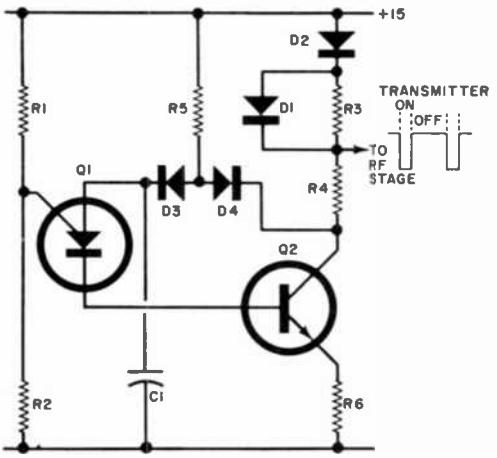
ESTES "TRANSROC" RADIO CONTROLLED TRANSMITTER

RECENTLY, we had the opportunity to build and test the "Transroc" model aircraft and rocket transmitter put out by Estes Industries. Since it was designed to be used in conjunction with a conventional Citizens Band receiver, we were surprised at the compact size of the six-transistor, crystal-controlled transmitter.

The Transroc is no simple little toy meant to be used just by aspiring young scientists. In fact, the transmitter did things that surprised even old model rocketry veterns like us. When properly set up, the Transroc can provide any one of three different modes of operation: first, it is a "beeper" which transmits one beep per second on the CB band—a signal used to locate a downed model aircraft or rocket. Second, it can be used for telemetry by employing some form of signal-to-resistance sensor (photocell, etc.). Finally, used with a microphone, it becomes an under-100-mW AM CB phone rig.

Circuit Design. To give you an idea of

the sophisticated circuit design used in the Transroc, the schematic diagram shows a portion of the modulator—in this configuration, a beeper. For the analysis, start at the collector of *Q2* and assume that this transistor is cut off. In this state, the diode gate consisting of *D3* and *D4* is switched on by the current through *D2*, *R3*, and *R4*. The junction of *D3* and *D4* is supplied with charging current through *R5*. This current builds up a voltage across *C1* and is also supplied to transistor switch *Q1* as one of its inputs. The other input to *Q1* is via voltage divider *R1*/*R2*.



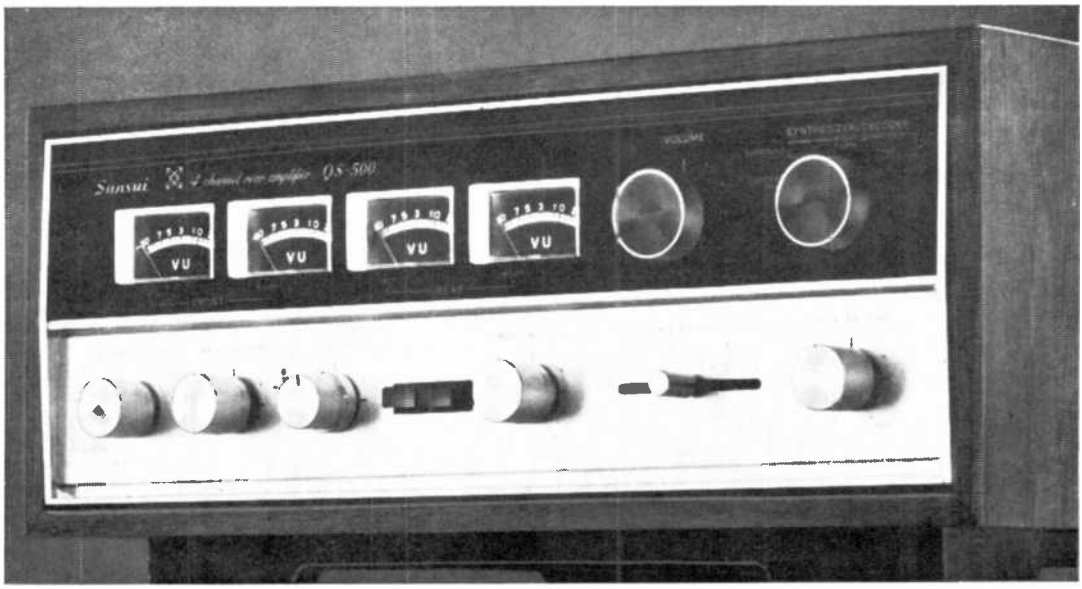
When the anode voltage of *Q1* reaches the level of its gate voltage, *Q1* conducts and *C1* begins to discharge through the transistor, the base-emitter junction of *Q2*, and current-limiting resistor *R6*. The flow of current turns on *Q2*, and the voltage drop at the transistor's collector cuts off the *D3*/*D4* gate. This stops the charging current to *C1*. After a time period approximately one-half as long as was required to charge *C1*, *Q1* automatically resets to the nonconducting state, cutting off *Q2* and allowing the process to repeat as long as power is applied.

The Transroc was tested (in the beeper mode) in a working model aircraft using a conventional CB receiver with a loop antenna. There was no trouble locating the downed aircraft almost a mile away. We listened to similar units operating in the telemetry mode and were surprised at the excellent signals.

Price of the Transroc is $21.95 assembled or $14.95 in kit form.

Circle No. 64 on Reader Service Card

if you go for four channel...



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Buy yourself a miracle for as little as $214.95. That's all it takes to get your conventional two-channel stereo to do anything any total four-channel receiver and control center can do, now or in the future.

The Sansui QS500 and QS100 converters are complete Four-Channel Synthesizer-Decoder-Rear-Amplifier-and-Control-Center combinations that transform standard two-channel stereo totally. The only other equipment you need is another pair of speakers.

You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $289.95.

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $214.95

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Television Scene

By Forest H. Belt

RCA Toes the Color Line

EARLY last fall, newspapers and television, and several consumer magazines, began showing new solid-state color-TV receivers and drumming the slogan, "It's a whole new ball game." The advertiser was RCA, and the occasion was the introduction of the company's 1972 color television line. The "new ball game" slogan tipped prospective color buyers to RCA's new emphasis: solid-state color TV.

Transistor design isn't new to RCA. The company's first transistor (one vacuum-tube high-voltage rectifier) color chassis, the CTC40, appeared three years ago. That chassis was distinguished by a deflection horizontal system using silicon controlled rectifiers (SCR). A more recent version, the CTC44, exchanged the tube rectifier for a solid-state voltage quadrupler; the set could honestly be tagged "all solid state."

RCA color models for 1972 swing decidedly to solid-state technology. In a color line encompassing some 55 models, 37 have solid-state chassis. That's above 65% of the choices available.

The basis for such overwhelming transistorization shows in the name RCA gives its solid-state color line: XL-100. The *X* and *L* stand for *extended life*. That's to cash in on greater reliability and cooler operation of transistors over tubes. The *100* touts 100% solid-state design. Company officials and planners indicate an even stronger blend of solid state in next year's color chassis. Few dispute the likelihood of eventually phasing out tubes altogether, but not by next year.

