Stereo Review's

# TAPE RECORDING & BUYING GUIDE 1973

SUMMER EDITION • $1.50

## SHOPPER'S GUIDE TO TAPE RECORDERS

Directory of all
4-CHANNEL COMPONENTS

TAPING POP MUSIC IN 4-CHANNEL

FOUR CHANNEL—A PROGRESS REPORT

Test Report...
CHROMIUM-DIOXIDE vs FERRIC-OXIDE TAPES

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Stereo Review's

# TAPE RECORDING & BUYING GUIDE 1973

SUMMER EDITION

## FEATURES



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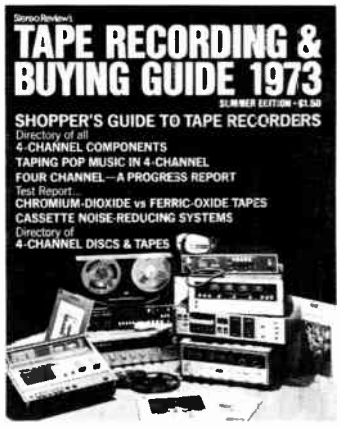


**Cover Photo: Bruce Pendleton**

**COVER PHOTO shows (from left): Akai's GXC-46D stereo tape deck; Braun's TG1000/2 reel-to-reel tape recorder; Lafayette's LR-4000 4-channel SQ receiver (center); right (top to bottom): Lamb 220 Dolby-B noise-reduction unit; Marantz 4100 4-channel amplifier; Wollensak 8060 8-track recorder; and Sansui QS-500 4-channel rear amplifier. The omnidirectional mikes are Shure SM61 while the headphones are Scintrex Model 98 stereo units.**

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**Ziff-Davis Publishing Company**
Editorial, Circulation, and Executive Offices
One Park Avenue, New York, New York 10016
212 679-7200

**Midwestern Office**
The Pattis Group
4761 W. Touhy Ave., Lincolnwood, Ill. 60646
312 679-1100
Midwestern Adv. Manager, Arnold F. Hoffman

**Western Office**
9025 Wilshire Blvd., Beverly Hills, Calif. 90211
213 273-8050, BRadshaw 2-1161
Western Advertising Manager, Bud Dean

**Japan**
James Yagi, Oji Palace Aoyama
6-25, Minami Aoyama, 6-Chome, Minato-ku
Tokyo 407-1930/6821

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# MOST OFTEN USED HI-FI TERMS

**Acoustic Feedback**—The echo, howling, or reverberation caused by a system's microphone (s) picking up the sound output from its own speaker (s).

**Air Suspension**—A specific type of speaker design which depends quite heavily on the back air pressure within a cabinet to reduce unwanted cone vibrations.

**AM**—or amplitude modulation. The amplitude of a transmitted signal is varied in accordance with the signal being superimposed. It is used widely in both AM broadcasting and television. Signals are not considered true high fidelity quality.

**Amplifier**—A component in a hi-fi sound system that boosts the signal from a preamplifier to a level which a speaker can reproduce.

**Antenna**—or aerial. A metal device that detects radio waves in the atmosphere and passes them on to the preamplifier. Also, a large tower-mounted apparatus that transmits radio waves from the broadcast station.

**Anti-Skate**—A device for balancing a tonearm so that the stylus rides in the record groove without any tendency to slide laterally across the record.

**Arm**—See Tonearm

**Automatic Frequency Control**—or a.f.c. A means of electronically keeping a receiver in tune. Used in conjunction with FM receivers/tuners.

**Automatic Gain Control**—or a.g.c. A circuit that keeps volume up to a pre-determined level irrespective of signal strength. It is especially useful in tuning weak FM stations.

**Binaural**—Two-channel reproduction. Literally, two-eared response to sound.

**Changer**—A record player with a mechanism that changes discs automatically. (See *Turntable*)

**Compact**—A high-fidelity sound system, almost always stereo, in which the components are designed to fit together conveniently. Usually all components except the speakers are housed in a single cabinet.

This handy guide to audio terminology has been adapted from the "Layman's Lexicon of Stereo Terms," compiled by Theodore A. Strongin for J.C. Penney.

**Components**—The various devices that make up a sound system; for example, microphone, tuner, record player, tape player or deck, preamplifier, amplifier, and speakers.

**Component System**—A high-fidelity system assembled from individual components. (Contrast with *Compact*)

**cps**—Abbreviation for cycles per second. The term "cps" is now obsolete and has been replaced by "hertz." (See *Frequency* and *Hz*)

**Decibel**—or dB. A relative measure of sound intensity or volume. It expresses the ratio of one sound intensity to another. Two dB is about the smallest change in sound volume that the average human ear can detect. (Also used to express voltage and power ratios logarithmically.)

**Distortion**—Any difference between the original audio signal and that reproduced. Distortion takes many forms and although it can never be completely eliminated, it can be reduced to a very low level in a good recording and reproducing system.

**Dynamic Range**—The voltage ratio (expressed in dB) between the softest and loudest sounds a tape recorder or other device can reproduce without undesirable distortion in loud passages and excessive noise in soft ones.

**EIA**—Electronic Industries Association. They do have their own set of standards for rating hi-fi components that differ in some respects to the rating promoted by the IHF.

**FET**—field-effect transistor. A special transistor used in receiver/tuner front-ends to pick up and detect weak signals.

**Flutter**—A form of distortion in which the higher frequencies oscillate rapidly in pitch. Often caused by faulty turntable, changer, or tape-transport mechanism, but sometimes due to faulty recording.

**FM**—or frequency modulation. The frequency of the transmitted signal varies in accordance with the signal superimposed. Widely used in FM broadcasting and is considered as an excellent medium for high-fidelity reproduction.

**Frequency**—The repetition rate of cyclic energy, such as sound or alternating electrical current, expressed in hertz or Hz (cycles per second) or kilohertz or kHz (thousands of cycles per second). By convention, "bass" frequencies in music extend from about 20 to about 200 Hz. "Treble"

sounds are at the high-frequency extreme of the sound spectrum and may extend from 2 or 3 kHz to the frequency limit of audibility (about 18 to 20 kHz). "Middle" (or mid-range) frequencies occupy the remainder of the spectrum, from 200 Hz to about 3 kHz.

**Frequency Range**—The span between the highest and lowest pitched sounds that a tape recorder or other sound-system component can reproduce at a usable output or volume level.

**Frequency Response**—Always specified as a range, such as 50-15,000 Hz; but in order to be meaningful must be further defined in terms of decibel variation from absolute flatness over a specified frequency range (e.g., ±3 dB from 50-15,000 Hz). An indication of a sound system's ability to reproduce all audible frequencies supplied to it, maintaining the original balance among the low, middle (or mid-range), and high frequencies.

**Front End**—The section of a tuner or radio that receives signals detected by the antenna or inputs from tape or record players and then passes the desired signal along the sound-system chain.

**Gram**—or g. A measure of weight, applied to stylus pressures in phono equipment.

**Headphones**—In effect, miniature speakers, which fit snugly to an individual's ears for private listening.

**High Fidelity**—The reproduction of sound from a broadcast, disc, or tape with a minimum of distortion. Commonly called "hi-fi."

**High-Fidelity Sound System**—The necessary components (i.e., amplifier, tuner, phono, tape equipment, etc.) hooked up so as to provide high-fidelity sound reproduction.

**Hum**—A constant tone directly related to the 60-cycle ac power main. All equipment produces some hum but it should be so subdued that it in no way interferes with sound reproduction at even low volume levels. If it is annoying, it is usually the result of poor design or incorrectly connected wires between various components of a hi-fi system. Grounding the various components of your system to a water pipe might help.

**Hz**—or hertz. The standard abbreviation (of hertz) which has replaced cps (cycles per second) as the term for the unit of frequency.

**IHF**—Institute of High Fidelity. An organization representing most of the manufacturers of high-fidelity component equipment. They do have standards of measurements for testing and rating hi-fi components that differ somewhat from those published by EIA.

**Impedance**—The resistance to the flow of alternating current in an electrical circuit, generally categorized as either "high" or "low," but sometimes given in ohms or megohms. Commonly used to rate electrical input or output characteristics of components so that proper "match" can be made when interconnecting two or more devices (such as a microphone, tape recorder, and loudspeaker). Power loss or frequency discrimination can result from a "mismatch" of impedances between two units.

**Intermodulation Distortion**—Distortion that results when two or more pure tones produce new tones with frequencies representing the sums and differences of the original tones and their harmonics.

**kHz**—or kilohertz. One thousand cycles per second (Hz). For example, 19 kHz equals 19,000 Hz.

**Microphone**—A component that changes sound into electrical signals for transmission through a sound system, to a speaker, where the signals are converted back into sound again.

**Microphonics**—A condition resulting from the mechanical vibration of some part (other than the microphone) within the electrical circuit of an amplifier, tuner, etc. that causes corresponding electrical disturbances in its output signal. Usually appears as a "bonging" sound.

**Monaural**—One-channel reproduction. Literally, single-eared response to sound.

**Muting Circuit**—Usually referred to as interstation muting—an electronic circuit that automatically quiets the output of a tuner or a receiver while tuning between stations. Used widely in FM equipment.

**mV**—millivolt. One-thousandth of a volt.

**Noise, Weighted**—The noise measured within the audio-frequency band using a measuring instrument that has a frequency-selective characteristic. The frequency sensitivity of the instrument is adjusted to correspond to that of the average human hearing response.

**Octave**—The interval between two frequencies of sound or electrical energy having a ratio of 2:1.

**Pickup**—The device that converts the vibrations of the stylus in the record grooves from the original sound on a moving disc into a signal in the form of electrical energy, which is then passed along the sound system for eventual transformation back to sound in the speakers.

**Player**—A component that plays back recorded sound from discs or tapes.

**Power Amplifier**—A component designed to produce sufficient output power to operate a loudspeaker. (See also *Preamplifier*)

**Power Cord**—A cord for connecting a tape recorder or other component to an external power source, such as a 120-volt a.c. line.

**Power Output**—The amount of power, expressed in watts, which an amplifier delivers to a speaker. Power output should be related to speaker efficiency to insure that a specific amplifier is capable of driving a particular loudspeaker(s).

**Preamplifier**—or preamp. An amplifier that raises extremely weak signal levels (such as those from a microphone, magnetic playback head, or phono pickup) to a level sufficient to drive a power amplifier. Some tape recorders combine a preamp and power amplifier. Others, especially tape recorders and tuners designed for use as a part of a hi-fi music system, may include a preamplifier but no power amp. The tape recorder's preamp usually includes the record and playback circuits.

**Quadraphonic**—One of the many terms that are being used to describe 4-channel stereo sound reproduction.

**Radio**—A component that detects radio signals in space, amplifies them, and then turns them back into their original sounds.

**Receiver**—An integrated unit comprising a tuner, preamplifier, and amplifier housed on a single chassis.

**RIAA**—A standard for long-playing records agreed upon by the Recording Industry Association of America.

**RMS**—root-mean-square. Represents the effective value of an alternating current or voltage. It is widely used erroneously to denote the continuous sine wave power rating of a power amplifier. Both the EIA and IHF methods of rating power outputs of amplifiers are not as severe as the continous sine wave power rating and result in numerically higher output figures.

**Rumble**—A very annoying low-frequency sound. Caused by an inferior or faulty mechanical assembly in turntables or changers.

**Servo Drive**—A device that supplies power to move a control or controls.

**Signal**—The form in which original music, speech, or other intelligible sound is transmitted through the atmosphere or sound system for eventual reproduction in a speaker.

**Signal-to-Noise Ratio**—(S + N)/N or S/N. The voltage ratio, usually expressed in decibels, between the loudest undistorted tone recorded and reproduced by a component and the noise reproduced when the audio signal is reduced to zero.

**Speaker**—The last component in the sound-system chain that converts the signal to sound.

**Speaker Sensitivity**—The relationship between the electrical energy impressed upon a speaker and its acoustical output.

**Speaker System**—A single speaker or a combination of speakers mounted within an enclosure.

**Stereophonic**—More than one channel of reproduced sound, each different.

**Stylus**—The "needle," usually diamond tipped, that rides the disc grooves. It is coupled to the pickup.

**Tonearm**—A pivoted arm that holds the cartridge at one end. When playing, the stylus is suspended from the cartridge on the disc grooves by means of the arm.

**Tracking**—The ability of a stylus to follow the grooves of a disc faithfully.

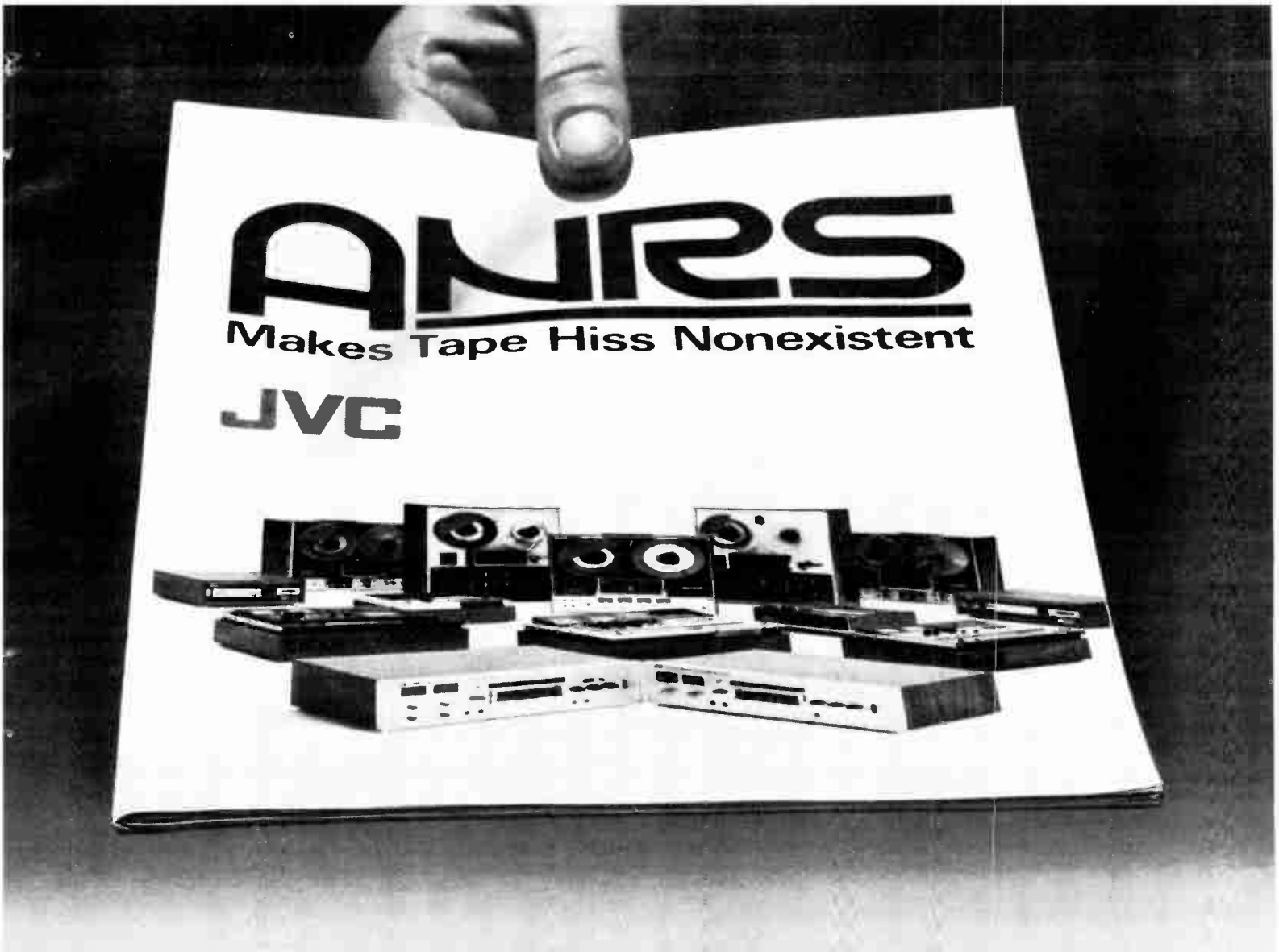
**Transistor**—A solid-state device widely used to provide varied functions within the electronic circuitry of hi-fi sound reproduction equipment. Solid-state devices of various types are now widely used in place of tubes in hi-fi component equipment.

**Tuner**—A component that selects the desired station from radio signals in the atmosphere as detected by the antenna. To convert such signals into usable form, a tuner must be connected into a sound system.

**Tweeter**—The section or component in a speaker system that reproduces the higher frequencies.

**Turntable**—A manually operated, non-automatic disc player.

**Woofer**—The section or component in a speaker system that reproduces the lower frequencies. □

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# DIRECTORY OF HI-FI MANUFACTURERS

If you have any additional questions about products described in this Guide, write direct to the company.



*(Continued on page 62)*

# The research behind the BOSE 901.®

By now almost all Hi-Fi enthusiasts know about the performance of the BOSE 901, about its unprecedented series of rave reviews[1] and its unparalleled acceptance by musicians, stereophiles and the public. But few people know how this unconventional speaker was born. In this first article of a series, we would like to share with you the highlights of the twelve years of university research that led to the 901.

### The research begins.

In 1956 a basic research program on musical acoustics was started by Professor Bose.[2] The motivation for this research came from the apparent discrepancy between the acoustical specifications and the audible performance of existing loudspeakers. Musicians were quick to observe the boomy and the shrill sounds produced by loudspeakers for which engineers claimed excellent specifications.

Dr. Bose's research began by making exacting measurements on loudspeakers and setting up experiments to correlate these measurements to aural perception.

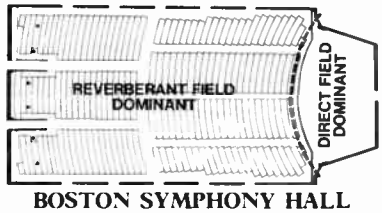
By 1959 it was clear that not only were the existing measurement standards (established 30 years before) incomplete, but worse, they were often misleading. For example, measurements of frequency response and distortion made in anechoic chambers not only fail to indicate what a speaker will do in a room, but speakers with better chamber measurements can actually give inferior performance in the home—and vice versa!

### Probing psychoacoustics.

By 1960 it became evident that basic psychoacoustic research was necessary to relate the subjective performance of loudspeakers to objective design parameters. This research was launched and the first major results were reported in November 1964 at a joint meeting of the Audio and Computer groups of the Institute of Electrical and Electronic Engineers held at M.I.T. It was this research that established the validity of the then controversial concepts of multiplicity of full range drivers, speaker equalization, and flat "power" response. It was also shown, with the help of computer simulations of ideal acoustical radiators, that electrostatic, or other types of speakers have no potential performance advantages over properly designed cone speakers—a result that was not known prior to 1964.

### Significance of reflected sound established.

At the time of the 1964 meeting, however, little was understood about the spatial properties of speakers. There was some evidence that direct radiating speakers caused shrillness in music but the reasons were not known. From 1964 to 1967 the research concentrated on these spatial problems. With the co-operation of the Boston Symphony Orchestra, measurements were made during live performances to determine characteristics of sound incident upon the listeners. Theoretical studies, verified by experiments, showed that in live performances sound arriving at the listeners' ears from different directions was much more evenly balanced than was the case for loudspeakers in home environments. Experiments then linked this spatial difference to the strident sounds produced by loudspeakers. Then it was discovered that the desirable spatial characteristics could be produced in the home by directing a large percentage of sound away from the listener at precise angles to the rear wall.



BOSTON SYMPHONY HALL
FLOOR PLAN

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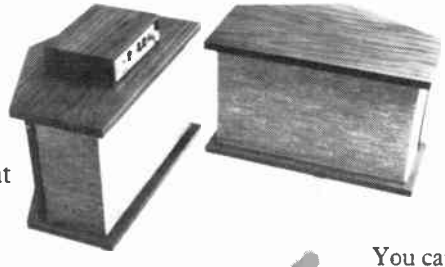
In 1968 we decided to incorporate all the knowledge gained from the years of research into the design of an optimum loudspeaker for the home. The result is the BOSE 901. Perhaps this explains our confidence in asking you to compare it to any other loudspeaker regardless of size or price.



[1]For copies of the reviews, circle our number(s) on your reader service card.
[2]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 Corporation for fifty cents.

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|---|---|---|---|---|
| 1.000 | 1.000 | 0 | 1.000 | 1.000 |
| 0.989 | 0.977 | 0.1 | 1.012 | 1.023 |
| 0.977 | 0.955 | 0.2 | 1.023 | 1.047 |
| 0.966 | 0.933 | 0.3 | 1.035 | 1.072 |
| 0.955 | 0.912 | 0.4 | 1.047 | 1.096 |
| 0.944 | 0.891 | 0.5 | 1.059 | 1.122 |
| 0.933 | 0.871 | 0.6 | 1.072 | 1.148 |
| 0.923 | 0.851 | 0.7 | 1.084 | 1.175 |
| 0.912 | 0.832 | 0.8 | 1.096 | 1.202 |
| 0.902 | 0.813 | 0.9 | 1.109 | 1.230 |
| 0.891 | 0.794 | 1.0 | 1.122 | 1.259 |
| 0.841 | 0.708 | 1.5 | 1.189 | 1.413 |
| 0.794 | 0.631 | 2.0 | 1.259 | 1.585 |
| 0.750 | 0.562 | 2.5 | 1.334 | 1.778 |
| 0.708 | 0.501 | 3.0 | 1.413 | 1.995 |
| 0.668 | 0.447 | 3.5 | 1.496 | 2.239 |
| 0.631 | 0.398 | 4.0 | 1.585 | 2.512 |
| 0.596 | 0.355 | 4.5 | 1.679 | 2.818 |
| 0.562 | 0.316 | 5.0 | 1.778 | 3.162 |
| 0.531 | 0.282 | 5.5 | 1.884 | 3.548 |
| 0.501 | 0.251 | 6.0 | 1.995 | 3.981 |
| 0.473 | 0.224 | 6.5 | 2.113 | 4.467 |
| 0.447 | 0.200 | 7.0 | 2.239 | 5.012 |
| 0.422 | 0.178 | 7.5 | 2.371 | 5.623 |
| 0.398 | 0.159 | 8.0 | 2.512 | 6.310 |
| 0.376 | 0.141 | 8.5 | 2.661 | 7.079 |
| 0.355 | 0.126 | 9.0 | 2.818 | 7.943 |
| 0.335 | 0.112 | 9.5 | 2.985 | 8.913 |
| 0.316 | 0.100 | 10 | 3.162 | 10.00 |
| 0.282 | 0.0794 | 11 | 3.55 | 12.6 |
| 0.251 | 0.0631 | 12 | 3.98 | 15.9 |
| 0.224 | 0.0501 | 13 | 4.47 | 20.0 |
| 0.200 | 0.0398 | 14 | 5.01 | 25.1 |
| 0.178 | 0.0316 | 15 | 5.62 | 31.6 |
| 0.159 | 0.0251 | 16 | 6.31 | 39.8 |
| 0.141 | 0.0200 | 17 | 7.08 | 50.1 |
| 0.126 | 0.0159 | 18 | 7.94 | 63.1 |
| 0.112 | 0.0126 | 19 | 8.91 | 79.4 |
| 0.100 | 0.0100 | 20 | 10.00 | 100.0 |
| $3.16\times10^{-2}$ | $10^{-3}$ | 30 | $3.16\times10$ | $10^{3}$ |
| $10^{-2}$ | $10^{-4}$ | 40 | $10^{2}$ | $10^{4}$ |
| $3.16\times10^{-3}$ | $10^{-5}$ | 50 | $3.16\times10^{2}$ | $10^{5}$ |
| $10^{-3}$ | $10^{-6}$ | 60 | $10^{3}$ | $10^{6}$ |
| $3.16\times10^{-4}$ | $10^{-7}$ | 70 | $3.16\times10^{3}$ | $10^{7}$ |
| $10^{-4}$ | $10^{-8}$ | 80 | $10^{4}$ | $10^{8}$ |
| $3.16\times10^{-5}$ | $10^{-9}$ | 90 | $3.16\times10^{4}$ | $10^{9}$ |
| $10^{-5}$ | $10^{-10}$ | 100 | $10^{5}$ | $10^{10}$ |
| $3.16\times10^{-6}$ | $10^{-11}$ | 110 | $3.16\times10^{5}$ | $10^{11}$ |
| $10^{-6}$ | $10^{-12}$ | 120 | $10^{6}$ | $10^{12}$ |

# New Heathkit Deck. Dolby Circuit. Made for each other...by you.

About five evenings does it. Following famous Heathkit check-by-step instructions written for first-time kitbuilders, you build up the modular plug in circuit boards. Wire in the factory assembled top-quality American-make tape transport mechanism. Install it in the handsome walnut-veneer cabinet. And you're in the Dolby stereo cassette business to stay...at a price designed to please. All controls are interlocked to prevent tape breaking or accidental erasing of prerecorded cassettes. An automatic shut-off returns the transport to STOP when tape ends in PLAY or RECORD mode. "Piano"-keys give you fingertip control of PLAY, RECORD, and STOP functions. Lever controls offer FAST-FORWARD REWIND and EJECT functions. Lever switches are also provided for STEREO or MONO input; DOLBY ON/OFF; tape-type REGULAR (iron oxide) or $CrO_2$ (chromium dioxide). In the $CrO_2$ position, both the bias and audio levels of the deck are increased to make full use of the greater fidelity and dynamic range of chromium dioxide tape. Other features are individual record level controls with separate VU meters; large three-digit resettable counter for reliable indexing of selections within a tape; input selector switch for either microphone or high-level source input (any low impedance microphone with standard ¼" phone jack can be used). For the life-like fidelity of low-noise cassette recording and playback at its finest, put together the Heathkit AD-1530 Deluxe Stereo Cassette Tape Deck next week.

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**AD-1530 SPECIFICATIONS: Frequency Response:** Regular (iron oxide) tape; ±3 dB from 40 Hz to 12 kHz typical. $Cr O_2$ (chrominum dioxide) tape; ±3 dB from 40 Hz to 14 kHz typical. **Distortion:** Tape dependent; electronics less than 0.2%. **Hum and Noise:** Dolby Switch OFF, −48 dB. Dolby Switch ON-Provides Additional Noise Reduction as Follows: −10 dB @ 4000 Hz and up. −9dB @ 2400 Hz. −6 dB @ 1200 Hz. −3 dB @ 600 Hz. **Wow and Flutter:** Less than 0.25% RMS. **Inputs: Microphone:** Lo-Z, 0.2 mV to 10 mV. Auxiliary: Hi-Z, 50 mV to 10V. **Bias Oscillator Frequency:** Approximately 100 kHz. **Tape:** Any good quality iron oxide or chromium dioxide tape cassette may be used. **Tape Speed:** 1⅞ in/s or 4.76 cm/s. **Fast Forward/Rewind Time:** Approximately 45 sec. for C-60 cassette. **Solid State Devices:** 37 transistors and 2 JFET's. **Output:** Greater than 0.5 volts from low impedance source. **Dimensions:** 5½" H x 9½" D x 14" W. **Power Requirements:** 120 volts, 60 Hz, 15 W.

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# HOW TO TAPE A SYMPHONY IN QUADRIPHONICS

The number and placement of microphones are important, but the biggest problem is balancing—obtaining the ideal direct-to-reverberant ratio.

**By JAMES C. CUNNINGHAM**
General Manager, Sound Market Recording Studio, Chicago

FIRST impressions can sometimes be misleading. When we were asked to record the Lake Forest Symphony in a performance of the Verdi "Requiem" conducted by Victor Aitay, we made the usual trip to the recording site. What confronted us was the difficult task of recording an 80-piece orchestra, a 100-voice choir, and four soloists—performing in a 500-seat, acoustically dead auditorium with a noisy blower system.

Although these difficulties seemed insurmountable at first, by the end of the venture we had a 4-channel recording which exceeded any classical quadriphonic recording we have ever heard.

As it turned out, the acoustically dead auditorium was more of a help than a hindrance. This proved interesting, since the average amateur recordist will most often encounter dead acoustics in the typical high-school auditorium, which is designed primarily for speech. He actually has a better chance of making a good 4-channel, ambient-type recording than the professional engineer who will undoubtedly encounter a hall designed primarily for music and thus "live" acoustically. The reasons for this phenomenon will be explained later, but first let's examine the microphone placement chosen for this recording.

The goal of 4-channel microphone placement is, in essence, to capture not only the sounds made by the musicians, but those sounds reflected from the walls and ceiling which add so much to the music.

Because these reflections come from every conceivable direction, a mono or stereo system can not reproduce them. However, a quadriphonic system with proper microphone placement can reproduce the acoustic field with breathtaking reality, giving the listener an incredible sense of involvement with the music. The quadriphonic technique used for this recording is basically a four-mike pick-up with accent microphones, as seen in Fig. 1.

The first consideration in microphone placement, when recording large groups, is the musical balance of instruments and voices. This problem will usually be solved by the conductor who will place the musicians so the loudest instruments and voices are farthest from him and he will control the intensity of sections to achieve a balance for the audience. Usually the first chair instrumentalist controls the balance of each section.

Basically, all the engineer has to do is find a spot where his microphones will "hear" what someone in the best seat in the audience will hear. Because microphones do not "hear" in the same way that our ears do, a second consideration arises; that is, the direct-to-reverberent ratio. This simply means the ratio of the amount of sound reaching the microphone directly to that reflected off the walls and ceiling of the hall. Usually a point is selected where the musical balance is correct for direct sound, then the amount of reflected sound is controlled by the pattern of the microphone. For example, as Fig. 2 shows, the instruments farthest from the podium, being three times the distance from the microphone, by the inverse square law

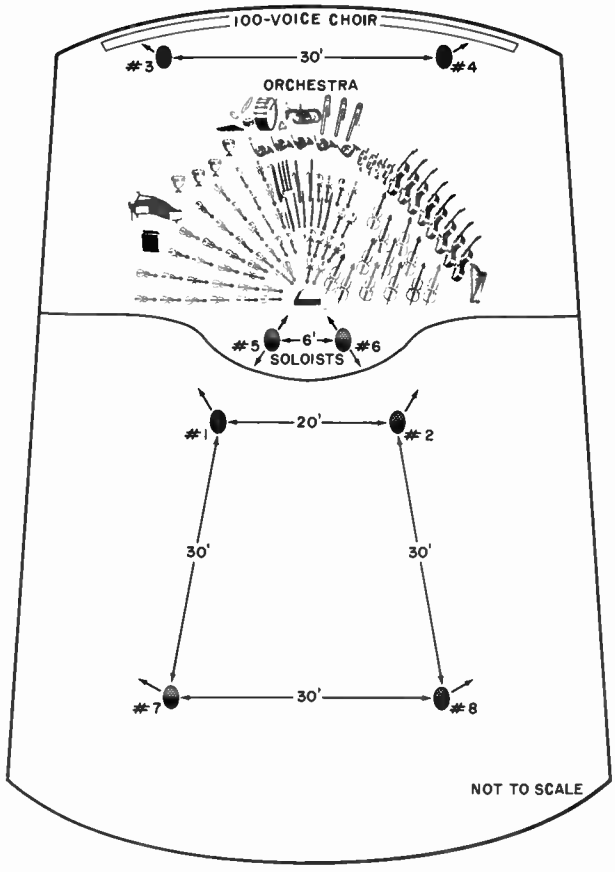



*Fig. 1. To record an 80-piece orchestra and a 100-voice choir takes at least eight microphones, spaced as shown.*

will be 9.5 dB softer than the closest ones. Many factors must be considered, such as the radiation pattern of the instruments, the fact that low-frequency instruments such as the double bass *should* be louder than the oboe to achieve balance, etc. Good balance with the average symphony orchestra will usually occur at a point about ten-to-fifteen feet above the conductor and about ten feet from the front row of instruments. A cardioid (unidirectional) or bidirectional microphone pattern will usually give the proper direct-to-reverberant ratio—the choice depending on the "liveness" of the hall.

If the hall is exceptionally dead, an omnidirectional microphone could be used.

Fig. 3 shows the location of the microphones (except the ambient ones) used in recording the Verdi "Requiem." The orchestra microphones, which are the primary ones, can be seen behind the conductor and are located more precisely in Fig. 1 as mikes #1 and #2. These mikes would also pick up the choir behind the orchestra but with a rather poor direct-to-reverberant ratio, so two more accent microphones are used, #3 and #4. For the same reason another stereo pair of mikes is used for the soloists. These can also be seen clearly in Fig. 3. Being so close to the singers, a bidirectional pattern is used because the direct-to-reverb ratio would otherwise be too high and the singers would sound as if they were in a closet. This pattern was chosen over the omnidirectional in order to allow some reflected energy from the hall to enter the microphones and yet keep secondary pickup from the orchestra low. This is always a problem when more than one stereo pair of microphones is used because when sound enters two microphones, which are some distance apart yet feeding the same channel, some unwanted phase problems can occur. These problems will be avoided if the mikes are close to the singers and used only for accent; that is, the mixer pots are opened far enough to give "presence" to the voices, but no more.

All six of the aforementioned microphones are mixed into the two front channels while two more microphones feed the two rear channels. These are located about 30 feet from the orchestra microphones and are about 30 feet apart. They are cardioid in pattern and face the slanting side walls.

Once all the microphones are in place and levels set during rehearsal, a check should be made to ensure that the four channels are receiving approximately the same level of reflected sound. One way is to make a loud noise on stage and observe the "die away" on all four meters. If they are not about the same, adjustments must be made. For example, if the front channels are too low, this means the microphones are too close to the orchestra and they must either be moved back or a less directional pattern used.

The equipment used for this recording was professional in specifications but not necessarily in cost. The four main microphones were AKG C-451's phantom-powered from a home-built unit ~~that~~ handles twelve microphones. The soloists' microphones were AKG C-412's also phantom-

*Fig. 2. Shows musical balance achieved by ratio of distances of instruments in orchestra from the microphone.*

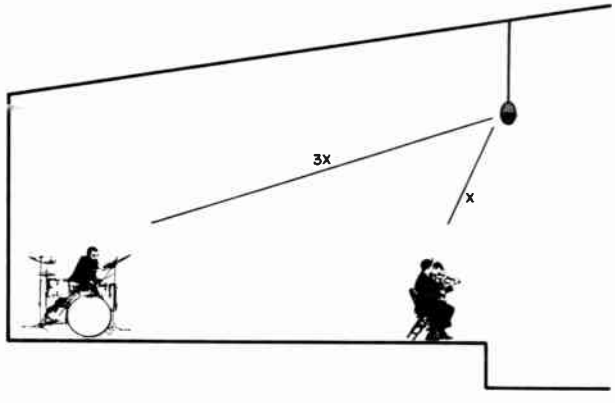


*Fig. 3. Primary microphone placement photographed during a choir rehearsal. The two choir microphones are shown hanging from ceiling above the choir. The soloists' microphones are standing in front of conductor and the two front two of the four main microphones can be seen directly behind and above the conductor.*

powered. The choir mikes were Neumann U-47's, more than fifteen years old but still giving superb service. A Tascam console and a Teac four-channel, ½-inch, 15-ips tape machine were used because their performance-to-weight ratio is unexcelled by any product we know of. The console has twelve microphone inputs and four outputs with equalization and filtering on each input. We had planned to use the low-frequency cut-off filter to reduce the blower noise in the air-handling system, but at the last minute we were able to induce the management to turn it off. The tape machine handles one-half-inch tape with very low flutter and has typical professional noise and frequency response specs.

Fortunately, there were two performances of the "Requiem;" because lack of preparation rendered the first recording of ours useless. First, we had not received timings from the conductor in advance and an hour before the performance we found the first break to change tapes came at 40 minutes. This meant we either had to get some one-mil, half-inch tape (an impossibility on such short notice), or record at 7½ ips. The machine was brand new and no one had checked it out at this speed, so we elected to record at 15 ips and use what we could get for possible editing into the next performance. Second, one of the mike cables had a loose connection, so one tug and out went a vocal mike just before the performance began. So this became a rehearsal for the second performance—enabling us to touch up the microphone placement and be fully prepared for the potential meter-bending sections of the "Requiem."