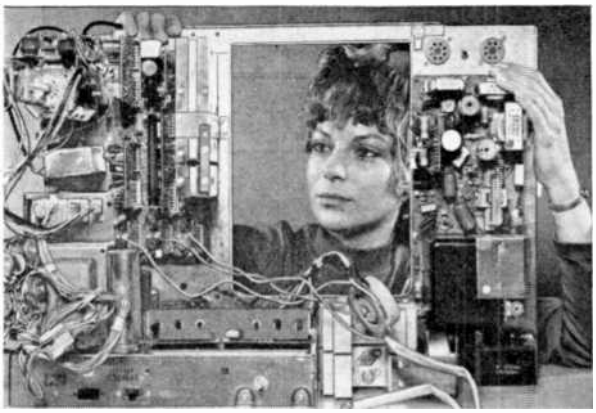
Of other U.S. color-set manufacturers, only Motorola, Sylvania, and Zenith offer fully solid-state models. Each builds one all-transistor chassis, for several cabinet models. RCA boasts three—the CTC46X, the CTC54X, and the CTC59X. However, all three are mostly alike. All use SCR horizontal deflection and a solid-state voltage quadrupler for high voltage. The key differences: the CTC54X carries a Varactor uhf-vhf tuner assembly, and the CTC59X operates the first 110-degree color picture tube.

Transistors outnumber tubes in four of RCA's six hybrid color chassis. The CTC51X, CTC52X, CTC53X, and CTC55X all have 12 tubes and 17 transistors. The CTC39X has 18 tubes and 13 transistors; the CTC50X, 17 tubes and 14 transistors. The accompanying chart shows all nine chassis, what picture-tube sizes they operate with, and other details.

A Plug-In Trend. Ask a service technician what he likes most about this year's RCA solid-state color and he'll probably say, "The modules." What RCA designers did was divide up nearly two-thirds of the chassis circuitry and light components and mount them on twelve phenolic cards. These printed-circuit modules slip into special sockets on the main chassis.

Modules create manufacturing economies, which ultimately reduce costs of solid-state sets. But they also offer repair-bill savings to owners. If a component goes bad in a regular solid-state chassis, diagnosis and replacement is ordinarily a bench job—and expensive. With modules, unless the faulty component is

large and not on a plug-in board, a knowing technician can spot the bad module and simply plug in another. The module costs more than some small part, but the labor saving generally makes replacing a module more economical.



Plug-in circuit cards give look of computer to RCA solid-state color TV.

RCA has no exclusive on plug-in modules. Motorola initiated the idea nearly five years ago in Quasar chassis. Zenith has Dura-Modules. But RCA's modules are unique—more like computer boards. Contacts are extensions of the printed foil along each board's edge.

Three of RCA's twelve plug-in modules are unique in another way; they are ceramic. RCA makes the special ceramic in large sheets. Automatic machinery stamps out substrates and plates them with conductive, resistive, and capacitive layers. Chip transistors, larger capacitances, and connecting strips are added after a protective coating has been applied over the basic "print." Finally, the whole board, except for the plug-in connector foils, is encapsulated.

RCA's three ceramic modules operate as video color drivers. Designers in the ceramic department are working out other circuitry for this special treatment. An encapsulated sound-output module for the CTC46X chassis is imminent.

The ceramic-circuit process doesn't save money *per se*, but properties justify the added cost. Heat-dissipating qualities of the ceramic contribute to reliability of transistors and other components. Size results in another reason. A thin, flat encapsulated video driver module occupies only a fraction of the space of its

HIGHLIGHTS OF RCA COLOR CHASSIS FOR 1972

Chassis	Picture Tube Size	Chassis Type	Number of IC's	Automatic Tint Control	Features
CTC39X	23S, 25S*	Hybrid	1	Yes	Remote control, aft, 75-ohm vhf input
CTC46X	21S, 25S	Solid state	5	Yes	Remote control, ACM, modular plug-ins
CTC50X	20	Hybrid	1	Yes	Remote control, aft, 75-ohm vhf input
CTC51 (X)**	14	Hybrid	2	Yes***	Portable
CTC52 (X)	16	Hybrid	2		Remote control on one button
CTC53 (X)	18	Hybrid	2		Aft
CTC54X	25S	Solid state	5	Yes	Varactor tuning, remote control, ACM, 75-ohm vhf input, modular plug-ins
CTC55 (X)	19	Hybrid	2		75-ohm vhf input
CTC59X	19S(110°)	Solid state	5	Yes	ACM, 75-ohm vhf input, modular plug-ins

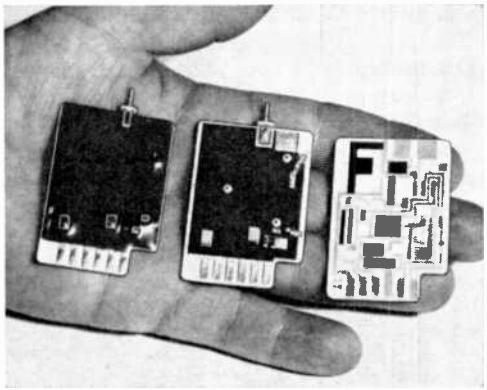
*S-square corner picture tube **(X)-transistor sound output in some models only ***Some models

counterpart with discrete components. Later, RCA expects ceramic modules in quantity will at least compete in cost with conventional construction.

IC's For Size and Cost. Dependability is a word that comes up repeatedly when you discuss the XL-100 line with company officials. Another bit of advanced technology contributes to that goal in 1972 RCA solid-state chassis. To wit: More monolithic integrated circuits are going into RCA solid-state chassis this year than ever before. In both reliability and cost, IC's have advantages over transistors.

The CTC46X, CTC54X, and CTC59X

each employ five integrated circuits. The sound i-f and discriminator circuitry, except for tuned circuits and decoupling networks, comes as one IC. Automatic fine tuning (aft) uses another. Chroma processing takes two IC's: one for chroma bandpass and chroma sync, and another for chroma demodulation. The CTC51X and CTC52X chassis have integrated circuits for the aft and the sound i-f/detector sections.



TV module is (r. to l.) plated, coated (with chips added), and encapsulated.

Company officials hesitate to speculate publicly on which is the trend at RCA —ceramic modules or integrated circuits. Judging by the evidence, I'd say some combination of both seems most likely. Neither one can displace transistors entirely, unless some technological breakthrough endows them with comparable power-handling ability. But don't discount that possibility. Technology hands out new surprises every year.

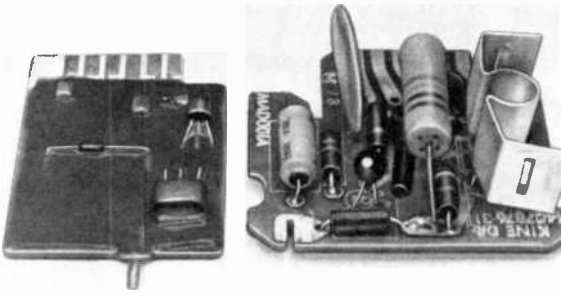
Wide-Angle Screen. Just looking at the picture, you can't tell anything special about RCA models that use the CTC59X chassis. But for the industry, they do represent something new. They use a 19VBLP22 picture tube, a square-corner 19-inch color CRT with 110-degree deflection.

The wider angle of deflection (typical color CRT's have a 90-degree angle) shortens the CRT neck. Cabinet designers move one step closer to the "ultimate" (but seemingly unattainable) picture-frame TV. The slim Model EQ-475 has a front-to-back dimension 20% less than ordinary 19-inch color receivers.

Outside of a special deflection yoke, the CTC59X varies little from the other two

solid-state chassis. No convergence changes were necessary to accommodate wide-angle sweep. Nor is there much change in the SCR horizontal deflection stage—just a few different parts values. The pincushion-correction circuits seem, if anything, simpler in the 110-degree system.