As indicated at the beginning of this article, the quadriphonic recording exceeded our fondest expectations. We attribute this to the acoustic properties of the auditorium which was designed to have an intimate quality—that is, the low suspended ceiling partitions or "clouds" as they are called—provided early reflections which "supported" the sound. The later reflections of the more distant walls also supported the sound, of course, but the danger is that these reflections will not be in the fusion time of the brain and the listener will get "two concerts for the price of one." It is the reproduction of these early reflections, in fact, which gives 4-channel sound the incredible "openess" it has. The walls of this auditorium are treated so that the sound does not bounce many times from one wall to another, giving the hall a short reverberation time and enabling us to put a microphone out in the hall and capture the early reflections without being swamped by the later ones. For final master we added a small amount of artificial 4-channel reverberation (described in the quadriphonic studio recording article; see page 30), but not enough to impair the definition of the original.

We have made many experimental quadriphonic recordings over the past eight years but, for the most part, they have been in major halls like Chicago's famous Orchestra Hall. Until this recording session, we would not have given the serious amateur recordist much hope of competing with the professional. Now we say, "go ahead," you may very well come up with a tape that is better than some of the commercial 4-channel recordings now available. □

# PLANNING TO BUY a TAPE RECORDER?

Do not buy a machine that does not meet your particular needs. Here are facts you should consider before making your purchase.

**BY JULIAN D. HIRSCH**
Hirsch-Houck Laboratories

BUYING a tape recorder, like buying an automobile, can severely test one's ability to distinguish between essentials and frills. In both cases, the "extras," which contribute little or nothing to the basic function of the product, have a disproportionate effect on its price. Worse yet, they can in some cases actually reduce the machine's reliability or its ease of operation. Nevertheless, their convenience justifies—to me at least—their cost.

Before considering what sort of performance will be needed for various types of recording, it might be well to review briefly some basic recorder performance characteristics and their significance.

*Frequency Response:* This usually refers to the overall record-playback response of a machine. The frequency-response specification of a recorder can be misleading rather than informative unless a tolerance in decibels (dB) is also specified. A typical tolerance, such as ±3 dB, over a given frequency range means that, with a constant-level input signal, the playback signal can vary over a total of 6 dB. Since the response curves of most recorders are somewhat similar in shape there will be a droop in response somewhere between 10,000 and 20,000 Hz. There may also be a rolloff below 50 Hz or so. The published frequency-response specification is therefore a useful guide to the overall performance quality of a tape recorder *as long as the variation from flat response is specified in decibels.*

*Wow and Flutter:* Wow and flutter are short-term fluctuations in the tape speed which, in turn, cause pitch fluctuations in the recorded program. Wow occurs at low cyclic rates (one-half to ten per second) while flutter is more rapid (ten to 300 per second). In tape transports there is usually more flutter than wow. The subjective offensiveness of flutter is a function of its amplitude and rate, the nature of the program material, and the aural acuity of the listener. In other words, a given amount of flutter in a machine will bother some people sometimes, with some program material, but it won't bother everybody all the time unless it is very severe. Flutter is expressed as a percentage (of frequency modulation) of the test signal.

*Signal-to-noise [S/N or (S + N)/N] Ratio:* Sometimes referred to as dynamic range, this is the "spread" between the highest signal level that can be recorded without exceeding a specified level of

distortion (usually 3 percent), and the residual noise. The noise comes from the interaction of tape and bias and is also produced in the playback amplifier. Since the ear's sensitivity to noise varies with frequency (in general, upper mid-range noise is most bothersome, and very-low and very-high frequency noise the least), the signal-to-noise measurement is sometimes "weighted" to match that sensitivity more closely.

There are many other recorder specifications, some of them not necessarily related to sound quality, that cover, in general, the "extras"—the added versatility and convenience factors. Some of these are:

*Tape Speeds:* Tape speeds are designated as the number of inches of tape passing over the recorder's heads per second. Cassette recorders operate only at 1⅞ ips, but all open-reel home recorders offer the option of at least two tape speeds, usually 3¾ and 7½ ips. Many open-reel machines also offer the 1⅞-ips speed, but their high-frequency response in this case is severely limited, usually to less than half what it is in a good cassette machine. A few machines can also operate at 15 ips, but these are usually of semiprofessional caliber—and they carry an appropriately high price tag.

*Quarter-track and Half-track Operation:* Stereo tape machines record two parallel magnetic tracks on the tape—one for each channel. Practically all home recorders have what are called "quarter-track" (4-track) heads, so that a stereo program being recorded takes up only half of the total width of the tape. This leaves room for a second stereo program, which is recorded in the opposite direction on the same tape. Some semiprofessional machines can be purchased with "half-track" heads, and these use the entire width of the tape for a single stereo program. Although this format provides a slight improvement in signal-to-noise ratio and is also the only sensible arrangement for tapes that must be edited, the sonic advantages of a half-track machine over a good quarter-track machine are not often apparent.

*Bi-directional (Automatic Reverse) Operation:* With quarter-track tapes recorded in two directions, the convenience of not having to interchange tape reels (or turn over a cassette) to play the second pair of tracks is undeniable. However, most auto-reverse recorders provide this extra facility only in the playback mode.

*Off-the-tape Monitoring:* Virtually all open-reel recorders with any pretensions to high-fidelity capability have separate recording and playback heads and amplifiers so that one can listen to the program from the tape an instant after it has been recorded. These "three-head" machines generally offer improved performance as well as convenience since each head can be designed for maximum performance of its special function. At present, with very few exceptions, cassette recorders are of the two-head variety and cannot monitor from the tape.

*Special Effects:* Many recorders offer "sound-on-sound," "sound-with-sound," echo, and other special-effects capabilities. All that any of these features require of a tape machine is the ability to record on one channel while playing back on the other. Sound-with-sound is the recording of a new program on channel two after channel one has been recorded. Sound-on-sound involves the transfer of a recording already made on channel one to channel two; at the time of the transfer, new material can be added. Sound-on-sound recording can be done with external patchcords, but many recorders now accomplish it with built-in switching.

Since the playback head comes after the record head in a three-head machine, synchronizing a recording on channel two with playback of channel one during sound-with-sound recording is impossible. Professional recorders therefore contain a system called "Sel-Sync" or "Simul-Sync," which temporarily switches part of the record head to play back an already recorded track while new material is being added on another track. This also avoids the slight degradation inevitable when using the re-recording technique of sound-on-sound. (Sel-Sync facilities have recently begun to appear on some home machines, principally four-channel models. These will be discussed later in the section on four-channel.)

*Number of Motors:* It is generally believed that separate motors for the capstan and each of the reel hubs results in better tape handling and reduced flutter. As a rule this is true, although there are a few single-motor machines with considerably better characteristics in this regard than some low-priced three-motor types.

Three-motor designs tend to require less frequent adjustment, since they do not depend on a system of clutches and belts to couple the output of a single motor to several rotating shafts operating at different speeds and in different directions. The most obvious advantage of three motors is the higher rewind and fast-forward speeds they provide, usually at least twice as fast as those of a single-motor machine.

Cassette transports use either one or two motors. The use of two motors may indeed result in lower flutter, but it is more likely to be justified by

better tape-handling characteristics at fast speeds. There are also cassette transports that use a dual capstan system, driven by a single motor, to keep the tape under controlled tension as it passes the head and thereby reduce flutter.

*Miscellaneous Features:* The special features of many tape recorders include: pause control, tape-bias selector for different types of tape, index counter with a memory system to stop the tape at a pre-determined point, headphone jacks, mixing inputs for microphones as well as high-level sources, simplified tape-loading paths, ability to use reels larger than 7 inches in diameter, tape-tension selector for tapes of different thicknesses, battery operation for portable use, built-in power amplifiers and monitor speakers, built-in Dolby or other noise-reducing systems, and many others.

Most of the better cassette decks have built-in Dolby noise-reducing circuits (some JVC machines use that company's Automatic Noise Reduction System—ANRS—which operates similarly), or a different system developed by Philips (Norelco) and called the DNL noise reducer, which can help reduce noise in material that has not been recorded with a noise-reduction processor in the first place.

To some users, one or more of these features may be vital. To others, they are quite unnecessary.

### THE INTENDED USES

Although the uses to which home tape recorders are put are too numerous to list individually, the bulk of them can be assigned to one of several major categories.

*Non-critical Voice Recording:* Probably the least demanding use for a tape recorder is the casual recording of voices. Practically any recorder is adequate for these purposes, but the convenience and portability of cassette machines have made them the preferred choice. A frequency response of 100 to 6000 Hz is more than sufficient for voice clarity, and flutter of 0.3 percent or more will often go unnoticed. Dynamic range, noise, and other normally important specifications are really of no consequence. One useful feature found on many portable cassette machines (as well as some open-reel decks), however, is automatic recording-gain control. Although this sacrifices the natural dynamic range of the "live" event (usually unimportant, in any case, for most speech recording), it relieves the recordist of the chore of adjusting levels for different voices, some or all of which may be at different distances from the microphones.

*Live Recording in the Home:* A related, but more demanding, application is the recording of live music in the home. A child's performance on a musical instrument, or the more serious efforts of an amateur chamber music group, instrumental soloist, or vocalist are typical examples. Here, the required degree of sophistication in the equipment must be directly proportional to the expected results. If what is wanted is simply a record of the event, a sort of sonic snapshot, then even a portable cassette recorder may suffice. But if a reasonable standard of quality is desired, other recorder specifications must be considered.

Unless you have a teenage bass-drum virtuoso in the family, there is no reason to record the very low (below 60 Hz) frequencies. On the other end of the spectrum, the contribution of frequencies over 10,000 Hz is actually quite subtle and their absence from most home recordings would seldom be noticed. An otherwise good recorder with its response limited to a 60- to 10,000-Hz range would probably be fine for most live home recordings.

For reasons of tape economy, 3¾ ips is becoming a preferred speed for tape hobbyists. Many lower-priced open-reel machines have good response to 10,000 Hz or higher (as well as fairly low noise) at that speed, and the better ones go beyond 15,000 Hz. However, you should not expect that the frequency response of an open-reel recorder at 1⅞ ips (or even, in many cases, at 3¾ ips) will match that of a good cassette deck.

If frequency response is not very important, then what is? Dynamic range, for one thing. This is usually expressed as a signal-to-noise ratio and may be 40 to 50 dB in inexpensive open-reel decks or cassette recorders without Dolby circuits, and 55 to 60 dB in the better medium-priced open-reel units or Dolbyized cassette decks. Only the best home open-reel recorders can achieve a S/N ratio better than 60 dB without the use of Dolby noise reduction. A S/N of 50 dB or less will almost always result in a pronounced background hiss, especially during quiet moments in the program. When the noise is reduced to −55 dB or below, this hiss may be heard only when the music in the program is silent, unless the playback volume is relatively high. The background noise level in most homes will often mask a hiss level of −60 dB or less, and may even make a poorer S/N ratio acceptable.

One of the few tape-recorder specifications that is directly related to price is speed constancy. For most home-recording purposes, the actual average tape speed is not critical. However, short-term fluctuations are highly objectionable, since they

cause the audible effects of flutter and wow. Depending on its frequency and amplitude, as well as the type of program material, flutter may be heard in different ways. In extreme cases (some very low-priced cassette machines) it produces a "gargling" or roughness that can be heard on voice recordings, and is quite intolerable for any kind of music. Smaller flutter percentages may simply "muddy" the sound, causing a loss of clarity that is sometimes blamed on other forms of distortion.

Some people find a flutter level as high as 0.2 percent quite acceptable (this is not true for wow, whose effects cannot be mistaken for anything else and therefore are more prominent). Most modern cassette decks have less than 0.2 percent flutter. Open-reel machines selling for more than about $200 frequently are rated at under 0.12 percent, and the fact that most people are not aware of flutter at this level suggests that it is a reasonable criterion for high-fidelity service, at least in ordinary home recording. Several of the best cassette machines also achieve a flutter rate of between 0.1 and 0.15 percent.

However, a 0.12 percent flutter rating does not automatically assure acceptability to a critical listener. Certain musical instruments, such as the piano and harp, can reveal minute amounts of flutter whose amplitudes are difficult to measure accurately. Also, some individuals have an acute sensitivity to flutter. Most of us would find 0.1 percent flutter quite insignificant.

*". . . The most demanding recording situation . . . is the taping of a live-music performance on location . . ."*

As readers with long memories will remember from my opening words, it is in their "extras" that most otherwise similar recorders have their differences. What, for example, of the question of one motor *vs* two or even three? The better three-motor machines have less flutter than most one-motor machines—but they cost a lot more. On the other hand, a really good single-motor transport can have much less flutter than a medium- or low-priced three-motor machine. There is more likely to be a correlation between low flutter and high price than between low flutter and the number of motors. If you now have—or intend to have—a large collection of recordings, a bi-directional machine can add a great deal of convenience to your tape playing. Special features such as sound-on-sound and echo are available on most recorders, although their ease of use varies widely; in any case, such features are seldom used.

For many home recordists, then, there is little to be gained by using a very expensive machine (say, a $700 as opposed to a $400 model), for the somewhat better specifications of the very expensive machines would, in most cases, be wasted on source material that did not require them. For most home recordists, it would be better to invest some or all of the price difference in two reasonably good microphones. Those microphones whose quality compares reasonably closely to that of a good tape deck cost at least as much as the deck itself—and you need two of them for stereo. Fortunately, some very good dynamic or capacitor (electret) microphones are available for less than $75.

Judged purely from the listening standpoint, the high-end cassette recorders are frequently adequate for live recording in the home. But a caution is in order here. As we have mentioned, some people are disturbed by flutter levels that may be inaudible to others. Considering that most home live-music recording is likely to include a guitar or piano, it may not be possible for some people using otherwise fine cassette machines to obtain a satisfactory recording. The better open-reel machines will usually have somewhat lower flutter, making them the preferred choice for the flutter-sensitive music lover.

The impossibility (or, rather, great difficulty) of editing a cassette recording is, of course, a real disadvantage, although careful planning and the use of the pause control make it possible to produce a well-organized recording. Some cassette recorders have appreciably higher noise levels

through their microphone inputs; if this is objectionable, there are external microphone preamplifiers that can be used to drive the recorder's line inputs.

*Taping from Discs and FM Broadcasts:* Another application for home tape recorders, probably more widespread than "live" recording, is taping FM broadcasts and copying phonograph records. It may seem paradoxical, but if you are trying for an exact copy of a record, a wider frequency response is required than for live recording, since the microphone will no longer be a limiting factor. On the other hand, FM broadcasts (especially in stereo) do not have any program content outside the 30- to 15,000-Hz range.

The situation with records is only slightly different. There is no need to restrict the recording bandwidth to 15,000 Hz, but neither is there any advantage in going much beyond this point.

From frequency-response considerations alone, it would seem that most component-quality open-reel tape decks (at the 7½-ips speed) and the better cassette machines should be able to record anything likely to be encountered on discs or FM broadcasts. Even at 3¾ ips, many tape decks have good response to 15,000 Hz, but they are generally more expensive than cassette recorders with the same bandwidth.

But, again, frequency response is by no means the only criterion (or even the most important one) for high-fidelity recording. Noise levels of modern discs are so low that much of the hiss we hear on them comes from the master tape itself. Making a facsimile tape copy of these records requires the lowest possible recorder noise level, preferably −60 dB or lower. A number of open-reel decks, and most Dolby-equipped cassette machines, will prove satisfactory.

The S/N of a received FM broadcast depends on several factors besides the original program's noise level. In most areas, mono FM reception will provide nearly the same S/N as the original recorded program. With stereo, the hiss level is always higher, and is usually audible. This eases the recorder S/N requirements somewhat, unless your stereo FM reception is exceptionally quiet. It is interesting to note that, now that some FM stations are transmitting a Dolbyized audio signal, a listener can actually improve the overall S/N as well as obtain a more balanced frequency response by first recording the tuner output on a Dolby-equipped cassette deck (with the Dolby switched off) and then playing it back with the deck's Dolby circuits switched on.

*Live Recording on Location:* The most demanding recording situation likely to be encountered by an amateur is the taping of a live-music performance. Here the goals—and the problems—are very similar to those of a professional recording engineer.

A comparison of professional tape recorders with those intended for home use will show that the former have few of the "extras" or special features found on most consumer products. Such niceties as index counters, bi-directional recording or playback, and built-in power amplifiers or speakers are usually absent from the "pro" recorder. Unless it is a specialized portable model, it will be equipped for 10½-inch reels, be more likely to have half-track heads than quarter-track, and be able to operate at 15 ips or higher speeds. It will also be very rugged, usually heavy, and always expensive.

Many of its special qualities are designed to make it a reliable instrument, capable of being transported under less-than-ideal conditions and able to operate without failure hour after hour, day after day. Fortunately for the part-time recordist, many good consumer tape recorders come remarkably close to meeting the electrical and mechanical performance of professional recorders, at least under less strenuous conditions. For reasons of quality as well as editing ease, it is preferable to use a 7½-ips tape speed (unless 15 ips is available).

It cannot be overemphasized that in live recording the microphones are the keys to the final results. The end product of a taping session can be no better than the quality of the microphones will

allow, no matter what recorder is used. For straight two-channel recording with two microphones, the microphone inputs of the better open-reel machines should suffice. With more than two microphones, or if the recorder's internal microphone preamps' S/N is not adequate, an external microphone mixer should be used.

In many situations, the 55 to 60 dB S/N of most good-quality open-reel machines may be sufficient. If both the ambient noise level and the average program level are low, the Dolby-B noise-reduction system can be used to advantage. A number of suitable add-on Dolby units are available, and at least one of the higher-priced recorders can be purchased with built-in Dolby facilities.

Cassette recorders can be used effectively for high-quality live recording, with some qualifications. The Dolby system is a "must," and the tape should be either chromium-dioxide or the best grade of ferric-oxide. All the cassette machines that we have checked have significantly higher noise levels through their microphone inputs than through their line or high-level inputs, and the Dolby system (because it comes after the mike input) cannot improve this situation. Therefore, a low-noise external microphone preamplifier or mixer is desirable. Quality aside, the cassette medium does not lend itself too well to serious live recording, since the tape cannot be edited directly.

*Four-Channel Recording:* By utilizing all four tracks of the quarter-track tape format, recorded in the same direction and played back simultaneously, discrete quadriphonic reproduction is possible through a four-channel sound system. At present there is a modest number of open-reel four-channel recorded tapes available and some tape machines to play them; many of these are also capable of recording in four channels (all, of course, can record and play two-channel tapes as well). Except in the addition of two more independent channels, quadriphonic recorders do not differ from two-channel machines in any significant respect, and the performance requirements are the same for both types of equipment. As mentioned earlier, some of the most expensive four-channel recorders have Sel-Sync facilities on all four channels—a feature that could be of real interest to rock groups seeking multi-track recording capability. For the home recordist interested in 4-channel sound, a two-channel-record, four-channel-playback machine might be the most practical choice, since the total investment (including microphones) for four-channel recording capability is likely to be quite high—especially if all four channels are to be Dolbyized.

*Listening to Recorded Tapes:* If a tape recorder is to be used primarily for playing commercially recorded and duplicated tapes, there is a wide choice of suitable models. Most open-reel machines have good playback equalization accuracy, and the same flutter considerations apply to playback as to a machine used for recording as well. Both 3¾-ips and 7½-ips speeds should be available. Since all recorded tapes being produced today are quarter-track, a bi-directional, automatic-reversing transport is a great convenience, minimizing the "turn-around" time normally required for switching reels and re-threading the tape. Most auto-reverse systems use a conducting strip that must be attached to the tape at the desired reversing point. With some machines, a subsonic tone is recorded where reversal is desired. Both systems work equally well, but the tone technique is, of course, more convenient.

A number of commercial open-reel tape releases are now available with Dolby-B encoding, and a Dolby playback decoder is necessary for playing them. A major weakness of high-speed duplicated tapes has always been their high noise level, and the Dolby system can make a dramatic improvement in this respect. As mentioned previously, open-reel machines are now being made available with built-in Dolby circuitry, but they are expensive. A simple external accessory is the most economical way of adding this capability to other recorders and the add-on unit can also be used with other sources.

Commercially recorded cassettes are notoriously noisy. Many are now Dolby-processed, however, and with a suitable Dolbyized cassette deck they can deliver surprisingly good sound—although not by any means the equivalent of a good-open-reel tape, a disc, or even a home-made cassette recording. There are some auto-reversing cassette decks available, but very few have built-in Dolby circuits as well.

### THE FINAL CHOICE

The guidelines offered in the foregoing discussion have deliberately been left very flexible. Depending on the user's expectations, it is often possible to achieve very good results with a rather low investment in equipment. You should not, however, expect to make professional-quality live recordings if all you have to work with is a $200 deck and a pair of $10 microphones. By the same token, it is a case of ridiculous overkill to use a deluxe Dolbyized open-reel recorder costing close to $1000 if all you intend to use it for is taping discs or an occasional FM program. □

# STATUS OF— 4-CHANNEL SOUND

Until the FCC approves—if ever—a 4-channel system for FM broadcasting, we will have to live with three distinctly different systems—the CD-4 for discrete disc, a compromise SQ/Sansui system for matrix disc or tape, and 8-track cartridge for discrete tapes.

**BY J. GORDON HOLT**

THE 4-channel picture has changed a lot since the early days of 1972 when the situation could best be, and often was, described as utterly chaotic. Today, the situation is merely utterly confusing. Obviously, the audio industry has embraced the 4-channel idea with boundless enthusiasm, as witness the proliferation of 4-channel discs and tapes as well as 4-channel amplifiers, decoders, etc. But some 4-channel discs are not entirely 4-channel at all, but are 2-channel with recoverable representations of 4-channel information on them. These are called matrixed discs and record companies are now issuing discs using Columbia's "SQ matrix" except for those using the Sansui matrix, or the RCA/JVC System—which isn't matrixed at all but is discrete.

Everyone agrees that discrete 4-channel—that is, 4-channel recording with effectively total isolation among all four channels—is best accomplished on tape, via four separate and parallel tracks. Some 4-channel tapes have already been issued in the open-reel and 8-track cartridge formats. But, you have to rewind a 4-channel open-reel tape, the audio quality from 8-track is still generally pretty mediocre, and some people are toying with the idea of using all four tracks of cassettes for four discrete signals, too. Besides, there is no way of broadcasting discrete 4-channel without giving up those cherished storecast-music services, and an FCC dispensation would be required anyway.

RCA/JVC "CD-4" discs can't be transmitted over 2-channel FM in all four channels either; the broadcasting process filters out the front/rear directional information and CD-4 decoding can't be used on tape, for the same reason. Extracting rear-channel signals from a CD-4 disc requires a rather costly decoding device, but the end result is very similar to that from four tape tracks. Matrix decoders can be much less expensive, but the cheapest ones do a very poor job; the best ones can simulate discrete 4-channel only on certain kinds of program material, and give mediocre performances on others. In theory, you *can* record and recover matrixed 4-channel from a tape. But, in practice, it may require tighter performance standards of tape players than are practical now.

All 4-channel recordings are supposed to be compatible, in the sense that if you reproduce them through a regular 2-channel system, you will hear all the recorded sounds, minus only the front/rear directionality. But SQ and CD-4 are not *mutually* compatible 4-channel systems, for you can't extract the rear-channel directionality from an SQ-encoded disc with a CD-4 decoder, and you can't get it from a CD-4 disc with an SQ decoder. If you want to play the field, you'll need one of each kind of decoder.

There is, in fact, reason to question the compatibility of either system with 2-channel playback. Record companies using Columbia's SQ system continue to release parallel recordings in 2-channel stereo versions, which would seem to suggest that they do not really feel the SQ versions are fully compatible. RCA's confidence in its CD-4 disc's total compatibility is reflected by the fact that it is releasing discs in the CD-4 format *only* but a number of FM-stereo stations have found that they can't broadcast the CD-4 discs even via 2-channel stereo.

Everything considered, it is no wonder that John Q. Public has not been beating down the door of his local hi-fi salon.

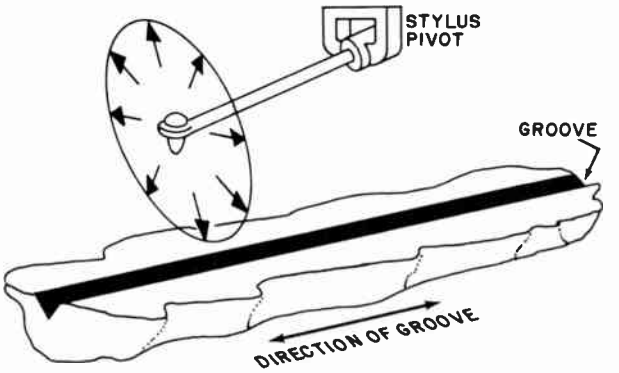



*Fig. 1. With its pivot at the rear, a pickup stylus tip's motion is restricted to a circular plane roughly perpendicular to the direction of groove.*

Those of us who remember the birth of the 2-channel stereo disc may be wondering what all this 4-channel fuss is about. Everyone agreed then that stereo could provide greater realism than monophonic sound (although there were many who objected to stereo because some early stereo recordings were so shockingly unrealistic), just as there is fairly universal agreement today that 4-channel sound can provide greater realism than stereo. And while putting two signals into a single disc groove looked like a formidable and possibly insurmountable task in 1957, you could buy stereo discs with entirely adequate channel separation in your local record store by the end of 1958. Why, then, should it be so difficult to find an equally "neat solution" to the current problem of adding two more channels to the stereo disc's two? The reason is simple: In any circle, there can only be one direction that is exactly perpendicular to another.

A pickup stylus has a rather limited range of motion. Being anchored at the rear, it cannot move in the direction of groove travel. It can vibrate from side-to-side to follow horizontal groove squiggles, it can vibrate up-and-down to follow undulations, or it can vibrate in any direction between the horizontal and the vertical. But its motions are essentially restricted to a plane perpendicular to the average direction of the groove. See Fig 1.

Mono LP grooves were signal-modulated horizontally only and pickups were designed to respond *only* to horizontal vibrations because they were thus insensitive to the vertical component of surface noise particles. Some broadcast discs, though, were modulated vertically and were played with pickups that were exclusively vertical-sensitive. The "simple" solution to the 2-channel disc problem was combining horizontal sensing and vertical sensing into a single phono pickup and recording one signal channel as horizontal squiggles and the other as vertical undulations. Each sensing element in the pickup reproduced its own modulations and rejected the other modulations and the end result was (and is) two signals from a single groove.

Here's how it works, and this is important for an understanding of the 4-channel disc problem: An object (the stylus) can move from side-to-side without changing its vertical position, or it can move up-and-down without moving to either side (Fig. 2). So a recording system based on modulat-

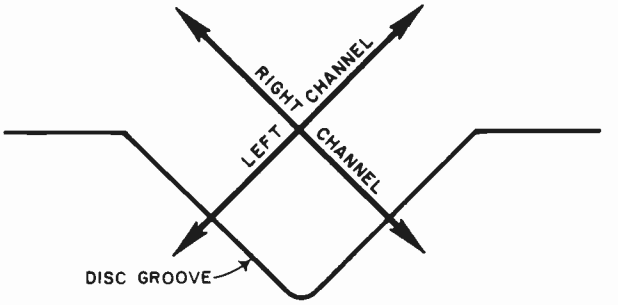
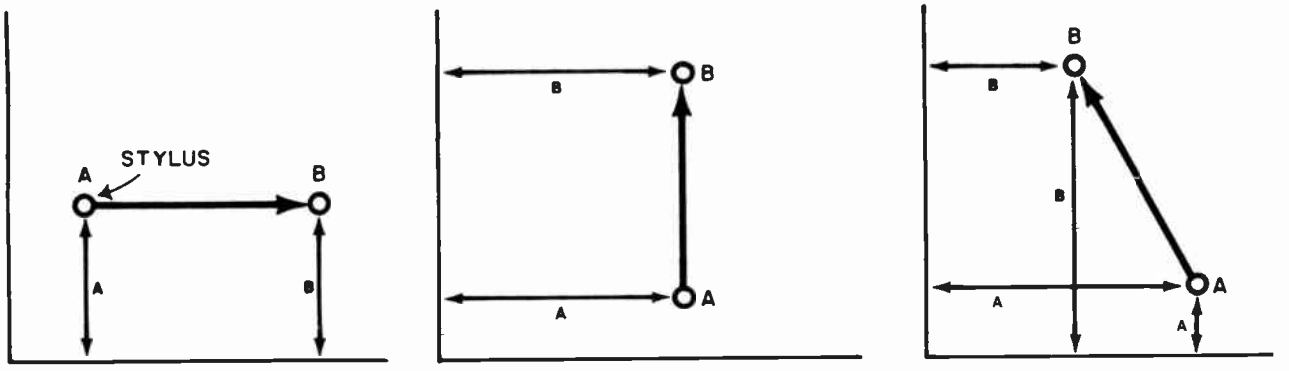



*Fig. 3. Modulation axes of actual 2-channel stereo disc groove (as viewed from the end of the groove).*

*Fig. 2. The principle of stereo disc recording: Stylus movement in one direction (from A to B) does not cause it to change its position in a perpendicular direction. (Left) Horizontal movement, no vertical movement. (Center) Vertical movement, no horizontal movement. (Right) Angular movement: has components of both vertical and horizontal movement.*



ing and playing back in two mutually perpendicular directions can be made to provide *total* channel separation. If the stylus moves in *any* direction except along either of these perpendicular axes, its movement will contain an element of horizontal motion and an element of vertical motion, and some signal will come from *both* pickup outputs simultaneously. This is the condition when a stereo disc is reproducing a sound that should appear somewhere *between* the channel speakers, rather than at one speaker only. And this is why ideal 4-channel stereo in a conventional 2-channel groove is impossible. (In actuality, the modern stereo groove is not modulated vertically and horizontally, but rather in two perpendicular directions, each tilted at 45 degrees from vertical (Fig 3). This is done for practical purposes, to achieve channel symmetry—because styli differ in their vertical and lateral behavior—but the essence of the system—mutually perpendicular modulations—remains.)

Because of the restrictions of stylus motion to that one circular plane perpendicular to the groove direction, all signal information to be reproduced must somehow be represented by stylus movements in that plane. Two signals can be represented, with complete channel isolation, by those original two mutually perpendicular modulation axes. And, obviously, it is no problem to get *more* perfectly isolated signals on there by using a *second*

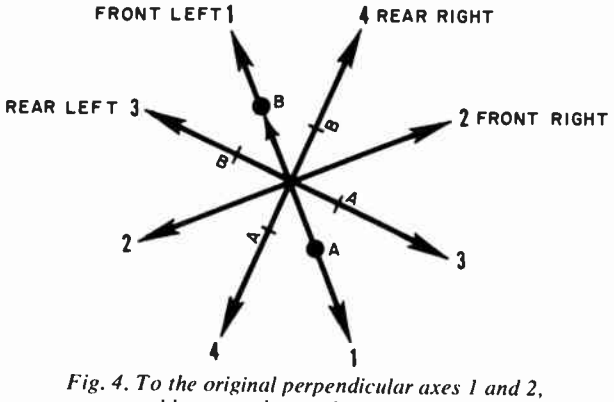



*Fig. 4. To the original perpendicular axes 1 and 2, we can add a second pair (3 and 4) between them to get another fully isolated pair, but the isolation between the adjacent axes will be very poor.*

pair of mutually perpendicular axes (Fig. 4). But that's where the fun begins. We now have perfect isolation between channels 1 and 2 and between channels 3 and 4, but what about between 1 and 3, and 2 and 4?

Modulation from A to B along axis 1 will not change the stylus' position relative to axis 2, but it will clearly change its position relative to both axis 3 *and* axis 4. The result: a signal in channel 1 will appear at reduced volume in channels 3 and 4! If axes 1 and 2 feed the Front-Left and Front-Right speakers, respectively, and 3 and 4 feed the Rear-Left and Rear-Right speakers, respectively, a sound that is supposed to come from Front-Left only will also come from both rear channels at only slightly reduced volume.

We can improve the separation between channels 1 and 3 by rotating axis 3 until it is more closely

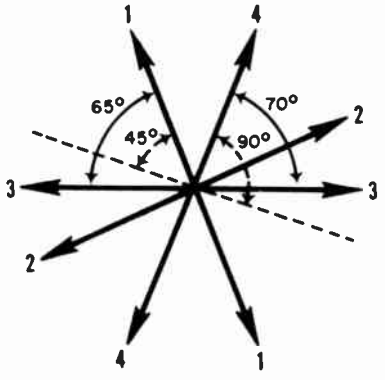



*Fig. 5. Making the original axis 3 (dotted line) more nearly perpendicular to axis 1 improves its isolation from axis 1 but degrades isolation between 3 and 4;3 and 2.*

perpendicular to 1 (Fig. 5). But this will make 3 *less* perpendicular to 2 and 4, so the separation gained between one pair of channels will be lost between the other pairs. We can also play games with the electrical polarity or phasing of the signals so that unwanted signals that leak into one channel will *sound* as if they are coming more from the proper direction. But what you gain here, you always lose there. "Designing" a matrix system, then, involves making compromises all down the line, trading off one thing for another, which explains the bewildering number of matrix systems that have been used to date. Basically, they differ only in that some strive for wide right/left separation and accept poor front/rear separation, while others try to approach better front/rear separation without giving up "too much" left/right separation.

It was clear at the start that no matrixing system, alone, could really hope to separate fully the original four signals from the 2-track composite. A possible solution was offered early in the game by an engineer named Peter Scheiber, who proposed combining a symmetrical matrix (axes at 45-degree intervals) with an ingenious "logic enhancer" that functioned as a set of computerized switches, determining from the signals in all four channels which ones didn't belong there, and automatically shutting those down. The enhancing was done instantaneously according to the signal impulses, and

gave a reasonably convincing simulation of a true discrete 4-channel reproduction.

It wasn't perfect by any stretch of the imagination, though, and went back to the drawing board. Meanwhile, other matrixing systems started to appear, some with logic enhancement, others without. The ultimate in complexity—the Columbia SQ system—used *circular* modulations in opposite directions for the rear channels, and called for a sophisticated logic-enhancement decoder in order to yield maximum channel separation. That, basically, is the matrix system in most common use in the U.S. today. Meanwhile Sansui came up with its own system, without logic enhancement, and recruited a number of licensees, too. (Later versions have separation enhancement, but the decoders are still different from SQ's.)

Those two systems account for the majority of matrixed discs being made today, with SQ releases outnumbering Sansui's by a substantial margin. Some other discs have been matrixed for two other systems—one proposed by Electro-Voice and the other, the so-called Dynaco/Hafler matrix.

The Electro-Voice matrix was based on the original Scheiber design, but minus the logic enhancement and, like all other matrix systems, it was at least slightly incompatible with any 4-channel disc cut for any other matrix. Playing one matrix on another decoder caused degraded separation between certain channels, and upset the directional information, shifting sound sources to one side or another and often causing vagueness of directionality. A second E-V matrix, more like the SQ one, enhanced SQ-encoded discs but made some other matrixed discs sound worse. But it was a sign that the industry was "zeroing in" on the SQ system.

The so-called Hafler matrix (a synthesized system) was never seriously proposed as a 4-channel technique (although some recordings were made using it), but was instead an ingenious and inexpensive way of extracting rear-channel ambience from conventional 2-channel stereo recordings, using nothing more than two extra loudspeakers and a resistor or two. It works reasonably well with many recordings, but does not do an acceptable job of "decoding" SQ-matrixed discs.

The one non-matrix disc in use—the RCA/JVC CD-4 system—makes no attempt at all to jam any more information into the already crowded stereo groove but instead widens the available information "space" by extending the disc's frequency response up to around 50 kHz. When the CD-4 disc is cut, all left-hand signals (from front and back of the 4-channel original) are blended together, as are all right-hand signals, and these are laid on the disc as the usual 2-channel stereo modulations. Before the blending takes place, though, the front and rear signals in each side are compared, and the *difference* between them is extracted and used to vary the frequency of a pair of *ultrasonic* tones, which are also laid on as conventional 45-45 degree stereo modulations (Fig. 6).