Instant Electronic Tuning. Ask an RCA salesman what's hottest in the line this year and—after solid state—he'll probably tell you the electronic tuning system. Instant Electronic Tuning, the company calls it. One feature is silence; no snap-snap-snap from station to station. Another is speed. Touch the tuning button and a soundless motor whirls a gliding channel switch through all 20 station positions in a couple of seconds.



Encapsulated video color driver requires no heat sink for transistors.

Two Varactor tuners form the heart of Instant Electronic Tuning. Inductors in the vhf tuner are switched by diodes to low or high band. Voltages preset by thumbwheel potentiometers bring the Varactor/inductance tuned circuits in either tuner to the desired channel frequency. Once the switch stops and the channel voltage is applied, automatic fine tuning (aft) takes over and locks the station in precisely.

Five switch positions select vhf channels 2-6. Seven others select 7-13. The remaining eight positions apply voltages to the uhf Varactor tuner, for whatever uhf stations are active locally. The switch turns in either direction. Push the UP button on the front of the color receiver and the noiseless motor slides the switch contacts from low channels toward high. Push the DOWN button, and the motor reverses. The motor is shut off at any active channel

whose thumbwheel potentiometer has been turned away from the "skip" position.

Automatic Everything. From season to season, tuning a color receiver gets easier and easier. Most manufacturers install automatic fine tuning, automatic chroma control (acc), and so on. The newest automatic circuit to gain popularity is automatic tint control (atc). Almost all the 1972 RCA chassis include automatic tint control.

Too, in the solid-state chassis, there's *automatic color monitor,* abbreviated ACM. It's exclusive with RCA. The ACM switch narrows down the range of color and tint controls. At the same time, ACM alters the color demodulation and color output circuits to give flesh tones a softer, warmer color. ACM can be turned on and off remotely or manually.

If you're familiar with older RCA chassis, you may recognize ACM as an advanced version of AccuTint. That was RCA's earlier name for automatic tint control. Six of the nine RCA chassis this year include either the new or the earlier version.

Warranties. In these days of rampant consumerism, it's hardly thorough to discuss a company's products without mentioning warranties. There's no such thing right now as a "standard" warranty, nor do companies implement their guarantees in the same ways. RCA labels its color-set warranty "PS," for Purchaser Satisfaction.

Warranty isn't the same for all models. Solid-state RCA color receivers get a parts *and* labor guarantee for a year. Others are similarly covered, but for only 90 days. You can use any service technician you wish, the warranty says, and RCA will pay his repair bill within those time periods. You have to take a portable to the repair shop; for a console, the home-call charge will be paid.

In any model, the picture tube carries a two-year warranty. But there are hitches. One: RCA's replacement for a defective color picture tube will be "a reliable rebuilt tube." Two: you pay for labor outside the one-year or 90-day limits. (Small parts are guaranteed for a year, but you pay for labor outside the limits designated for labor warranty.)

Those are the highlights of the RCA color line. Just one part of the TV scene. ◈

FOR INVENTIVE PEOPLE ONLY:

If you're the kind of guy who likes to devise his own equipment or the kind who appreciates clever mechanical design, then Mallory do-your-thing products are for you.

They'll let you invent, create, modify, so things work your way. And of course, you'll get famous Mallory quality and performance you can count on too. Get them at your nearby Mallory Distributor.

AUTOMOBILE REMINDER ALARM

Ever leave your lights on? Never again... with solid-state Sonalert®. Its shrill sound warns you, prevents battery drain. Use on turn signals, reverse gear... or any electrical component on your car, truck, boat, tractor. For 6 and 12 volt.

CONTROL YOUR TIME

Use "Easy Time" 24-hour timer. Turns anything you plug into it on and off. Appliances, lights, pumps, motors, humidifiers... you name it. Tough enough to handle 12 amps, 1500 watts.

ON-THE-GO GROOMING

Free yourself from conventional, bulky shaving gear. Handy Shaver . . . it's about the size of a cigarette pack. Hi-speed, quiet, 3-volt motor for fast, no-pull shaving. Comes with Duracell® batteries, mirror cap and tough carrying case. Also available in new sideburn trimmer model.

HIGH INTENSITY NOISE

Compact, purse-size, big-sound Handy Blast... your personal alarm. Use it for anything... boat horn, emergencies, scare muggers, signals, call kids, scouting, bicycling... even cheer your team.

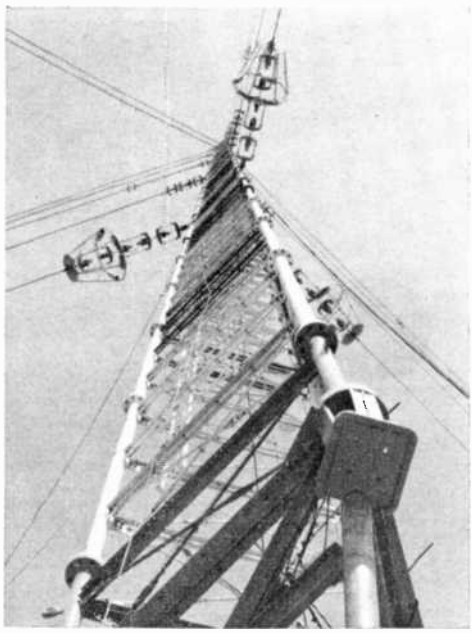
SILENT PROTECTION

Crime Alert®... uses invisible, silent ultrasonic sound-waves. Anything that moves triggers its piercing alarm. Use anywhere... battery or plug in. Accessories to make it total security system.

Hawaii's Tallest Towers

THE tallest man-made structures in the Hawaiian Islands, 1500-foot twin antenna towers, were recently completed at the Lualualei Naval Radio Station on the western side of Oahu. The towers provide the latest link in the U. S. Navy's Communication System.

Designed for the Naval Facilities Engineering Command by Holmes & Narver, Inc., in association with the Systems Development Division of Westinghouse Electric Corp., the towers were fabricated from solid rounds of COR-TEN B steel furnished by U. S. Steel. Each of the two towers is triangular in cross section with 12-foot sides and is guyed at six levels. The legs are solid steel rounds measuring 28½ feet between bolted flange splices. Tower leg loads at the bottom of each tower amount to about 1,200,000 pounds.



The towers are painted with alternate bands of orange and white to provide aircraft warning, though it is said that the steel's use would be enhanced if it were permitted to oxidize and form its own protective coating. ◈

THE DIFFERENCE BETWEEN BEING HEARD AND NOT BEING HEARD

Have you ever received a signal that hits a strong 9 on your S-meter but is completely unintelligible? That's because the signal is poorly modulated. You can have the strongest CB signal going, but with poor modulation you might as well not be transmitting. Don't let it happen to you.

Chances are, the single most effective thing you can do to clear and strengthen your CB signal is to start using a good pre-amplified microphone. If your microphone doesn't do its job, expensive transceivers and antennas are wasted. But with full modulation, even older and weaker transceivers can chop through the hash and noise. A pre-amplified microphone makes it possible to achieve full modulation.

Be heard. Get a pre-amplified microphone. Get the best. Get a Turner. Write for details. Turner Division. Conrac Corporation. 909 Seventeenth Street N.E., Cedar Rapids, Iowa 52402. Telephone (319) 365-0421.