Played on a 2-channel reproducer, the ultrasonic tones are simply lost by the wayside. Front, rear, and side sounds are all reproduced through the front pair of speakers. Played through a suitable decoder and pickup, the ultrasonic tones are detected in a manner similar to an ordinary FM broadcast, and the resulting difference signals are used to separate the original front and rear signals from the blended 2-channel pairs. Thus, the system is eminently compatible for 4-, 2-, or single-channel reproduction, but it is clear why CD-4 is not applicable to any other 2-channel medium but the disc: neither tapes nor (without modification) FM transmissions will pass the 30-kHz ultrasonic tones. Those self-same tones can, in fact, ruin 2-channel FM stereo transmissions by forming very audible 8-kHz beat notes with the 38-kHz stereo FM carrier signal. It is possible that suitable filters at the FM stations will eliminate the beat-tone problems, but at present it appears that CD-4 is almost exclusively for disc reproduction in the home.

At present, the RCA/JVC CD-4 disc's 4-channel performance is clearly superior to that of any of the matrixing systems, and approaches that of discrete 4-channel tape. But, it is not entirely without its problems. It is not usable with most existing phono pickups—they lack the necessary high-frequency range, and some will abrade the ultrasonic signals rather rapidly. Stylus cleanliness is crucial too, which means that some popular record-cleaning devices, like silicone-impregnated cloths which tend to gum up the stylus, won't be usable any more. In fact, the unprecedented requirement for record cleanliness may prove detrimental to CD-4's public acceptance, because most people just can't be bothered keeping discs that clean. In addition, there is still a tendency for the CD-4 system to break down a bit during occasional loudly recorded treble passages, causing a most distressing tearing sound in one or more channels that is not unlike the sound of severe mistracking distortion.

The tearing sound, which is apparently related to mistracking of the carrier, will undoubtedly be eliminated as pickups and CD-4 cutting techniques are refined. When CD-4 *is* working right, the sound can be extraordinarily good. Some of the discs, even through two channels, have a magnifi-

cent, transparent lustre that is rare from a conventional 2-channel disc.

SQ performance is harder to evaluate, because it is profoundly affected by the decoder used. Logic enhancement was considered as an integral part of the total SQ system design, and no SQ disc can perform to its full capability *without* so-called "full-logic" decoding. But full-logic decoders are still relatively scarce and fairly expensive (although not as costly as a minimal CD-4 decoder), and as a result, most people tend—unfairly perhaps—to evaluate SQ performance on the basis of its use with decoders having "partial logic" or, more commonly, no logic enhancement at all. Under these conditions, SQ's matrixing tradeoffs become evident. The SQ matrix aims for wide right/left stereo separation (to maintain 2-channel compatibility) and depends on the logic enhancement to improve an exceedingly poor front-to-rear separation. Without the logic enhancement, an SQ disc in 4-channel playback sounds almost like a 2-channel disc, and is less satisfactory than an unenhanced Sansui disc.

With fully enhanced decoding for both, differences between the Sansui and SQ systems are rather academic—one is better in some respects and the other better in others. But neither is a match for a good CD-4 playback. Except for slightly imperfect separation—20 dB is about par—which will probably be improved with time, a CD-4 disc can do anything a discrete tape can do. With either matrix system, even with enhancement, it is not possible to get anything approaching true discrete performance from all four channels simultaneously. Instruments in one or two channels are handled easily, but any more than that start to confuse the enhancer, which can't "decide" which sound should be routed to which channel, and starts to tear everything apart. Channel separation goes to pot, instruments start hopping from one channel to another on a seemingly random basis, and the control action of the decoder becomes audible as plopping changes in the volume of each channel. In addition, listening tests conducted for the preparation of this article revealed that many of the logic equipped SQ decoders on the market have rather high electrical distortion and cause an audible roughening or hardening of the sound—something that was not observed with any of the CD-4 decoders used. Since the distortion was audible on 2-channel stereo discs, as well as mono LP's, it was probably not a sign of inherent problems in the SQ system, but merely that some decoders are not designed with enough care to do full justice to the potential sound quality of the SQ discs. It is also possible that CBS's own "logic chips," which they have just begun to make available to decoder makers, may work better than the printed-circuit versions in the decoders tested. But both shortcomings in present units cannot but help to temper consumer enthusiasm for SQ.

### WHERE DO WE STAND NOW?

That 4-channel sound is starting—slowly—to go over with the buying public, despite customer confusion, is unarguable. Equally unarguable is the fact that anyone buying a 4-channel system at this time must face the possibility of it becoming obsolete since the industry could opt for SQ or CD-4, or even some presently undiscovered matrix system—and when it does, all others may fall by the wayside.

To date, the 8-track cartridge has been the leading seller in the 4-channel field, for two reasons: It has no performance limitations except those pertaining to fidelity, which could and probably will improve, and it has been around longer than any other 4-channel format. (Actually, the first 4-channel releases were on open-reel tape, but the general public has already rejected that format.) The SQ disc didn't appear until two years later, but sales of these, and their decoders of various types and efficacies, have been gaining on 8-track cartridges in recent months, probably because most people still prefer discs to any other format, and will accept the shortcomings of matrixing if they have no alternative but tape. And then there's the newcomer—the CD-4 disc, which has nothing to recommend it except that it is a disc, is fully compatible, and produces tape-type 4-channel performance.

Virtually every record company interested in 4-channel is now issuing on discrete 8-track cartridges. And in the disc field, Columbia and their SQ licensees are offering a vast selection of artists and repertoire, while about all that RCA could offer for its initial releases was some Hugo Montenegro and a few sonically brilliant recordings of undistinguished performances by the Philadelphia Orchestra. The question was, Who would invest in a CD-4 system when all the big recording "Names" were on SQ? CD-4 looked like a dead duck, despite its performance superiority—another triumph of mass appeal over quality.

Things being as they are, so-called pop records always outsell recordings of classical music by a substantial margin. Until recently, though, the big U.S. record companies and the hi-fi industry in general have nurtured an image of concern with things cultural, touting the concert-hall realism of

their latest recordings and reproducers, while knowing full well that most buyers had never been in a concert hall in their lives. Predictably, when 4-channel sound came along, it was hailed as another breakthrough in reproduced realism—a better way then ever of transporting the listener "right into the concert hall" by providing him, via the rear channels, with the ambience information that tells a concertgoer's ears that he's in a very large, enclosed space. The implied appeal was, as usual, to the classical listener who is traditionally somewhat conservative in his acceptance of new recording techniques. Only as an afterthought, it seemed, was 4-channel sound suggested as a means of creating new sonic experiences, such as that of being bathed in instrumental sounds coming from all directions.

Some classics enthusiasts were initially attracted to the idea of 4-channel sound until Columbia, followed by several other companies, announced that they were abandoning rear-channel ambience in favor of instruments from all directions for all future classical recordings. The reaction of the "serious" music listener was predictable. He lost interest in 4-channel sound, and may not bother with it again at all. The record companies figure they won't miss him; he is an insignificant segment of the market, compared with the millions of pop-music buyers. And by and large, the pop market—which *is* receptive to innovation—had shown a gratifying lack of critical perception in the past.

But today's popular music buyer is a different breed of cat from "Saint Polly of the pimples" who was the cynical record maker's stereotyped consumer of ten years ago. Many rock enthusiasts have developed sophisticated ears and they and the recording artists themselves, who have more than a little say about how they shall be recorded, *like* the discrete approach to 4-channel, because what goes in comes out. They helped to establish the 8-track cartridge as a primary 4-channel format, and it seems they will do the same for CD-4. The Warner group—the largest single manufacturer of popular recordings in the world—has announced that it will adopt CD-4 for all 4-channel releases. And all of a sudden, the future of the matrixed disc looks less certain than it did before.

### WHERE DO WE GO FROM HERE?

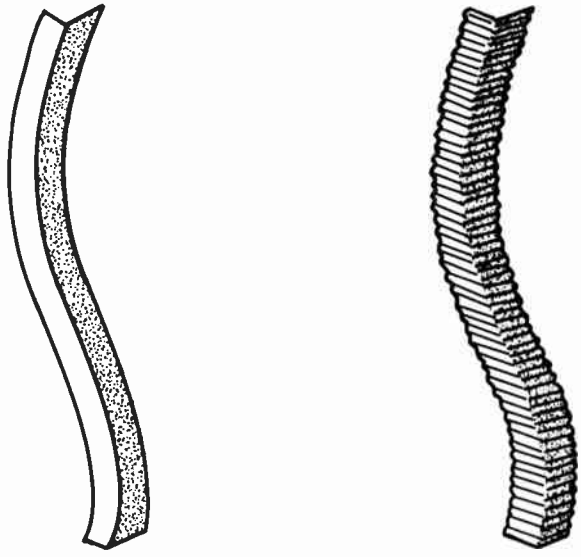
Americans do not like a stalemate. We like to see conflicts concluded decisively, with a Winner and a Loser. So, few people consider seriously the possibility of both SQ and CD-4 co-existing for long. As for a sensible "compromise" solution—a disc encoded for *both* systems, neither RCA nor Columbia will even admit to the possibility of this.

It is obvious, though, that we can't go on with some firms making CD-4 discs, some making SQ discs, and others the Sansui QS discs. Even a tacit agreement among the record companies would not maintain such a status quo, because the public, by consistently choosing one system over the other—on the basis of available artists if not technical excellence—would eventually phase out one system or the other. And every consumer who had picked the loser would be stuck with a library of obsolete discs.

But there is no reason whatsoever why the 4-channel system that is best-*suited* for a given format should not be used for it, even if this means CD-4 for discs, the SQ matrix (or Sansui, or a combination of both) for cassettes and for FM broadcasting, and four discrete tracks on 8-track cartridges. Mutual incompatibility would be little problem; you can't play a cassette on a phonograph or a disc on an 8-track cartridge player even now. One matrix decoder could be used for cassettes, FM reception, and the matrixed discs that have been issued (and sold) to date. And a CD-4 preamp-decoder would allow you to play CD-4 discs or any older discs, including matrixed ones. Without the 30-kHz carrier tone, the CD-4 decoder would put out a conventional 2-channel stereo signal, which could then be decoded by the same device used for FM or cassettes.

With Warner committing its vast stable of artists to CD-4, that's exactly what may come to pass. But then, anything could still happen. That's the way the 4-channel field is, these days. □

*Fig. 6. Modulated 2-channel stereo groove (left) and same groove modulation with superimposed ultrasonic carrier tones for CD-4.*



# Studio Recording of POP MUSIC

Four overdub sessions were required to tape Ovation's 4-channel recording of the group "Heaven & Earth."

**By JAMES C. CUNNINGHAM**
General Manager, Sound Market Recording Studio, Chicago

REALITY is not usually the goal in popular-music recordings. For most engineers and producers this is a happy fact; a studio full of musicians and several hundred thousand dollars' worth of complex electronics is a chance for them to get involved in the creative process. There is a risk; if their involvement becomes an ego trip for either of them, the result is nearly always an unqualified disaster. Since the recording studio bill has been known to run as high as $100,000 for one album, nobody needs disasters. In fact, a hit album in the rock field is often a "happening" – the final result is greater than the sum of the individual contributors.

Before we get to the 4-channel recording session itself, a description of some techniques of pop music recording in general will be useful. Most recording sessions – mono, stereo, or 4-channel – will be accomplished in two parts: the live sessions with musicians and then the mixdown. The live sessions (there may be up to five or six of these) are primarily for the purpose of getting each instrument on its own separate channel of a multi-track tape with the "right sound." Sweeteners, such as vocal groups, strings, brass, etc., are usually added at subsequent sessions. These are called overdubs and are synchronized with the previous session by using the record head on the multi-track head stack for playback while recording the new information on an unused track. Thus the sweetening musicians listen to the previous recording and play in synchronism with it.

In the mixdown session all the recorded tracks, usually 16, are mixed into two or four channels for the final product. At this time attention is paid to exact balances of the instruments; equalization may be used to "bring forward" certain instruments and reverberation is added to certain instruments and vocals. The addition of artificial reverberation is

*Overall view of the control room showing the location of monitor speakers and the elaborate mixing console.*

necessary for certain instruments and vocals because they have been "close miked" in a dead studio in order to gain isolation between instruments. This isolation allows the mixer more flexibility: he can raise the level of the guitar, for instance, without affecting the levels of other instruments.

For mono and stereo, these techniques have been developed by engineers and producers to a very fine art. Some engineers are so proficient at this art that they can get $100 an hour for mixing on a free-lance basis. At the moment, however, 4-channel is something of a mystery to most engineers and producers, partly because not very many studios are as yet fully equipped for 4-channel mixing. This situation is starting to change now that the sales of quadriphonic records and components are increasing rapidly.

Actually 4-channel mixing is not much of a mystery if an understanding of the elements of human hearing are combined with existing technology. There are new technical developments which complicate matters somewhat, but these will be dealt with a bit later.

The balance control on your stereo will show how the ultimate tool of 4 channel—the pan pot—works. If you play a mono record and rotate the balance control slowly from one extreme to the other, the sound will seem to move between the two speakers. This is not a condition that exists anywhere in nature, normally everything is a point source, but luckily our ears fuse the sound from the two speakers into a point source and this is called a "virtual image." The 4-channel pan pot is a device which varies the intensities going to the four speakers with a single joy stick. With this control the engineer can take the guitar track, for example, and place the instrument anywhere 360° around you. He can make it move in a figure-8 pattern if he likes or make it seem as if it were directly overhead by sending an equal amount of sound to all four speakers.

Now let's suppose the engineer has 16 of these pan pots, one for each track on his tape machine, and he has placed the musicians in a circle around him—electrically speaking. The acoustic result will be roughly the equivalent of having the 16 musicians come into your living room and play for you. The starkness of this sound would have little appeal for most people so the engineer will simulate a larger room by adding artificial reverberation to many of the instruments (he can select which instruments and how much with controls on his console) and little or none to certain ones, such as percussion. Thus, with this flexibility, he can improve upon reality. Four-channel, however, presents some interesting special problems to the engineer in regard

*Jo D. Andrews and Pat Gefell during the first live session to record their new pop album, "Refuge."*

to reverberation—which we will cover briefly before we describe a 4-channel recording session.

The traditional "echo chamber" in a recording studio is really a small live room, something like a tiled bathroom, with a loudspeaker and a microphone in it. The microphone picks up several thousand reflections a second coming from the walls, floor, and ceiling. This technique has been used in broadcast and recording studios since the 1920's and serves well in a mono recording system. When stereo came in engineers soon learned they had to put two microphones in the chamber to get a spatial effect from the reverberation. Because each microphone "hears" a slightly different set of reflections, thousands of virtual images are produced and the reverberation spreads between the speakers. In 4-channel, if four microphones are placed in the chamber the reverberation comes from every direction, just as it does in real life, and the effect is breathtaking on certain instruments, such as strings. There is one difficulty with the traditional "echo chamber" in that it can simulate "liveness" but not size. In a real room of large dimensions the reflections build up slowly but in the chamber they build up very fast and tend to "cover" the direct sound—causing a lack of definition. This is partially solved by delaying the sound by a small fraction of a second before sending it to the chamber. Recent developments in digital delay lines have led to experimental units which electronically simulate large-room reverberation in 4-channel. These should be

available soon and will no doubt help to advance 4-channel to a dominant position in recording in the world today.

A great deal of preparation goes into any recording session, 4-channel or not; tunes must be picked carefully, arrangements must be written, musicians must be contracted, and studio time booked. The recording session must be planned so the right instruments are isolated to provide flexibility in the final mixdown session. Four-channel becomes an additional complication because now the planning must make sure the placment of instruments for 4-channel will yield a good stereo and mono sound, inasmuch as the record may well be released in one of the matrix systems which are supposed to be stereo compatible.

### "HEAVEN & EARTH"

The Ovation recording session for the rock-folk group "Heaven & Earth" was no exception; the live sessions consisted of one basic session in which Jo D. Andrews and Pat Gefell tracked the vocals and acoustic guitar (played by Pat) for the entire album. There were four overdub sessions, the first of which included bass, drums, electric and acoustic guitars. The drums were stereo miked with a total of eight microphones. The next overdub session was strings; four violins, one viola, one cello. One mike was used on the four violins, one on the cello, and one on the viola. The strings were then "multed" twice, which means they played the same parts again, giving the effect of 18 strings. The third overdub session was piano or clarinet and flute. The piano was stereo miked. The last overdub was percussion—conga drum, bongos, and tamborine.

The mixdown session followed the advanced plan for 4-channel placement except for minor alterations. The tune, "Feel the Spirit," is a typical example of how most of the tunes were mixed. Jo D's vocal was panned just to the left of center and Pat's just to the right. This means the solos are on all four speakers and cannot be lost no matter where the listener moves in the room. Toward the end of the tune some motional panning is used. The drums are in stereo on the front channels along with the bass which is panned in the center. Electric guitar is left-front and Pat's acoustic guitar is right-front. The violins are on the left side with stereo reverb returned on the right side. Just the reverse for the viola and cello. Left-rear contains congo drum and another acoustic guitar. Right-rear has bongos and the flute is on all four channels with 4-channel reverberation on all four. The over-all effect is that the listener is engulfed in the music without being distracted by any important musical lines coming from behind.

Anyone interested in 4-channel mixing techniques would do well to listen to and analyze current tapes as there are many more techniques in use today than can be discussed in one article. The album—"Refuge"—is available on discrete four-channel tapes, cartridge and open reel, as well as a record encoded in the Sansui QS matrix (# OVGD/1428). □

*Rear monitor speakers (center) and patch panel (right).*

*A close-up view of the 16-track studio control console.*

# Test Report.....

# CHROMIUM DIOXIDE VS FERRIC-OXIDE TAPES

To the critical listener $CrO_2$ tape does provide superior performance—the S/N is about 3 dB better. To the average listener, though, the benefits may not be worth the higher cost of tape and machine.

**By JULIAN D. HIRSCH**/Hirsch-Houck Laboratories

THE acceptance of the tape cassette as a true-high fidelity medium can be credited, in large measure, to the special tape coatings developed to complement the unique characteristics of cassette recorders. Periodically, in fact, tape capability seems to outstrip recorder performance so that new recorders must be designed to exploit the performance potential of the tape.