TURNER

DIVISION OF CONRAC CORPORATION

CIRCLE NO. 40 ON READER SERVICE CARD

A super 25V Color TV—new electronic calculator

NEW Heathkit "Computer Tuner" — we've brought new digital technology to FM stereo for the man who knows his music

NEW TO CONSUMER ELECTRONICS — pure digital design philosophy brings you one of the most fascinating and satisfying kits you'll ever build. Plus, a piece of precision audio gear that's already the talk of the stereo world. With the Heathkit AJ-1510 "Computer Tuner" you "keyboard" your FM station frequency and, if the broadcast is receivable, you hear it instantly. Numerical display tubes show your location on the FM spectrum. And the "Computer Tuner" automatically center-tunes for optimum reception! Gone are the knob, slide-rule frequency scale and tuning meter. A digital frequency synthesizer, employing phase-lock-loop techniques, does the tuning — with channel frequency accuracy better than 0.005%. The preassembled varactor FM RF tuning unit (front end) uses field-effect transistors to provide high sensitivity (less than 1.8 uV) and low cross modulation with no overload on strong signal local stations. The familiar mechanically-ganged variable capacitor has been replaced by varicaps (voltage variable capacitance diodes) to provide complete electronic tunability. An inductorless digital frequency discriminator of the pulse counting (averaging) type follows two fixed-tuned five-pole LC IF filters thus eliminating all IF and discriminator adjustments while achieving distortion levels of 0.1%.

THREE TOTALLY DISTINCT PROGRAMMING MODES. Besides the exclusive keyboard tuning, you can select your FM with a sweep/scan mode. Push a button and the synthesizer counts down through the band, stopping at each station of listenable quality, or just stereo stations if you prefer. Or, you can pre-program your favorite frequencies on the computer-type punch cards included with the kit. Up to three cards can be inserted simultaneously behind the hinged front panel with instant access to these stations via A, B, C pushbuttons.

AUDIBLY SUPERIOR PERFORMANCE SPECS. Selectivity and IF rejection are better than 95 dB. Image and spurious rejection are better than 90 dB. Signal-to-noise ratio better than 65 dB, separation better than 40 dB. The 55 ICs, 50 transistors and 50 signal diodes mount on 10 modules with seven plugging into a master board for maximum computer modularity. And that makes assembly even easier. Order your "Computer Tuner" and start enjoying the FM sound that only true digital technology can bring.

Kit AJ-1510, "Computer Tuner" less cabinet, 23 lbs. **539.95***
AJA-1510-1, optional pecan cabinet, 6 lbs. **24.95***

The Heathkit AA-2004 Integrated Amplifier — 200 versatile watts for discrete or matrixed 4-Channel sound, and stereo or mono

AA-2004 puts you right in the middle of the 4-channel excitement — without obsoleting all the stereo gear you already own. It serves up a block-busting 200 watts through four channels, with control versatility that lets you put the power into any format — mono, stereo, matrixed 4-channel, discrete 4-channel.

IMPROVES WHAT YOU ALREADY OWN. Thanks to built-in matrix circuitry that decodes matrixed 4-channel recordings and 4-channel broadcasts, the AA-2004 lets you use your present turntable, tape equipment or tuner. Also, the decoder enhances your present stereo record & tape library, and conventional 2-channel FM broadcasts by feeding the "hidden presence" to rear speaker for an extremely satisfying 4-channel effect.

PUTS YOU AHEAD OF TOMORROW'S DEVELOPMENTS. As discrete 4-channel media becomes more prevalent, the AA-2004 is ready. Four conservatively rated and fully protected amplifiers produce 260 watts into 4 ohms (4x65), 200 watts into 8 ohms (4x50), 120 watts into 16 ohms (4x30). Controls are provided for every source, mode and installation. Amplifier sections are controlled in pairs with one complete stereo system for left & right front speakers and another for left & right rear — so your AA-2004 can be used to power two separate stereo systems if desired. With outputs for both main and remote speaker systems, it can be used to power two 4-channel systems (up to 8 speakers).

PERFORMANCE SPECS YOU'D EXPECT FROM HEATH. Make your own comparison of the AR-2004's impressive specifications: Full power bandwidth on all channels from less than 5 Hz to more than 45 kHz for 0.25% total harmonic distortion. IM distortion less than 0.2%. Damping factor greater than 100. Hum and noise −65 dB for phono, −75 dB for tape and aux.

GOES TOGETHER WITH TRADITIONAL HEATHKIT SIMPLICITY. Plug-in circuit boards and preassembled wiring harnesses reduce point-to-point wiring — make the AA-2004 as much fun to build as it is to use. Get with the 4-channel revolution now. Order your Heathkit AA-2004.

Kit AA-2004, 39 lbs., less cabinet **349.95***
AAA-2004-1, pecan cabinet, 7 lbs. **24.95***

—"Computer Tuner"—4-channel amp

And 350 other exciting projects in the FREE Heathkit Catalog

If you're not already into a Heathkit hobby, what's holding you back? Ask around and you'll find a Heathkit builder who can show you the rewards. You'll pay yourself back for your kitbuilding time with better products. Better in terms of price, value, performance specifications, and self-service features. And the Heathkit line-up is bigger and better than ever. Including color TV, stereo/hi-fi, electronic organs, home appliances, engine tune-up tools, radio control, shortwave, marine gear, instruments, hundreds more. They are all in the free '72 Heathkit Catalog. Send for yours now.

NEW Heathkit Electronic Desk-Top Calculator — full-function, 8-digit readout for a low, low kit price

Approximately eight enjoyable hours of your time can give you that calculator you've been wanting for home or office — at a price substantially below any assembled unit with comparable features. The new Heathkit 2008 Electronic Calculator handles addition, subtraction, multiplication and division with up to eight-figure totals displayed on extra-bright ½" seven-segment readout tubes. The 2008 accepts both positive and negative numbers. Solves problems in either constant or chain operations. Simply push the K (constant) key and multiply or divide by one preselected number, release the key and you can work a series of multiple-operation problems with the Calculator automatically displaying running sub-totals with each step.

FOOLPROOF CREDIT BALANCER. The IC-2008 automatically displays a minus result to make credit balancing as easy as keying in the credit and debit columns in any sequence. Touch the total key and you have the result with no need to manually sub-total. You can balance the family checkbook in minutes! A thumbwheel sets the decimal in any one of seven fixed positions, or you can select the floating mode for decimal totals carried out to completion. A ninth readout tube at the left of the display indicates plus or minus overflow, as well as a minus sign for negative results. A partial clearing key allows you to remove the last entry from the circuitry while preserving the rest of the problem.

DEPENDABLE AMERICAN-MADE LARGE SCALE INTEGRATED CIRCUIT is the "brain" of the Heathkit IC-2008 Calculator. Components mount on two roomy circuit boards for quick, neat construction. And you can wire your IC-2008 for either 120 or 240 VAC operation. Figure it out for yourself — the Heathkit IC-2008 is a great kit-form value. Take advantage of it today.

Kit IC-2008, 11 lbs. 129.95*

NEW Heathkit GR-900 25 V Color TV — the most technically advanced set we've ever offered

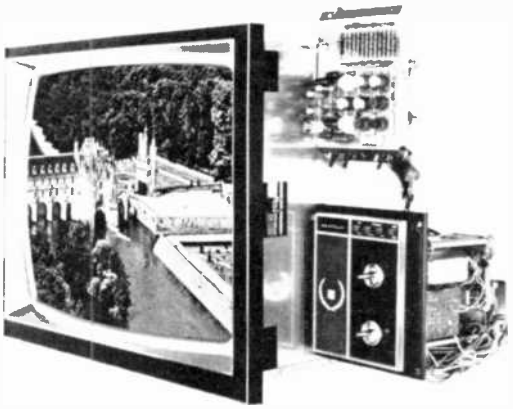
13 SUB-KITS SIMPLIFY ASSEMBLY — and take you from the first circuit board through final alignment. The result is the largest color picture you can buy anywhere, with a complement of convenience controls found only on the world's most expensive receivers. A soldering iron and a few conventional hand tools are all you need to get your GR-900 together. We supply everything else.

UHF/VHF DETENT POWER TUNING — heads up the impressive list of GR-900 features. Push a button and you scan either UHF or VHF channels, in either direction, with detent action locking in on the 12 VHF and any 12 preselected UHF channels.

NEW VOLTAGE-CONTROLLED VARACTOR UHF TUNER and a newly designed VHF tuner with MOS field effect transistor contribute to better fringe-area reception and increased sensitivity. A new angular tint control for "normal" or "wide angle" color demodulation minimizes tint and flesh tone change when you switch channels or when programs change. And check this list of deluxe features. "Instant on" with override; automatic fine tuning; adjustable tone control; stereo/hi-fi audio output; automatic chroma control; adjustable video peaking; adjustable noise limiting; gated AGC; illuminated channel identification. For total armchair control, there's even an optional wireless remote control.

EXCLUSIVE HEATH MTX-5 ULTRA-RECTANGULAR BRIGHT TUBE measures a full 25 inch diagonal, 315 sq. in. viewing area — has a specially etched face plate to cut glare, with each color dot projected against solid black background for extra crispness.

STATE-OF-THE-ART RELIABILITY. The modular solid-state design utilizes 46 plug-in transistors, 57 diodes, and four ICs, with the majority of the circuitry on plug-in boards. The built-in dot generator and tilt-out convergence panel are periodic adjustment aids you'll find only on Heathkit sets. And further, a built-in volt-ohm meter and simplified troubleshooting section in the manual permit self-servicing should the need ever arise. The '72



Catalog lists four beautiful cabinets for the GR-900, plus the exciting new Custom Wall Mount that allows you to build the set into a wall. Brighten your life with Heathkit solid-state color entertainment. Order your GR-900 now and know the pride of building and owning the best.

Kit GR-900, TV less cabinet, 125 lbs. 599.95*

Kit GRA-900-6 wireless remote control, 6 lbs. 79.95*

See them all at your Heathkit Electronic Center...or fill out the coupon below

HEATHKIT ELECTRONIC CENTERS — **ARIZ: Phoenix,** 2727 W. Indian School Rd.; **CALIF.: Anaheim,** 330 E. Ball Rd.; **El Cerrito,** 6000 Potrero Ave.; **Los Angeles,** 2309 S. Flower St.; **Pomona,** 1555 Orange Grove Av. N.; **Redwood City,** 2001 Middlefield Rd.; **San Diego (La Mesa),** 8363 Center Dr.; **Woodland Hills,** 22504 Ventura Blvd.; **COLO.: Denver,** 5940 W. 38th Ave.; **FLA.: Miami (Hialeah),** 4705 W. 16th Ave.; **GA.: Atlanta,** 5285 Roswell Rd.; **ILL.: Chicago,** 3462-66 W. Devon Ave.; **Downers Grove,** 224 Ogden Ave.; **KANSAS: Kansas City (Mission),** 5960 Lamar Ave.; **MD.: Rockville,** 5542 Nicholson Lane; **MASS.: Boston (Wellesley),** 165 Worcester St.; **MICH.: Detroit,** 18645 E. Eight Mile Rd. & 18149 E. Eight Mile Rd.; **MINN.: Minneapolis (Hopkins),** 101 Shady Oak Rd.; **MO.: St. Louis,** 9296 Gravois Ave.; **N.J.: Fair Lawn,** 35-07 Broadway (Rte. 4); **N.Y.: Buffalo (Amherst),** 3476 Sheridan Dr.; **New York,** 35 W. 45th St.; **Jericho,** L.I., 15 Jericho Turnpike; **Rochester,** Long Ridge Plaza; **OHIO: Cincinnati (Woodlawn),** 10133 Springfield Pike; **Cleveland,** 5444 Pearl Rd.; **PA.: Philadelphia,** 6318 Roosevelt Blvd.; **Pittsburgh,** 3482 Wm. Penn Hwy.; **TEXAS: Dallas,** 2715 Ross Ave.; **Houston,** 3705 Westheimer; **WASH.: Seattle,** 2221 Third Ave.; **WIS.: Milwaukee,** 5215 Fond du Lac.

HEATHKIT Schlumberger

HEATH COMPANY, Dept. 10-5
Benton Harbor, Michigan 49022

☐ Please send FREE Heathkit Catalog.

☐ Enclosed is $ _____ — —, plus shipping.

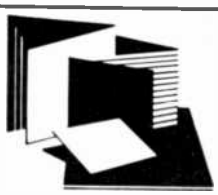
Please send model(s)_____

Name_____

City_____ State_____ Zip_____

Prices & specifications subject to change without notice.
*Mail order prices; F.O.B. factory. CL-433R

CIRCLE NO. 17 ON READER SERVICE CARD



New Literature

BEYER DYNAMIC MICROPHONE BROCHURES

Three brochures available from *Revox Corp.* describe the Beyer Dynamic line of microphones and headphones for hi-fi use. The first brochure discusses why a flat response curve is not necessarily desirable in obtaining good performance from headphones and includes listings for three popular Beyer headphone models. "Supermikes for Superstars," the second brochure, lists and describes microphones, stands, and accessories; while the last brochure includes both mike and phone lines. Address: Revox, 155 Michael Dr., Syosset, NY 11791.

NORTH ELECTRIC POWER SUPPLY CATALOG

Standardized Modular Power Supplies, ranging from 3.7 to 150 volts dc output, are described in detail in a newly revised 16-page catalog available from *North Electric.* Included are listings for racks, panels, meter combinations, over-voltage crowbar, and other optional accessories with complete dimensions, specifications, and prices. Address: North Electric Co., Portland Way North, Galion, OH 44833.

EDI COLOR TV REPLACEMENTS

A new 4-page catalog on solid-state replacement and renewal parts for color TV receivers is being offered by *Electronic Devices, Inc.* Listed are solid-state "Solid-Tube" high-voltage rectifiers, focus rectifiers, and damping diodes; silicon and selenium focus cartridges; and tripler and quadrupler voltage multipliers. Provided also are diagrams showing dimensions and socket connections for Solid-Tube replacements for vacuum tubes with maximum ratings for pulse rectifier service. Address: Electronic Devices, Inc., 21 Gray Oaks Ave., Yonkers, NY 10710.

EDMUND SCIENTIFIC CATALOG

Just off the press, the latest 1972 catalog put out by *Edmund Scientific Co.* details thousands of hard-to-find bargains in optical and scientific equipment. As with past issues, Catalog No. 722 has something for everyone—such as pollution testing equipment, lasers and accessories, the world's largest collection of unique lighting products, a dry ice maker, and a new low-cost Colorimeter. Among the new

additions are adjustable ear muff hearing protectors for fighting noise pollution and a see-through flashlight that puts a beam of light along your line of sight for seeing into places like gun barrels, pipes, sockets, etc. Address: Edmund Scientific Co., 380 Edscorp Bldg., Barrington, NJ 08007.