Perhaps the most publicized cassette-tape development has been that of chromium-dioxide ($CrO_2$) coatings, in contrast to the more common ferric oxide. Among the advantages claimed for $CrO_2$ are extended high-frequency response and improved signal-to-noise (S+N)/N. The major disadvantage of $CrO_2$ is its need for higher recording bias and erase currents, as well as special equalization characteristics if the tape's full potential is to be realized. $CrO_2$ tape can only be used effectively in recorders specifically designed for it and most high-quality cassette decks now have switches to optimize their performance for chromium and ferric oxide tapes (and sometimes for more than one grade of ferric-oxide tape). $CrO_2$ cassettes, although relatively expensive, are priced competitively with premium-grade ferric-oxide cassettes.

The relationship among operating bias, recording level, distortion, and frequency response in cassette recording is explained in detail by Herman Burstein on page 42. Briefly, as the ultrasonic bias signal combined with the audio signal in the recording head is increased from a low value, there is an increase in the playback output level and a reduction in distortion. Since the residual noise level (hiss) remains relatively constant, there is a net improvement in (S+N)/N with increasing bias.

Simultaneously, however, the higher audio frequencies are partially erased by the stronger bias signal as they are recorded, resulting in a loss of high-frequency response. At the optimum bias (from distortion and output considerations), the loss of highs is usually excessive, so a lower compromise bias is used. In all cases, a treble boost is used during recording to achieve a "flat" response with a standard playback equalization. Although it might seem that increasing the recording high-frequency boost would allow a flat frequency response to be achieved together with maximum output and minimum distortion, the tape coating would then become magnetically saturated with relatively low-level, high-frequency signals.

Tape manufacturers have concentrated on developing magnetic coatings capable of storing higher energy levels, as well as being more resistant to de-magnetization by the bias flux. In the better tapes, the microscopic magnetic particles have been made even smaller and the tape surface polished for closer contact with the record/playback head. These premium tapes are usually identified by such names as "Low Noise," "Super Dynamic," "Ultra Dynamic," "Extended Range," "High Energy," etc. They can provide significantly better high-frequency response and improved (S+N)/N than standard tapes, especial-

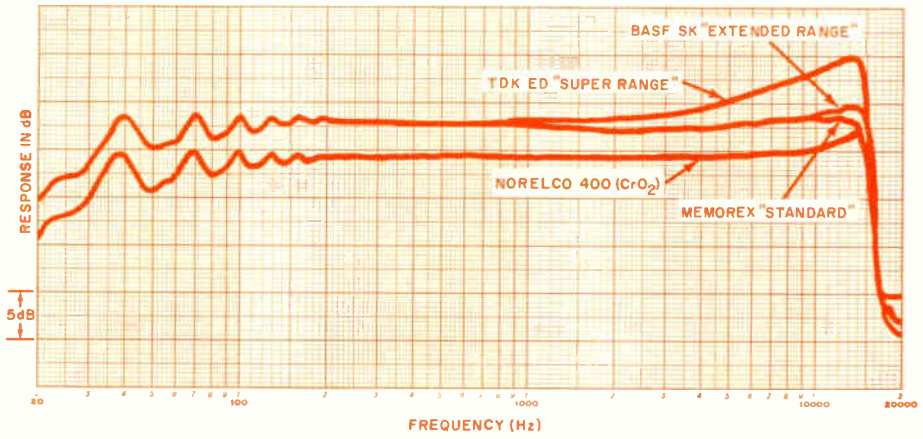



*Fig. 1. Frequency response of four distinctly different types of tapes, taken at −30 dB level to prevent high-frequency tape saturation. An Advent Model 201 tape deck was used. The bias and equalization for the three ferric-oxide tapes were set for "standard" type tape. The various high frequency peaks could be reduced to near flat performance by increasing the bias. Refer to text.*

ly in a recorder whose electrical characteristics complement the tape requirements.

It is interesting, from a semantic standpoint, to observe that a number of manufacturers of premium-quality tapes also use the "Low Noise" name for their standard cassettes. On the other hand, some other "Low Noise" cassettes are actually their manufacturers' top-of-the-line, premium-quality products. As with many packaged foods and household products, the over-use of superlatives has complicated the problem for the consumer who wishes to know which is the highest grade!

The $CrO_2$ cassettes go a step beyond the best ferric-oxide offerings in their capacity to store energy (particularly at high frequencies), and to resist bias de-magnetization. They must be operated at a higher bias level and recorded at a higher level as well. Since they resist erasure, a higher erase current is also required in the recorder. The improved treble response of $CrO_2$ tape can be utilized in several ways. Using more treble cut in the playback equalization gives an improved (S+N)/N ratio while retaining a flat frequency response. On the other hand, with standard playback equalization, high-frequency response can be extended and the higher bias and recording level still gives a (S+N)/N ratio at least as good as ferric-oxide tape. Each manufacturer has selected the operating conditions which he considers optimum.

To summarize, the overall performance of any cassette recorder is dependent on the tape properties, the recording bias and equalization, recording level, and playback equalization. Of course, there are other important factors, such as head design, which we are not considering at this time, There are accepted industry standards for playback equalization (a necessity for playing commercially recorded cassettes), but each manufacturer is free to choose his own combination of the other factors. In the case of $CrO_2$ tape, there is not yet a universally accepted playback equalization characteristic, resulting in a potentially chaotic situation.

Often there is a gap between theoretical expectations and the actual performance of a commercial product. This in no way diminishes the importance of a sound theoretical design. It can usually be explained by a failure to consider *all* aspects of the problem (such as equating apples and oranges, simply because both are fruits).

Mr. Burstein's article has clearly pointed out what *should* be expected from $CrO_2$ tape, as compared to ferric-oxide tape, in cassette recording. Our goal in these tests was to measure what the *actual* differences were among a number of cassette tapes, when used in a single high-quality cassette recorder. The test machine was an Advent 201, which has bias and playback equalization switching for ferric-oxide and chromium-dioxide tapes. The factory-set $CrO_2$ bias was used, since we had determined that it gave flattest frequency response. For the ferric-oxide tapes, we adjusted the bias for flattest overall frequency response with typical "standard" tapes, such as Memorex and Scotch "HE."

Each cassette was measured under identical conditions, without altering any control settings or operating levels (except the recorder's selector switch for $CrO_2$ tapes, where applicable). With a 1000-Hz signal recorded at 0 dB, we measured the playback output level. The noise was measured in a section of tape which had been recorded with no input signal. This was essentially an unweighted measurement, although frequencies below 250 Hz were attenuated to prevent hum and low-frequency disturbances from influencing our data, since we were only concerned with "hiss."

The playback distortion (THD) was measured at a number of recording levels to determine what point on the recorder's level meter corresponded

to a standard 3% THD in the playback. The output (S+N)/N ratio was the difference (in decibels) between the output at 3% THD and the playback noise with no recorded signal. The overall record/playback frequency response was measured with each tape, using a level of −30 dB to prevent tape saturation at the higher frequencies.

A common problem with cassettes is a fluctuating output level, caused by tape imperfections or mechanical faults in the cassette. To evaluate this, we recorded a 10-kHz signal and played it back onto a graphic-level recorder, over a three-minute period. An ideal tape would produce a straight horizontal line on the chart, generally though cassettes always show some irregularity or thickening of the line as the output varies. The graph also allows us to identify the nature of the problem, random coating variations, occasional "drop-outs," or a periodic "cogging" effect due to uneven friction in the cassette hubs.

We also made listening comparisons among the cassettes, both to check the similarity of some which tested identically, and to hear how much difference in sound resulted from some of the measured differences.

The cassettes tested were representative of the current offerings of several leading manufacturers. Whenever possible, we chose manufacturers who produced both ferric- and chromium-dioxide cassettes. In a couple of cases, where the line did not include a $CrO_2$ tape, we tested the best grade of ferric-oxide cassette. The following cassettes were tested: BASF SK ("Low Noise/Extended Range"), LH, and Chromdioxid ($CrO_2$); Capitol 2; Memorex, and Chromium Dioxide; Norelco 300 ("High Output/Low Noise"), and 400 ($CrO_2$); Scotch HE ("High Energy"); TDK LN ("Low Noise"), SD ("Super Dynamic"), ED ("Extra Dynamic"), and KR ($CrO_2$).

Many of these cassettes are available in different playing times; we tested only the popular C-60 length. Since the longer playing cassettes use thinner tapes and coatings, they do not necessarily give the same performance as a C-60 cassette carrying the same designation.

Table 1 lists the results of our measurements. The "Output" figures are purely relative, but do show a "spread" of almost 5 dB among the tapes. Similarly, the 3% THD levels apply only to the particular machine and bias settings we used. The actual numbers could be quite different in another recorder, but we would expect the relative standings of the tapes to be about the same. The S/N figures have been rounded off to the nearest decibel, since the method of measurement does not warrant greater precision.

Instead of showing actual tape output variations, we have interpreted them according to our experience with this test, and assigned relative rankings to the various cassettes. Higher numbers indicate more variation in output, and cassettes carrying the same number had essentially the same performance.

The frequency-response charts were all alike (except for level) up to about 1000 Hz. At higher frequencies, some tapes had a slight decrease in output, some were uniform, and some had a rising characteristic. Most had a slight peak at 14 or 15 kHz (a recorder characteristic) and fell off rapidly at higher frequencies. Some typical curves are shown in Fig. 1. Since most of the differences were at higher frequencies, we have tabulated the outputs at 4 kHz and 12 kHz, relative to the 400-Hz level, for each tape.

*Table 1. Results of measurements show variation among different cassette tapes tested.*

| TAPE | OUTPUT dB | REC. LEVEL dB @ 3% THD | S/N re 3% THD dB | OUTPUT FLUCTUATION* | FREQ. RESP. re 400 Hz 4 kHz | 12 kHz | PRICE |
|---|---|---|---|---|---|---|---|
| BASF SK | +0.8 | +1 | 57 | 1 | −0.6 dB | +1.8 dB | $1.75 |
| BASF LH | −0.2 | +1.5 | 55 | 1 | −1.0 dB | +0.7 dB | $2.65 |
| BASF $CrO_2$ | −2.3 | +2 | 58 | 2 | 0.0 dB | +2.0 dB | $3.89 |
| Capitol 2 | +0.9 | −1 | 54 | 2 | +2.2 dB | +5.3 dB | $2.98 |
| Memorex | +1.4 | 0 | 56 | 3 | 0.0 dB | +1.0 dB | $1.99 |
| Memorex $CrO_2$ | −1.3 | +3.5 | 60 | 2 | +0.3 dB | +1.8 dB | $2.99 |
| Norelco 300 | +0.5 | +1.5 | 57 | 2 | 0.0 dB | +2.6 dB | $2.95 |
| Norelco 400 $CrO_2$ | −2.3 | +2 | 58 | 1 | 0.0 dB | +1.5 dB | $3.49 |
| Scotch "HE" | +2.1 | −1 | 56 | 4 | −2.0 dB | 0.8 dB | $2.80 |
| TDK LN | +1.6 | +1.5 | 55 | 1 | −0.7 dB | +0.5 dB | $1.49 |
| TDK SD | +1.5 | +1 | 57 | 1 | −0.4 dB | +2.2 dB | $2.29 |
| TDK ED | +2.2 | 0 | 55 | 2** | +1.5 dB | +6.4 dB | $3.00 |
| TDK KR $CrO_2$ | −1.5 | +3 | 59 | 1 | 0.0 dB | +1.0 dB | $3.00 |

*Number rankings increase with greater fluctuation
**Largely due to internal cassette mechanical friction, otherwise would rank 1.

In spite of the considerable "spread" in output, noise, and maximum recording level among these tapes, the final (S+N)/N figures fell into fairly well defined categories. The "standard" tapes are those which operated best (gave flattest response) in the Advent 201 recorder with the bias we used. These included Memorex, Scotch HE, and TDK LN cassettes. The Scotch HE cassettes, designed to operate with "standard" bias recorders, have a higher output level, which extends their dynamic range somewhat.

A second group, which we will call "extended range" for want of a better name, had a slightly rising high-end response (up about 2 to 2.5 dB at 12 kHz), which could have been reduced by a slight increase in bias. However, these tapes (BASF SK, BASF LH, Norelco 300, and TDK SD) are completely satisfactory with a standard bias level. The third category might be termed "super range" (since we have evidently fallen victim to the use of superlatives!). These have a strongly accentuated high end, with an appreciable rise as low as 4 kHz, and really require a higher-than-standard bias for satisfactory performance. In the "super" category were the Capitol 2 and TDK ED tapes. Finally, of course, there were the chromium-dioxide cassettes—BASF Chromdioxid, Memorex Chromium Dioxide, Norelco 400, and TDK Krom-$O_2$ (KR).

In general, the (S+N)/N ratio improved as we progressed from "standard" to "extended range" to $CrO_2$ tapes. It was typically 55-56 dB for the "standard" cassettes, 57 dB for the "extended range" types, and 58-60 dB for the $CrO_2$ tapes. The "super range" cassettes, operating with standard bias, had the poorest S/N ratio, 54 to 55 dB. Obviously, an increase in bias would flatten the high-end response and allow higher recording levels. Almost certainly their S/N ratio under optimum conditions would be slightly better than that of the other ferric-oxide tapes. However, the point of this investigation was to show comparative performance under *real*, not necessarily *optimum* conditions. If your recorder is biased for these "super" tapes, they will outperform the others. Few, if any, cassette decks are so adjusted at the factory, and only the Advent 201 (to our knowledge) even has accessible bias adjustments for the benefit of a knowledgeable user.

The Scotch HE tape, although its output was higher than other standard bias tapes, also reached 3% THD at a lower recording level. The net result was a (S+N)/N of 56 dB, high for this group, but not quite matching the "extended range" cassettes.

As Mr. Burstein pointed out in the conclusion of his article, an improvement of 3 dB in (S+N)/N ratio is always welcome to a recordist, even if it doesn't look impressive in print. Our measurements show that 3 dB is the actual (S+N)/N advantage of $CrO_2$ over the best ferric-oxide cassette tapes. $CrO_2$ can be recorded at a 2 to 3 dB higher level without exceeding 3% THD, but its output level, to our surprise, is also about 2 to 3 dB lower than that of ferric-oxide tapes. The net improvement in (S+N)/N ratio is evidently due to the added roll-off in the playback equalization of the Advent recorder. This was confirmed by our experience with other cassette recorders which use the same playback equalization for all tapes. With these machines, the (S+N)/N ratio is no better with $CrO_2$ than with any good ferric-oxide tape, although the high-frequency response is usually considerably extended.

Most $CrO_2$ cassettes use DuPont "Crolyn" tape and therefore have identical magnetic properties. An exception is BASF Chromdioxid, made in West Germany by a BASF process. In our tests, it reached 3% THD at a slightly lower recording level than the Crolyn tapes and, as a result, did not have quite as good a (S+N)/N (the difference, although measurable, was slight). The Norelco 400 appeared to be identical to the BASF Chromdioxid in its properties.

### DO $CrO_2$ TAPES SOUND BETTER?

There is little in our measurements to suggest that $CrO_2$ cassettes would be audibly superior to high-grade ferric-oxide tapes. Obviously, they are "better," but it is not so easy to judge if the benefits are worth the higher tape cost.

We could not fully resolve this question in listening tests. Generally, the $CrO_2$ cassettes sounded more "open," with less of the apparent compression of dynamics, particularly at high frequencies, that one sometimes hears in cassette recordings. On the other hand, we always knew what cassette was in use, which conceivably could have affected the objectivity of our judgment. A test of this sort should really be made before a panel of listeners who are unaware of the products being judged.

Our conclusion: for the very finest cassette recordings, $CrO_2$ tape is indicated. Its use may be uneconomic, since the price of the cassettes is beyond the point of diminishing returns for most people. For 99% of home cassette recording needs, a good grade of "extended range" ferric-oxide tape will do about as well, at an appreciable cost saving. The "super range" tapes—Capitol 2 and TDK ED—rival $CrO_2$ in most respects (including price!), but will require a bias adjustment on most tape recorders. □

# CASSETTE NOISE-REDUCING SYSTEMS

There are several different systems in use today. Their effectiveness is, in a way, related to the price you have to pay.

DESPITE impressive advances in magnetic tapes, narrow-gap heads, and low-noise electronics, cassette recorders still have a relatively poor signal-to-noise (S + N)/N ratio, compared to standard open-reel tapes or phonograph records.

The problem is fundamental. The very narrow track width (about 0.020 inch) severely limits the amount of energy which can be stored on the tape and, therefore, the playback output voltage is low. Both theoretical and practical considerations set a lower limit on the noise in the tape and electronic circuits; hence, the (S + N)/N ratio is necessarily lower than in open-reel recorders with their wider tape tracks.

The most audible and objectionable noise is "hiss"—random noise, predominantly at the higher frequencies. Taking an example from many amplifier and receiver designers, who were faced with the same problem of noise in radio reception and in phonograph records, one could use a low-pass filter, attenuating the system output above a frequency which is typically in the 3- to 7-kHz range. Since this inevitably removes some high-frequency content from the program, it is unacceptable for high-fidelity applications.

However, it *is* possible to reduce noise (actually, to improve the (S + N)/N ratio) without audibly affecting the reproduction of high-frequency signals. Two basic techniques have been used successfully. In an *open-ended* system, noise reduction takes place entirely at the point of playback and requires no special processing of the transmitted or recorded program. In a *closed* system, the original program is modified in a predetermined manner and a complementary modification takes place during playback.

### CLOSED SYSTEMS

**Compressor/Expander:** A typical closed noise-reduction system is the combination of a compressor and an expander. During recording, low-level signals are amplified more than stronger signals, so that they are not lost in the tape noise. For example, a recorder with a 50-dB dynamic range (the ratio between the noise level and the maximum signal that can be recorded without excessive distortion) cannot handle a program with a 70-dB dynamic range. The lowest 20 dB of the program will be submerged in the noise and lost—irretrievably. By compressing the recording, so that the weakest signals are amplified 20 dB more than the strongest, the program dynamic range can be reduced to 50 dB, so that the lowest level signals will not be below the noise level.

To restore the dynamics of the original program, it is necessary to expand during playback. The expander reduces the playback gain for low-level signals so that (in the example cited) the weakest are again 70 dB below the strongest. In the process, any noise introduced during recording and playback is reduced by 20 dB so that the recorder has not added any noise to the program.