LASER EYE PROTECTION BOOKLET

Users of laser systems and devices must now have an understanding of proper laser eye protection as a result of new legislation. *American Optical Corp.* has prepared a booklet which describes a complete line of eye protection items for laser users. Address: American Optical Corp., Dept. 4506, Southbridge, MA 01550.

XCELITE PROFESSIONAL HAND TOOLS

The newest color-illustrated catalog, No. 171, available from *Xcelite* lists a number of items which have become standards with electronics engineers, technicians, and hobbyists. Listed and described in detail are slotted, Frearson, Allen, clutch-head, and Scrolux screwdrivers, nutdrivers, pliers, cutters, snips, Seizers, wrenches, and a belt-type tool holster. Also included are complete tool sets—from offset ratchet drivers, pocket rolls, and mini convertible drivers to a truly remarkable technician/serviceman's & field engineer's tool kit. Address: Xcelite Inc., Orchard Park, NY 14127.

TUNER REPLACEMENT GUIDE & PARTS CATALOG

PTS Electronics, Inc., is making available for $1 (redeemable with the first order placed) their latest "Tuner Replacement Guide and Parts Catalog." The catalog shows blow-up photos and exploded-view diagrams of all types of vhf and uhf TV and FM tuners. A replacement guide for antenna coils and shafts is also provided. More than 600 exact-replacement tuners are listed under their original manufacturer numbers for easy exchange. Address: PST Electronics, Inc., Box 272, 5233 Hwy. 37, Bloomington, IN 47401.

B&F ENTERPRISES CATALOG

The new *B&F Enterprises* catalog has been given a face-lifting; it now has an 8½" x 11" format. It features such diverse offerings as magnetic-core computer memories, a navigator's pocket chronometer watch, a 150X microprojection lens, and a wide assortment of solid-state devices including diodes, transistors, LED 7-segment readouts, and both digital and analog IC's. As usual, there are listings for wide assortments of resistors, capacitors, trimmer controls, and panel indicators. This edition also lists a digital electronic calculator (also in kit form), a digital electronic clock kit, and a hybrid audio amplifier module kit. Address: B & F Enterprises, P.O. Box 44, Hathorne, MA 01937.

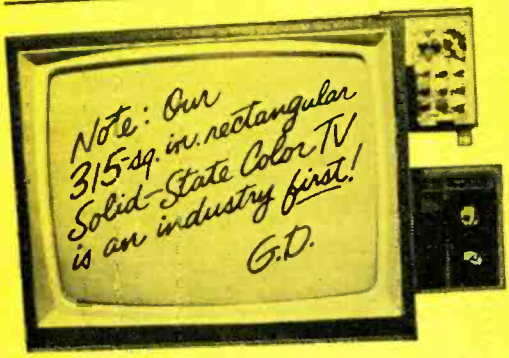
BELL & HOWELL TECHNICAL REPORT

Subject: New Home Entertainment Electronics Systems Program

Competitive Advantages:

- Features first Solid-State Color TV (315-square inch, rectangular screen) Kit for at-home training to build, keep.
- Helps prepare recipient for Color TV Service Business of his own. Covers solid-state circuitry in depth--also other Home Entertainment equipment. Fully updated.
- Provides three additional professional quality kits to assemble, keep, use.

COMPONENTS:



Specifications:

New 25" diagonal, ultra rectangular screen. 315-sq. inch viewing area. 25,000 volt, solid-state design, w/ 45 transistors, 55 diodes, 2 silicon rectifiers. 4 advanced IC's w/46 transistors, 21 diodes. 2 tubes: picture and high voltage rectifier. Solid-State VHF and UHF tuners. 3-stage solid-state IF. AFT standard. VHF power tuning. Also: "Instant On" circuit, automatic color control, noise limiter.

Descriptive analysis:

Modular plug-in circuit board design provides for more than 100 advanced solid-state devices. Insures premium color, sound control, exceptional reliability, easy access. Includes Hi-Fi amplifier for sound output, built-in dot generator, tilt-out convergence panel. Handy Volt-Ohm meter permits initial set-up and adjustment plus detailed trouble-shooting. 315-sq. inch picture tube face transmits entire image. Push button channel advance. AFT module brings in perfect picture, sound automatically. Easier to service than older, non solid-state sets. Quality components throughout.

Electro-Lab-at-Home: Components included:

The Electro-Lab® consists of three units, arriving in 16 shipments which recipient assembles, keeps. All components are professional quality. The circuit DESIGN CONSOLE contains built-in power supply, test light, speaker. Patented Modular Connectors permit plug-in to console to rapidly "bread-board" many different circuits. No soldering or messy un-soldering necessary.

The portable 5-inch, wide-band OSCILLOSCOPE is calibrated for peak-to-peak voltage and time measurements... offers 3-way jacks to handle test leads, wires, plugs. Images on screen are bright, sharp.

The lightweight TRANSISTORIZED METER combines most desired features of a vacuum-tube voltmeter and a high-quality multimeter. Features a highly sensitive, 4-inch, jewel-bearing d'Arsonval meter movement. Registers current, voltage and resistance on large, easily read dial. CONSENSUS: first class gear.

Program is designed to give:

- Understanding of electronic circuits in most home entertainment electronic systems
- Ability to analyze and trouble-shoot a wide variety of advanced solid-state and other TV circuits
- Capability to understand and use test equipment and procedures with special emphasis on TV testing
- Ability to assemble, test and adjust the solid-state TV kit included with the program

MAIL CARD TODAY FOR ALL THE FACTS
No Postage Needed

Color TV is going Solid-State—here's how to help yourself get ready for it:

There's nothing else like this exciting new program that offers the *first* 315-sq. inch Solid-State Color TV available for at-home training.

As you follow the simple, step-by-step assembly and testing procedures, you will soon become thoroughly familiar with the most advanced solid-state TV circuitry. And you'll help prepare yourself for a profitable Color TV service business of your own—either full or part time.

Why Color TV pays better.

Today, Color TV is the big seller. And tomorrow, when it goes all solid-state, the man who has mastered this circuitry, will be in demand. This, of course, is where the money is going to be made.

But, this new Bell & Howell Schools program will also give you the in-depth knowledge of the basics as well as TV circuit analysis. You'll get the theory and practical experience you need to handle radios, Hi-Fi's, stereos, tape recorders, B & W television as well as most other home entertainment electronic devices.

Build, keep your own 25″ diagonal Solid-State Color TV Set

Whether you are a beginner, an experienced hobbyist, or a pro working in the field, you are going to be delighted with the performance you get from this new solid-state kit. So proud, you'll want to show it off to your relatives and friends.

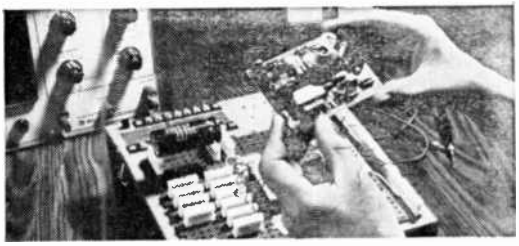
The "specs" at left give a few of the facts. But there are many, many features besides these which you will not find in any set on the market today. Send for all the facts and this is the one you'll want.

You're ready for many kinds of Home Entertainment Equipment

This is a thorough-going program, put together by professionals, with completely up-dated components and materials. When you have completed it, you'll have a new kind of confidence in your ability to tackle almost anything related to electronics in the home. And I can assure that these devices are definitely on the increase!

In addition, you'll have the kind of sound technical background you need for either a career as a technician in the Electronics industry or a business of your own—either full or part time.

Note: TV picture is simulated.



CONSIDER THESE ADVANTAGES:

Bell & Howell Schools' Electro-Lab-at-Home Plan gives you the most thorough background possible in solid-state Color TV. Everything comes to you by mail. No traveling. You go at your own speed and never miss a paycheck!

When you have completed your program our **Lifetime National Placement Service** will help you locate in an area that interests you. This service is available at any time—now or in the future.

Approved for G.I. Benefits.

Our programs are approved for Veterans' Benefits. If you're a Vet, check the space in the card for full details.

Student Loans now available

If you are a non-veteran and need financial assistance, you may qualify for Student Loans, which are also available.

Special Help Sessions.

These are scheduled regularly (Saturdays) at seven Bell & Howell Schools and in many other cities. Here you can get expert guidance by top instructors to help you over any rough spots.

Bell & Howell Schools offer you even more. Once you have finished your program at home, you may decide you want more advanced preparation. In this case, you can earn transfer credits to any one of our seven schools which are located all across the country.

Mail the postage-free card today for all the facts. There is no cost or obligation of any kind.

DeVRY INSTITUTE OF TECHNOLOGY
ONE OF THE
BELL & HOWELL SCHOOLS

(TV kit is not available in Canada)

FREE! MAIL CARD TODAY FOR ALL THE FACTS
No Postage Needed

322

New Products

ARROW WIRE & CABLE STAPLERS

A gun tacker and stapler to accommodate every diameter of wire and cable up to ½" made by *Arrow Fastener Co., Inc* can be obtained through dealers. Three models of tackers are available. The Model T18 is for wires up to 3/16" diameter; T25 is for wires up to ¼" diameter; and T-75 is for wires and cables up to ½" diameter. Typical uses for the T-18 and T-25 are fastening bell, telephone, intercom, and other low-voltage wires to walls and moldings.

Circle No. 65 on Reader Service Card

HEATHKIT STEREO FM COMPUTER TUNER

Heathkit's new Model AJ-1510 stereo "computer tuner" is easily the ultimate in FM tuners available in kit form. It's loaded with IC's, transistors, and signal diodes, all arranged on 10 computer modules, seven of which plug into

a master board. Tuning frequency, derived from a digital frequency synthesizer employing phase-locked loop techniques to achieve tuning accuracies of better than 0.005%, is displayed on four 7-segment Numitrons. Tuning is accomplished by punching in the frequency of the station desired via a 10-button panel; by operating a sweep/scan switch; or by using any one of three buttons for activating the appropriate builder-punched computer memory card.

Circle No. 66 on Reader Service Card

SONY THREE-HEAD STEREO TAPE DECK

The new *Sony/Superscope* Model TC-353-D stereo tape deck features a three-head design which provides improved record and playback performance. The use of separate record and playback heads allows instantaneous comparison of the recorded tape and the program source. Dual concentric level controls regulate the record level of the microphone and line inputs. Both line and mike inputs can be mixed and source material recorded simultaneously. The three-speed deck has such features as a record equalization selector, a non-magnetizing record head, pause control with lock, tape counter, built-in reel locks, automatic shut-off, record interlock, and sound-on-sound with an optional Sony MX-6S mixer.

Circle No. 67 on Reader Service Card

LEL DYNAMIC TESTER

One might easily be tricked into asking just what is the *Lee Electronic Labs* Serviset Model E-C tester? Actually, a more appropriate question to ask is: What *isn't* this tester? The Serviset can be used for voltage tests (0-20,000 volts), signal injection tests in both a-f and r-f equipment, signal tracing in both a-f and r-f equipment, testing of all discrete components including transistors and diodes, and a host of other things. So, if you want to know what the Serviset is and what it can do, we suggest that you send for more information.

Circle No. 68 on Reader Service Card

TURNER CB MICROPHONE FOR SSB

A solid-state amplified dynamic microphone designed for use with single-sideband and solid-state CB transceivers has been announced by *Turner*. Dubbed the "Sidekick 100," it uses

an IC amplifier to provide a perfect impedance match with all transistorized and AM SSB transceivers. Its dynamic acoustic cartridge supplies the fidelity required for SSB transmission. Additionally, the dynamic interior is extremely rugged and is unaffected by temperature and humidity conditions. The adjustable volume control provides gains of up to 40 dB. The Sidekick 100 is adaptable to either relay or electronic switching, uses an easily replaced standard 9-volt battery, and comes with a push-to-talk bar with locking switch.

Circle No. 69 on Reader Service Card

RUSSOUND TAPE RECORDER SELECTOR

The Model TMS-1 Tape Recorder Selector Switch made by *Russound/FMP, Inc.*, fulfills the need for a convenient interconnect system where more than one tape recorder is used. It is designed to be connected into the tape monitor system of a stereo preamplifier or receiver, multiplying its function to include input and putput connections for three tape recorders. Switching functions are provided for independent selection of input, output, and multiple mixing between units. A two-position selector switch permits either the source recorders or the duplicating machines to be monitored, providing convenient cueing and auditioning.

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KENWOOD DOLBYIZED STEREO CASSETTE DECK

The newest addition to the *Kenwood Electronics, Inc.*, line of tape decks is the Model KX-700 stereo cassette deck featuring a Dolby Noise Reduction System which provides approximately a 10-dB improvement in signal-to-noise ratio. Features include an extremely hard super-ferrite record/play tape head with a virtually wearproof head gap, a pushbutton tape selector for optimizing the bias for different tape formulations, and FET's in the first preamplifier stages for low distortion and high signal-to-noise figures. With the Dolby circuits switched in, S/N is 55 dB for regular and 58 dB for chromium-dioxide tapes.

Circle No. 71 on Reader Service Card

LAFAYETTE 3-CHANNEL CB WALKIE-TALKIE

The Dyna-Com 3B, a switchable 3-channel crystal-controlled 3-watt walkie-talkie available from *Lafayette Radio Electronics* features a mike/speaker jack which permits use of an optional microphone while the unit is shoulder or belt carried. Internal features include all solid-state circuitry, TVI trap, and lightning protection. External features include an r-f/S meter, variable squelch and volume controls, and a PA switch. A mechanical filter is used to provide sharp selectivity, while the superheterodyne receiver design provides a 1-μV sensitivity.

Circle No. 72 on Reader Service Cord

Electronics Library

TRANSISTOR SPECIFICATIONS MANUAL, Fifth Edition

For each bipolar transistor described in this Manual, there are entries for polarity (npn or pnp), maximum applied voltages, power dissipation, collector current, operating frequency, collector cutoff current, and dc gain. A separate listing of r-f power transistors includes design frequency, power output, power gain, and collector efficiency in addition to most other information. All EIA-registered TO case outlines are shown and, where a nonstandard case is used, a dimensioned drawing is provided in a separate section.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 160 pages. $4.50.

INTRODUCTION TO ELECTRICITY

by L.T. Agger

A comprehensive introduction to electrical science, this book is designed to meet the requirements of courses for electrician license preparation. In the general treatment of electrical science, physical explanations are widely used, and the mathematical standard is set no higher than is strictly necessary. A graded set of questions is appended to each chapter.

Published by Oxford University Press, 200 Madison Ave., New York, NY 10016. Hard cover. 451 pages. $20.50.