The compressor/expander system might seem to be the complete answer to the noise problem in recording. Unfortunately, it has several serious drawbacks. The compression and expansion actually takes place at all program levels, although its amount varies with level. It cannot act instantaneously and considerable effort has gone into de-

termining the optimum "attack" and "decay" time-constants. Whatever time-constants are used, the compressor and expander must have exactly the same values, as well as exactly inverse input/output characteristics.

When these conditions are satisfied, the results can be excellent. However, even a slight difference between the two processes can result in a "breathing" or "pumping" effect, which may be as disturbing as the original noise, since it can occur even at full program level. Also a compressed program often sounds rather unnatural when played through a linear (non-expanding) system, which essentially requires that a compressed recording be played through the proper expander.

From time to time, compressor/expander devices have been offered to the high-fidelity tape recording enthusiast, although most have not enjoyed commercial success. Currently one such unit, the dbx 117, is manufactured by dbx, Inc., of Waltham, Mass. It features a continuously adjustable compression/expansion slope with a wide range, and can also be used as an "open-ended" compressor or expander as well as part of a closed system. Our tests showed it to be effective in tape-recording noise reduction, but it requires careful adjustment of the two characteristic slopes to avoid the "pumping" effect mentioned earlier.

**Dolby "B" System:** The well-known Dolby "B" system, probably the most widely used cassette noise-reduction method, is similar in some respects to the compressor/expander approach, but with some very important and basic differences. Although it is a closed system, it is widely used, is incorporated in many high-quality cassette recorders, and many commercial cassettes are now recorded with the Dolby process.

The unique operating characteristics of the Dolby "B" process are:

1. It affects only the high frequencies, in accordance with the frequency content of the program material. When highs are present, the Dolby action is inhibited, since the program will then mask the hiss. If no highs are present, the Dolby action (a high-frequency boost during recording and a high-frequency cut during playback) starts at about 500 Hz. When higher frequencies are present, the Dolby operating frequency moves upward so as to only affect noise frequencies higher than the signal. This effect is illustrated in Fig. 1, prepared from data furnished by Dolby Laboratories. Fig. 2 shows the complementary recording and playback response characteristics, which together produce a flat overall frequency response at any level.

2. It functions only at low program levels (−15 dB or below). The degree of compression and expansion is an inverse function of the level. Therefore, any side effects due to attack or decay time time-constants occur at such low levels as to be inaudible.

The levels and operating characteristics of the Dolby system are tightly controlled and must be adhered to by all Dolby licensees. As a result, a recording made on any Dolby-equipped machine can be played back through any other, with a flat overall frequency response, and a noise reduction of 6 to 10 dB. A Dolby tape can also be played through a non-Dolbyized machine; it will sound bright and somewhat noisy, but can be made listenable by adjusting the amplifier tone controls.

**JVC ANRS System:** The Victor Company of Japan, manufacturer of JVC cassette recorders, has developed a closed noise-reduction system, similar in some respects to the Dolby system. It is called Automatic Noise Reduction System (ANRS).

In addition to a completely different circuit approach, ANRS controls the response at high frequencies starting at a fixed frequency of about 500 Hz. Although the "hinge" frequency is not controlled by the program frequency content, the actual response curves vary in accordance with program level and frequency characteristics.

JVC has attempted to make the ANRS characteristics resemble those of the Dolby system as closely as possible. Since they are not identical to the Dolby characteristics, a Dolby recording will not play back with a flat response on an ANRS machine. The differences are not great, being typically about 5 dB at the higher frequencies. It is often possible to hear a noise "swish" when playing a Dolby recording of a solo instrument or voice through an ANRS system. Generally speaking, however, ANRS can give satisfactory results when playing Dolby material, and it affords about the same degree of noise reduction. Like the Dolby system, ANRS-processed tape can be played through a machine lacking the ANRS system, but will sound bright and a bit noisy.

### OPEN-ENDED SYSTEMS

An open-ended noise reduction system is essentially a dynamic low-pass filter whose cut-off frequency and/or attenuation are controlled by the level (and sometimes the frequency content) of the program. It has the advantage of being usable with any program source, since it does not depend on complementary recording and playback characteristics.

**Philips DNL:** The most widely used open-ended system today is the Philips Dynamic Noise Limiter

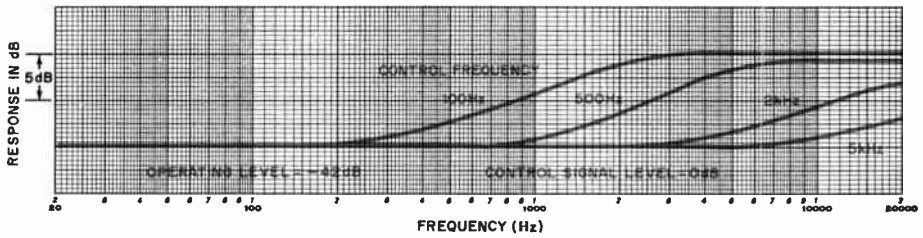



*Fig. 1. Dolby "B" recording processor frequency response. The control frequency moves up and down, depending on the high-frequency content of program material.*

(DNL), found in some Norelco cassette decks. The DNL uses a cancellation circuit to produce the effect of a very sharp cut-off filter (18 dB/octave) at very low signal levels, taking effect above 4 kHz. The amount of noise reduction increases with frequency, from about 10 dB at 6 kHz to 20 dB at 10 kHz (with no signal present). The action is also controlled to some extent by the high-frequency content of the program.

Like all open-ended noise reduction systems, the Philips DNL can produce audible side effects—usually a "swish" of noise as it goes into and out of operation on a solo instrument or voice. With more complex material, its action is less noticeable.

**Kenwood "De-Noiser"**: A similar, but more sophisticated approach is used in Kenwood's KF-8011 "De-Noiser." This is an "add-on" accessory, connecting to the tape recorder inputs and outputs of an amplifier or receiver.

The KF-8011 contains four band-rejection filters, covering the ranges 3-4.5 kHz, 4.5-6.5 kHz, 6.5-10 kHz, and 10-15 kHz. The rejection in each band is controlled by the program content in that band, so that the de-noiser action has a minimum affect on high-frequency signal components. The filters can be switched in or out by individual push-buttons, and the threshold level, below which they operate, can be varied over wide limits.

The KF-8011 can reduce hiss by 6 to 15 dB. When properly adjusted, it goes into action only at levels of −35 dB or below, and has almost no affect on program content. However, like the DNL, it can produce a "swish" on solo instruments, especially when the program contains appreciable amounts of noise.

Our experience has been that the Dolby "B" system is the most effective method of cassette noise reduction, since its operation is never audible to the listener. Furthermore, the wide use of the Dolby system allows interchangeability of recording and playback equipment, and the playing of commercial cassettes with the benefits of noise reduction.

JVC's ANRS is, for most practical purposes, about as effective as Dolby in noise reduction, and is "quasi-compatible" with it. There is no commercially recorded ANRS material, so its value lies chiefly when making and playing home recordings.

The dbx 117, at least potentially, can provide more noise reduction than any of the other systems (about 20 dB). It is also effective at all frequencies and can, therefore, reduce recorder hum and other low-frequency noises, which are ignored by the other systems. However, tapes made with it cannot be played properly without the use of the same device. It requires more care in setting up and adjusting for best results.

The Philips DNL and Kenwood KF-8011 are less ideal than the closed systems since their action can be heard under certain conditions. However, the KF-8011, which is a rather expensive unit ($220) can "de-noise" FM programs and can be used with its front-panel switching to reduce noise in a signal *before* it is recorded as well as during playback.

Each of these systems can make a worthwhile contribution to cassette recording. Once you have discovered how quiet a processed cassette can be, it is not easy to accept "hissy" recordings! □

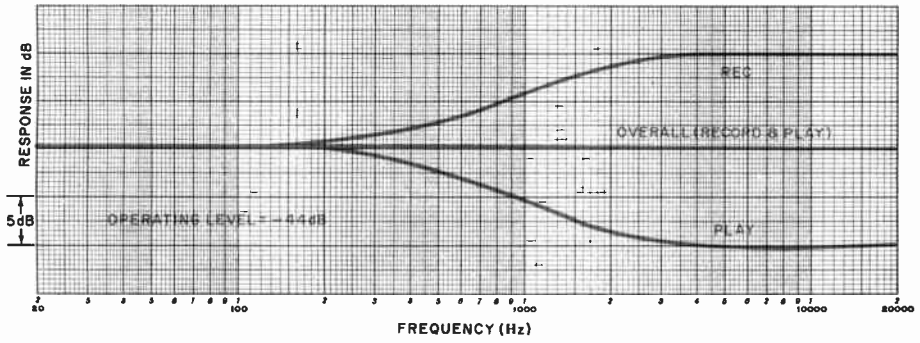



*Fig. 2. Dolby "B" recording and playback response. When used for both record and playback, they will produce a flat overall frequency response at any level. Note the high-end rise when playing a Dolby-ized tape on a standard machine without Dolby.*

# Which Speaker Reflects The REAL YOU?

Swinger or square, your choice will depend on how you listen, with whom, and to what!

**By J. GORDON HOLT**

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 catalogues 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 speaker measuring 18 by 14 by 15 inches and weighing 33 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 speaker costing under $200?" The answer, usually, is "There is no very best; it all depends on what you're looking for."

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 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 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 overdamps 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.

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 impress all your non-hi-fi friends with your 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.

### 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.

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.

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 just as 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.

If you're a "hard" or "acid" rock enthusiast, who likes—and is able—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, 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 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 in terms of volume as the classical extrovert. You thus have by far the widest range of speakers to choose from, which is a mixed blessing. □

# DESIGNING FOR CHROMIUM-DIOXIDE TAPE

Manufacturers must decide which is more important—noise, distortion, or frequency response—when designing equipment for $CrO_2$ tapes. There are many factors that can be balanced out to obtain any desired results.

**By HERMAN BURSTEIN**

ONE of the most glamorous, heralded, and long-awaited developments in the world of audio tape recording, particularly the cassette field, is chromium dioxide tape[1], hereafter $CrO_2$ for short. Synthesized in the laboratory in 1961, it emerged into the realm of exacting video and computer applications in the mid- and late 'sixties, and began to make some headway in audio during 1971-72. At the cassette speed of 1⅞ ips, and with a tape only .15" wide bearing four tracks, it is held to make high-fidelity performance possible. Specifically, it is claimed to extend treble response out to 15 kHz and to bring S/N (signal-to-noise ratio) above 50 dB.[2] When Dolby B noise reduction is added to the cassette system, S/N approaches 60 dB, which truly qualifies as high fidelity. At the same time, disadvantages, true or rumored, have been cited for $CrO_2$.

We seek here to make clear what its potential advantages are, what the disadvantages actually are, and what the makers of tape machines and their users can do to reap the benefits. We shall be talking largely about cassette systems, where $CrO_2$ seems to have most to offer, but we shall also deal briefly with open-reel application. To begin, for necessary background, we shall discuss some major characteristics and problems of magnetic tape.

### TAPE CHARACTERISTICS

Major aims of high fidelity are to reproduce sound with low noise, low distortion, and flat frequency response (*i.e.*, reproduction of frequencies between 20 and 20,000 Hz at the same relative amplitudes as in the original sound). In tape recording, loss of high frequencies is a major problem so the focus shifts to flat treble response. When a transport element is involved, as in the case of tape machines and phono turntables, high fidelity further aims at low wow and flutter, namely pitch deviations which, respectively, occur a few times or many times per second.

We will stress low noise, low distortion, and flat treble response. In doing so it is important to recognize that distortion is used as a reference level in comparing one tape with another (or one machine with another) in terms of noise and treble response. If S/N of one tape is compared with S/N of another tape, it is understood that both tapes are being operated at the same distortion level; this reference level is usually 3%, although levels of 1%, 2%, or 5% are sometimes employed. Similarly, a comparison of two tapes with respect to treble response is based on a stated reference level of distortion. It is necessary to make comparisons based on the same level of distortion inasmuch as variations in distortion can be traded for variations in noise and/or treble response. An improvement in treble response, or an improvement in S/N, or a moderate combination of both can be achieved by allowing distortion to rise. Reduced bias current can extend treble response of a tape, but at the cost of higher distortion. An increased recording level can improve S/N, but at the cost of more distortion.

Noise is a relative matter. What we really want is noise (undesired audio signals) much lower than desired audio signals—at least 55 dB lower. Thus, a requirement of high fidelity is stated to be S/N of at least 55 dB. To achieve high tape output (a large

amount of signal recorded on the tape), it is necessary to employ bias. This consists of a current in the range of 75,000 to 150,000 Hz which is fed to the record head along with the audio signal, or else fed to an auxiliary (cross-field) head situated opposite the record head on the backing side of the tape. Bias current is approximately 10 times as great as the audio signal fed to the record head. Up to a point, as bias is increased, tape output increases, and therefore so does S/N

A second and equally fundamental reason for using bias current is to minimize distortion. Without bias, the recorded signal is unbearably distorted. Again up to a point, as bias is increased, distortion decreases.

Unfortunately, bias current also partially erases the audio signal, increasingly so as frequency rises, as tape speed drops and as bias is increased. Therefore, particularly at the low cassette speed of 1⅞ ips, we face a perplexing major problem: It is necessary to use a substantial amount of bias in order to increase tape output (for good S/N) and to minimize distortion, but such bias robs us of treble response.

In this vital respect, some tapes perform better than others, depending on the magnetic and physical properties of their magnetic coating; that is, for a given level of distortion and output, some are more resistant to bias erase. Here is where $CrO_2$ excels, as we consider later in detail.

Another threat to treble response is lack of intimate tape-to-head contact, both in recording and playback, but especially in playback. A tape with a smooth magnetic coating permits closer contact than a tape with irregular surface and therefore provides better treble response. Here, too, $CrO_2$ excels.

Returning to the question of bias, how does the manufacturer of a tape machine decide the amount to use? He seeks if possible to increase bias to the "optimum" level, where output at low- and mid-frequencies is maximized and distortion is minimized. But with conventional tape, and at slow tape speed, he finds that treble loss due to bias erase becomes *excessive* (as explained in the next paragraph) before optimum bias is reached. He is forced to settle for "compromise" bias of smaller amount, which avoids *excessive* treble loss but at the same time results in less than maximum output and less than minimum distortion.

We digress to consider what is meant by *excessive* treble loss. To begin, treble loss can be compensated by treble boost in the record amplifier. But there is a limit to how much treble boost can be applied in recording without saturating the tape, causing great distortion. This limit depends in good part on the "spectral amplitude distribution" of typical sound sources, particularly music. This refers to the relative amplitudes of the various frequencies throughout the audio range. Studies of music energy indicate that relative to a mid-frequency of about 500 Hz, amplitude is typically down about 12 to 14 dB at 10,000 Hz (and, as a side note, about 10 dB down at 50 Hz). Assume that sound energy is down 12 dB at 10,000 Hz. This permits us to apply 12 dB boost at 10,000 Hz in recording to offset 12 dB of treble loss on the tape. What the tape sees as it passes the record head is approximately equal magnetic flux at all frequencies inasmuch as the drop in audio


*Four of the leading manufacturers of $CrO_2$ tapes: BASF, Memorex, Norelco, TDK.*

energy at the high end is offset by treble boost furnished by the record amplifier. Now assume that treble loss on the tape is appreciably greater than before, say 15 dB loss at 10,000 Hz. This is troublesome. Now 15 dB of boost at 10,000 Hz is required in recording, and the tape may be presented with more magnetic flux than it can accept without saturating. In short, 15 dB treble loss on the tape at 10,000 Hz is excessive.

In sum, the cassette machine manufacturer will increase bias *toward* the optimum level for maximum output and minimum distortion, but is forced to stop short of that point if treble loss is excessive, namely more than about 12 dB at 10,000 Hz.

These figures as to how much treble loss is excessive are illustrative and not necessarily exact. But they are reasonably close to the facts. Further, it must be recognized that the risk of high-frequency tape saturation depends not only on the amount of magnetic flux *presented* to a particular tape, but also on the relative ability of that tape to *accept* large amounts of flux as frequency rises. Compared with conventional tape, $CrO_2$ is superior in this respect. Put differently, large amounts of record treble boost are less likely to cause tape saturation of $CrO_2$ tape than in the case of other tapes.

### PERFORMANCE OF $CrO_2$ TAPE

We can now fully appreciate the major advantage of $CrO_2$ tape at the slow speed of 1⅞ ips: It permits bias to be brought up to the optimum level which generally maximizes output at low- and mid-frequencies and minimizes distortion, yet with considerably less treble loss than would be considered excessive. (All the more so because, as pointed out above, it can withstand substantial increase in magnetic flux resulting from record treble boost.)

Assume that we wish to compare the performance of $CrO_2$ with conventional (gamma ferric oxide) tape. Assume that bias is individually set for each tape for best overall performance: in the case of $CrO_2$, for generally maximum output; in the case of ferric oxide, for maximum output consistent with avoiding excessive treble loss (about 12 dB at 10,000 Hz). Assume that record treble boost for both tapes is the amount used for conventional tapes, reaching about 12 dB at 10,000 Hz. And assume that recording level for each tape is set to achieve the same amount of distortion, say 2% at 1000 Hz.

$CrO_2$ tape then displays the following performance differences: (1) on average, about 3 dB higher output than conventional tape at low and middle frequencies; (2) markedly higher output than conventional tape at frequencies above 5000 Hz, reaching about 8 dB difference at 10,000 Hz and 12 dB at 15,000 Hz. These differences in output are shown in Fig. 1.

The higher output of $CrO_2$ is significant in two important ways. (1) The 3 dB higher output at low- and mid-frequencies permits a 3 dB improvement in S/N (ordinarily measured in the range of 300 to 1000 Hz). Engineers will usually stand on their heads for this degree of S/N improvement in a tape system, especially one operating at 1⅞ ips. (2) The 4 dB to 12 dB higher output from 5000 Hz upward gives the maker of a cassette machine a choice of further increase in S/N, or reduced distortion, or extended treble response, or some combination of these three possible improvements.