WIRING THE WORLD

Presenting a history of the growth of cable television and government regulation of the medium, the text includes a description of how CATV works, an analysis of programming, and the advantages and disadvantages compared to broadcast TV. The book also informs the reader about picture telephones, videocassettes, and uses of communication satellites. A feature is an interview with Dr. Whitehead, director of the White House Office of Telecommunications Policy.

Published by Book Division, U.S. News & World Report, 2300 N St., N.W., Washington, DC 20037. Soft cover. 207 pages. $2.95 (plus 23¢ postage); quantity orders available at reduced cost.

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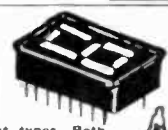

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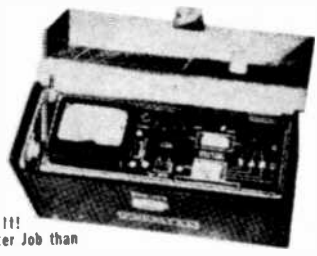

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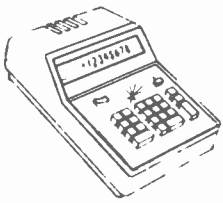

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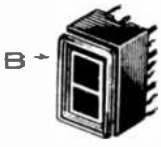
7 SEGMENT READOUTS

A



B

7 Segment Readouts. Two types are available, a large size model with wire leads for P.C. Board Mounting illustrated at (A) and a small size low-current version in a Dual In-Line type package for miniature battery operated instruments illustrated at (B).

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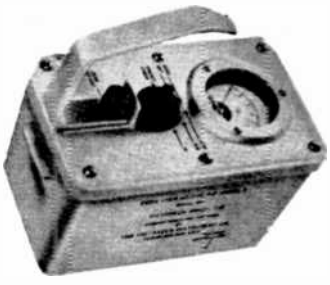

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READER SERVICE NO.	ADVERTISER	PAGE NO.
1	Allied Radio Shack	67
2	Allied Radio Shack	79
3	B & F. Enterprises	103
	Bell & Howell Schools	90, 91, 92, 93
4	Bese	65
	Burstein-Applebee Co.	80
	CREI, A Division of the McGraw-Hill Continuing Education Company	72, 73, 74, 75
5	Center for Technical Development, Inc., The	23
6	Cleveland Institute of Electronics	18, 19, 20, 21
7	Cobra Communications, Dynascan Corporation	11
8	Datak Corporation, The	96
9	Delta Electronics Co.	101
10	Delta Products, Inc.	13
11	EICO	96
12	Edmund Scientific Co	108
45	EI Instruments, Inc.	69
13	Electro-Voice, Inc.	14
14	GC Electronics	94
	Grantham School of Engineering	7
15	Greenlee Tool Co.	79
16	Gregory Electronics Corp.	106
17	Heath Company	86, 87
47	ICS School of Electronics	8, 9
18	Jermyn	70
19	Lafayette Radio Electronics	77
20	Liberty Electronics, Inc.	101
21	McIntosh Laboratory Inc.	81
22	Magitran Company, The	70
23	Mallory Distributor Products Company	82, 83
	National Radio Institute	SECOND COVER, 1, 2, 3
	National Technical Schools	54, 55, 56, 57
24	Nortronics Company, Inc.	61
25	Olson Electronics	84
26	PTS Electronics, Inc.	88
27	Pickering & Co., Inc	63
28	Poly Paks	99
	RCA Institutes	36, 37, 38 39
46	S B E	77
29	Sams & Co., Inc., Howard W.	17
30	Sansui Electronics Corp.	71
31	Shure Brothers Inc.	FOURTH COVER
32	Solid State Sales	105
33	Sonar Radio Corp.	81
34	Sony Corporation of America	97
35	Stanton Magnetics, Inc.	16
36	TDK Electronics Corp.	89
37	Tab Books	95
38	Techni-Tool, Inc.	84
39	Tri-Star Corporation	80
40	Turner Division, Conrac Corporation	85
	U.S. Air Force Recruiting Service	15
41	United Audio Products, Inc.	22
42	Utah Electronics Division	78
43	Valparaiso Technical Institute	88
44	Xcelite Inc.	59
	CLASSIFIED ADVERTISING	98, 100, 101, 102, 104, 105, 106, 107

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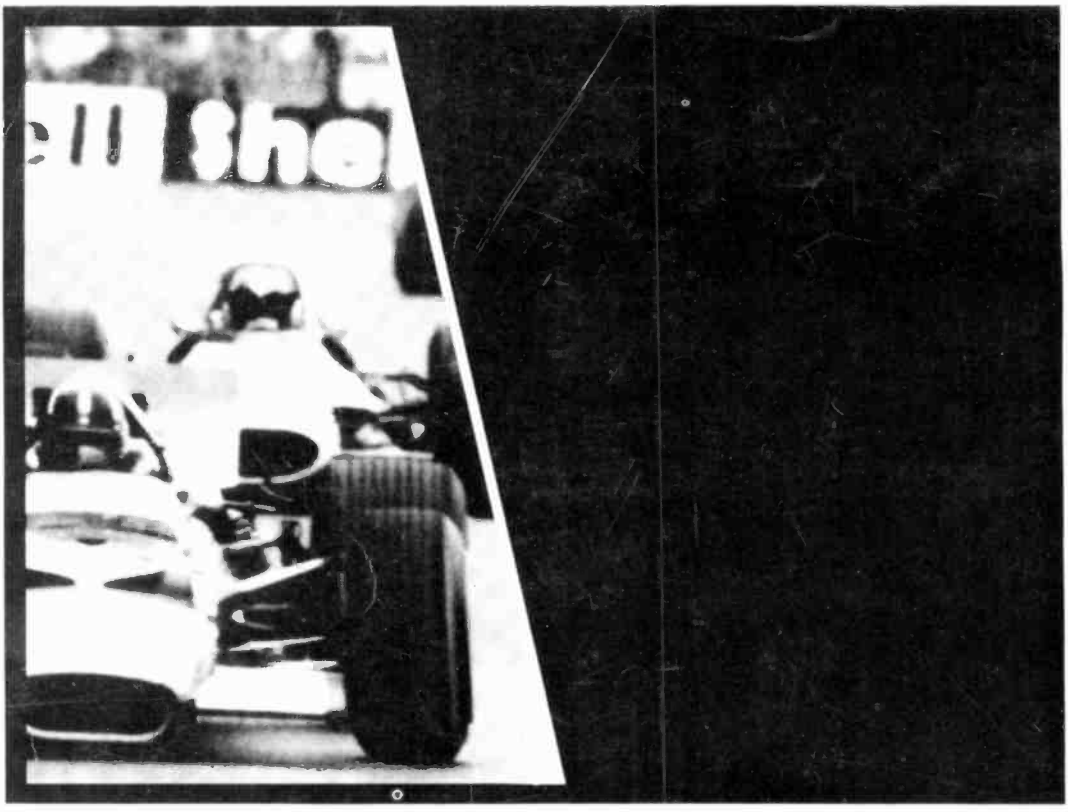

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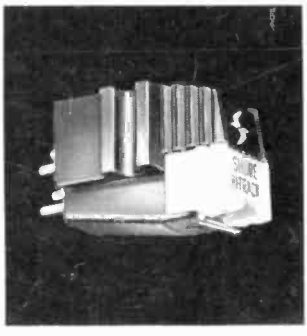

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