To illustrate the second point: Augmented treble response from 5000 Hz upward can be offset by reduced treble boost in recording. This allows the recording level to be increased without risk of overloading the tape at high frequencies, and the increase in recording level produces higher S/N. Or the manufacturer can reduce treble boost to a smaller degree, thus obtaining less improvement in S/N but at the same time retaining some of the extended treble response. Or he can increase bias. thus reducing the excessive treble and at the same time reducing distortion. Or he might employ both an increase in bias and a reduction in treble boost. thereby gaining a reduction in distortion and an extension of treble response. Or he might go for extended treble response and maximum S/N by applying an appropriate amount of treble cut *in playback*. There may well be more possibilities.

In addition to the ability of $CrO_2$ tape to yield important improvements in the major respects of noise, distortion, and treble response, the following performance advantages are claimed for it:

*Lower print-through.* Measurements of print-through developed over a 24-hour period and over a 10-week period indicate 4 dB to 5 dB less print-through than for conventional tape.

*Lower modulation noise*, that is, noise due to irregularities in the physical and magnetic characteristics of the tape coating. In the presence of an audio signal, such irregularities become manifest as noise. Tests indicate superiority of 4 dB to 10 dB over other tapes.

*Lower FM modulation noise*, which is caused by failure of a tape to pass smoothly over the heads. This is sometimes called "stiction" and is likened to the grabbing effect when a rosined bow is moved against a violin string.

*Smaller loss of high-frequency signal due to repeated replays.* Tests indicate that after 30 replays, $CrO_2$ tape suffers about 1.2 dB loss at 15,000 Hz, compared with 2.5 dB loss for conventional tape.

*Reduced head wear*, owing to a smoother oxide coating. Tests indicate that minimum head life is 3000 hours for conventional Mumetal heads of decent quality, and 30,000 hours for ferrite heads.

*Reduced jamming of cassette mechanisms*, owing to a smoother coating.

*Slightly greater uniformity of output level* within a reel and from reel to reel, owing to ability to control the magnetic and physical properties of $CrO_2$.

On the other hand, $CrO_2$ tape has three distinct but conquerable disadvantages; it requires:

*More drive current*, that is, a higher level of audio signal fed to the record head in order to achieve maximum output consistent with 3% harmonic distortion. Specifically, it requires about 3 dB more drive than conventional tape.

*More erase current*, specifically about 4 dB more in order to achieve the same amount of erasure as with conventional tape.

*More bias current* in order to achieve the optimum output level. The increase is variously cited as 3 dB to 6 dB; a 4 dB increase in bias is most commonly cited.

### PROPERTIES OF $CrO_2$ TAPE

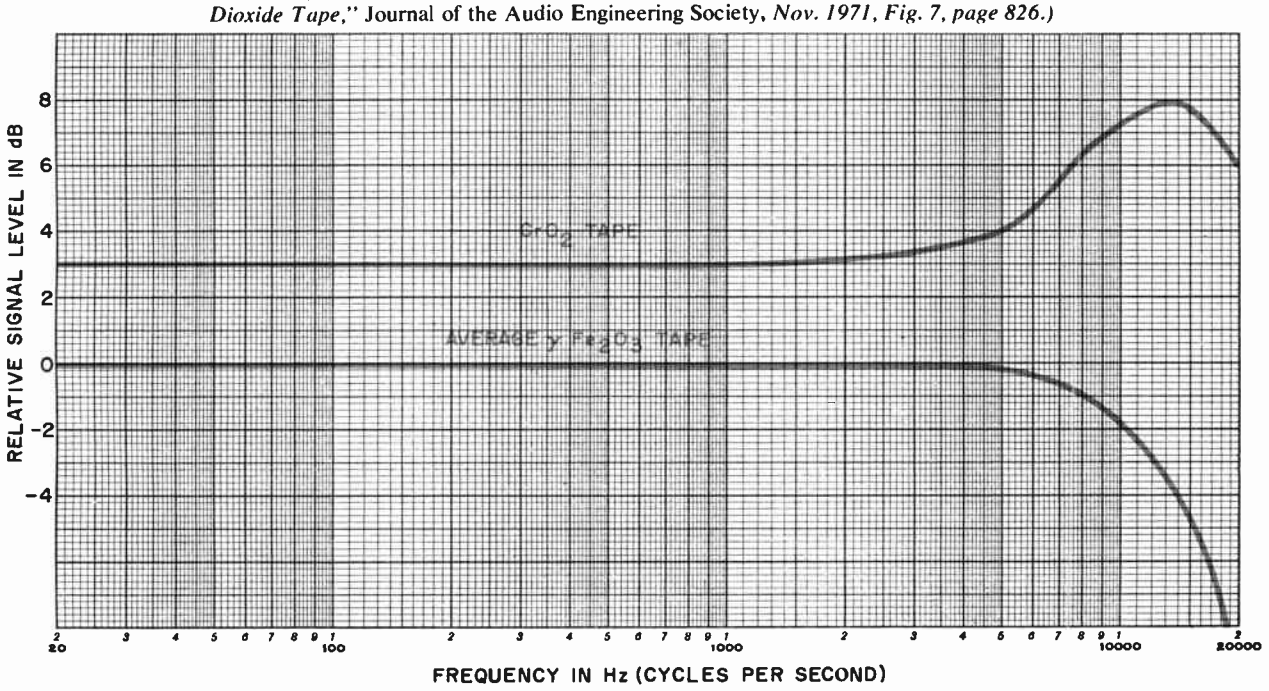
Having brought the reader this far, it seems appropriate to inquire how $CrO_2$ tape achieves its performance. In other words, what are its special physical and magnetic properties?

The $CrO_2$ coating contains very fine, relatively uniform, smooth, principally needle-like, highly magnetic particles, which tend to align themselves substantially in the direction of tape length and to disperse evenly and densely throughout the tape coating. This makes for increased retentivity (retention of magnetization) and increased coercivity (resistance to magnetization and demagnetization) compared with conventional tape (gamma ferric oxide). High retentivity, namely ability to acquire a high degree of magnetization, accounts for higher output and improved S/N, particularly at the low- and mid-frequencies. High coercivity results in increased treble output relative to the rest of the audio range, because the particles are more resistant to demagnetization by the bias current.

The fine, uniform, smooth, evenly distributed particles lead to low tape noise and low modulation noise. Their uniform distribution minimizes dropouts; and it makes for a smooth coating, permitting close tape-to-head contact and consequent preservation of treble response. Their high resistance to magnetization reduces print-through, while their high resistance to demagnetization reduces treble loss after repeated playback.

An additional property has been *incorrectly* attributed to $CrO_2$ tape: loss of magnetization at moderately high temperature such as might be encountered in a southern clime or in a closed car on a

*Fig. 1. Comparison of output of $CrO_2$ and conventional tape, with bias optimized for each tape. Recording level is 20 dB below level producing 2% harmonic distortion at 1000 Hz. (Based on Klaus E. Naumann & Eric D. Daniel's "Audio Cassette Chromium Dioxide Tape," Journal of the Audio Engineering Society, Nov. 1971, Fig. 7, page 826.)*



summer's day. Actually, $CrO_2$ does not reach its Curie temperature, where magnetization disappears, until 257° Fahrenheit (or 125° centigrade), which is well above the point at which water boils at sea-level. Moreover, if the Curie temperature has not been reached, whatever changes in magnetization have occurred, owing to high temperature, will disappear when the tape is returned to its initial temperature. In short, $CrO_2$ retains its original magnetization if not brought to 257° F.

### MAKING THE MOST OF $CrO_2$ TAPE

A number of cassette machines today provide a panel switch in order to meet the special requirements of $CrO_2$ tape and permit its potential advantages to be realized. Bringing together what we have learned, in going from conventional (gamma ferric oxide) to $CrO_2$ tape, four changes are necessary: (1) Recording level should be increased 3 dB. (2) Bias current should be increased 3 to 6 dB, preferably (it seems) 4 dB. (3) Erase current should be increased 4 dB. (4) Either record equalization or playback equalization should be modified to reduce treble response; the reduction should be on the order of 8 dB at 10,000 Hz and 12 dB at 15,000 Hz, thus offsetting the substantial excess in treble response from 5000 Hz upward.

Let's see what the cassette industry is doing about these four steps to make the most of $CrO_2$ tape.

1. *Increase in Recording Level.* It appears that the $CrO_2$ switch generally increases the recording level by 3 dB for a given VU meter indication, unless this conflicts with setting of Dolby level (as in the case of the Wollensak 4760). Users are generally advised by makers of $CrO_2$ tape to make sure that recording level is increased. The user can discover whether his machine makes such provision by consulting the operating manual or the manufacturer. If unsure, he can increase recording level by means of the record gain control, seeking a 3 dB increment as indicated by the VU meter; if the result is an unwelcome increase in distortion, he can back down on gain. If a cassette machine does not automatically increase recording level because of conflict with Dolby setting, the user should consult the operating manual for the proper method of increasing recording level.

2. *Increase in Bias Current.* The general practice appears to have the $CrO_2$ switch increase bias 4 dB. But there are exceptions, such as the Heath AD-1530, which raises bias 6 dB, a figure that the literature on $CrO_2$ indicates to be within the appropriate range.

3. *Increase in Erase Current.* Indications are that the $CrO_2$ switch does not change erase current, but that this current is already at the 4 dB higher level required for $CrO_2$ tape.

4. *Treble Reduction.* We have previously indicated that, in a variety of ways, manufacturers of cassette machines can use the surplus treble response of $CrO_2$ tape in order to extend treble response or reduce noise or reduce distortion or attain some combination of these. At present there are mixed practices, and it is not quite clear how the surplus treble response can best be used. At the same time, there are some definite signs which way the industry intends to go. Four Wollensak machines designed for $CrO_2$ (Models 4755, 4760, 4770, and 4780) illustrate the situation. Two of them (Models 4755 and 4760) reduce treble boost when the panel switch is put in the $CrO_2$ position. The other two introduce treble cut in playback, atop the usual playback equalization for cassettes; this cut amounts to about 5 dB at 10,000 Hz.

There appears to be a strong trend toward leaving record treble boost alone—that is, leaving it the same as for conventional tape—and instead introducing treble cut in playback. This is illustrated by the two Wollensak cassette machines mentioned, the Heath AD-1530, the Advent 200 and 201, a Sansui machine, and doubtless others.

The reason for preferring treble cut in playback to reduced treble boost in recording is to deal in the most effective way with the major obstacle to high-fidelity performance by cassettes: noise. Treble cut in playback, at the same time that it serves to restore flat response, also reduces noise originating in all stages of the tape system—noise on the tape due to the record amplifier, noise due to the tape, and noise in the playback amplifier.

Accordingly, it remains for the industry to develop a new standard for cassette playback equalization, one which pulls down treble response to a greater extent than the present standard. The existing standard calls for bass boost starting (3 dB up) at 1326 Hz (120 $\mu$s turnover) and leveling off (3 dB below maximum) at 100 Hz (1590 $\mu$s turnover). Some visualize that the new standard will add treble cut to the present standard, perhaps along the lines of Heath's practice, which is to introduce treble cut starting (3 dB down) at 4547 Hz (35 $\mu$s turnover).

Another approach has been proposed by DuPont, the originator of $CrO_2$ tape. This would consist of an 8.5 dB increase in playback bass boost. Specifically, DuPont has suggested that cassette playback equalization should have bass boost starting at 2274 Hz (70 $\mu$s turnover) and leveling off at 50 Hz (3180 $\mu$s turnover). The effect of more bass boost is to further reduce the treble range relative to

the low- and mid-range; in relative terms, to achieve treble cut. DuPont indicates that with 3180/70 $\mu$s playback equalization, with record treble boost quite close to that used for conventional tape, and with 4 dB increase in bias above that required for conventional tape, it achieves response flat within ±2 dB between 30 and 15,000 Hz with its $CrO_2$ tape (Crolyn). The amount of record treble boost used by DuPont reaches 17 dB at 15,000 Hz; as previous discussion has indicated, $CrO_2$ tape is able to accept larger amounts of magnetic flux at high frequencies than can conventional tape.

The DuPont proposal has been endorsed by a number of firms, according to Advent: by Advent, Wollensak, Philips, Sansui, Dolby Laboratories, Memorex, and BASF, to name several. Advent further indicates that pre-recorded $CrO_2$ cassettes with DuPont equalization are on the way.

DuPont playback equalization is quite close—within 3 dB—of the present NAB standard for open-reel machines at 7½ (and 15) ips, which starts at 3180 Hz (50 $\mu$s turnover) and levels off at 50 Hz (3180 $\mu$s turnover). This opens up the interesting possibility that NAB 7½-ips playback equalization now provided by many audio amplifiers and receivers would be suitable for playback of $CrO_2$ cassettes with DuPont equalization. One could then play a pre-recorded cassette into the "tape head" jack of an amplifier or receiver, with less than 2 dB loss at 15,000 Hz (assuming the tape is flat out to 15,000 Hz).

What can the user do to get into the swing of things, using $CrO_2$ tape with older cassette equipment not intended for $CrO_2$? As just indicated, if pre-recorded $CrO_2$ cassettes have DuPont equalization, they can be played back satisfactorily through the "tape head" input jack of the audio system. If the user wishes to record, it may or may not be feasible to modify his cassette machine in order to increase bias and erase current; this depends on the design of the machine and the skill of the person seeking to make the adjustment. Certainly these adjustments, if feasible, are not for the novice. Assuming that bias and erase current can be boosted 4 dB, nothing need be done about record equalization if one premises that DuPont or NAB 7½-ips equalization will be used in playback. If such playback equalization is not available, he can fall back on the treble tone control of his audio system, using it to supply a healthy amount of treble cut, and relying on his ear to tell him when response is satisfactory.

### $CrO_2$ FOR OPEN-REEL?

The question has been asked: If $CrO_2$ tape is good for cassettes, isn't it also good for open-reel? The answer is certainly yes if one has 1⅞ ips in mind. At this speed the improvements in S/N and treble response would be equally great for the cassette and open-reel formats. But the improvements would be of smaller magnitude at higher speeds. As indicated previously and by Fig. 1, the source of improvement in S/N and treble is the elevated output from about 5000 Hz upward at 1⅞ ips. However, this is actually a wavelength effect; the elevated output occurs at certain wavelengths (tape speed divided by frequency), and what Fig. 1 shows is the output when wavelength is translated into frequency at the particular speed of 1⅞ ips. When wavelength is translated into frequency at higher speeds, we find that the elevated output does not commence until 10,000 Hz at 3¾ ips, and until 20,000 Hz at 7½ ips.

Thus the advantages of $CrO_2$ are greatest (and most needed) at the slowest speeds. But, although limited, the benefits of $CrO_2$ at higher speeds are not to be ignored. As pointed out earlier, an improvement of 3 dB in S/N is something for which it is worth standing on one's head. □


**References:**

1. *I am indebted to the following persons and firms for providing or directing me to data presented in this article: Andrew G. Petite, Advent Corporation; John E. Jackson, BASF Systems; Harold Banick, Heath Company; Walter G. Salm, Frank Barth Advertising Inc., for TDK; Clyde Donaldson, 3M Company. Technical data has been drawn from the following publications: Leland K. Jordan, Robert J. Kerr, and John E. Dickens, "Chromium Dioxide Audio Cassette Tape,"* Journal of the Audio Engineering Society, *January/February 1972, pp. 2-6; Klaus E. Naumann and Eric D. Daniel, "Audio Cassette Chromium Dioxide Tape,"* Journal of the Audio Engineering Society, *November 1971, pp. 822-828; W. H. Andriessen, "Chromium Dioxide Tape,"* The Gramaphone, *October 1971, pp. 722-728;* Advent Newsletter, *May 1972 (Joseph Hull, Editor);* The TDK Guide to Cassettes, *1972.*
2. *Throughout this article we employ dB to indicate the magnitude of* change *in S/N, bias, erase current, or bass or treble cut or boost. These changes involve changes in voltage (of the audio signal, noise frequencies, or oscillator frequency). To assist the reader in converting a dB change into a percentage increase or decrease in voltage, see table below. We have used S/N throughout the article instead of (S + N) /N to simplify the text. In those instances where the noise is an appreciable part of the signal, the notation (S + N)/N should be used.*


| dB Change | Voltage Increase % | Voltage Decrease % |
|---|---|---|
| 1 | 12 | 11 |
| 2 | 26 | 21 |
| 3 | 41 | 29 |
| 4 | 58 | 37 |
| 5 | 78 | 44 |
| 6 | 100 | 50 |
| 8 | 151 | 60 |
| 10 | 216 | 68 |
| 12 | 298 | 75 |
| 15 | 462 | 82 |
| 20 | 900 | 90 |
| 30 | 3060 | 93 |
| 40 | 9900 | 99 |


*Finished tapes moving into final packaging area.*

# How Magnetic Tape is Made

To understand the differences among various types of raw tape, you should know how they are made and how they differ in the manufacturing process.

**By JOSEPH KEMPLER**
Mgr., Advanced Technology, Audio Devices, Inc.

MUCH has been written about the performance properties of magnetic recording tape and much advice has been offered to educate the recordist as to *which* tape might be the best one for him. Articles of this type, however, seldom explain *why* one tape is different from another, or *how* the tape is manufactured to develop certain desired characteristics.

One of the reasons for the scarcity of such "how" and "why" answers is that such information delves into materials and manufacturing processes, subjects which are considered proprietary by tape manufacturers.

This article, however, is intended to shed some light on how the various tape types are designed and produced. It presents a simplified description of how tape is made, its basic construction and ingredients, and the effects these have on the performance.

There are quite a few tape types available to the home user for the recording of sound. The most popular types are: 1. general-purpose; 2. low-noise; 3. high-output, low-noise; 4. lubricated tape (for 8-track cartridges); and 5. cassette tape (in various quality grades).

To this must be added the large assortment of thicknesses, lengths, and methods of housing. Some tapes also employ special coatings applied to the backside of the tape to improve mechanical handling and storage or to permit operation in continuous-loop, 8-track cartridges.

In spite of this rather bewildering assortment of products, all tape types appear to be very similar to each other, with the exception of some differences in color, surface shininess, or, as already mentioned, the presence of a backcoating. In fact, if a group of different tapes were separated from their boxes and wound on unmarked reels, it would be nearly impossible to visually identify the various types—even for an expert.

The reason for this uniformity in appearance is simple: nearly all tapes are very similar in *basic* construction as well as in composition and ingredients; moreover, they are manufactured using the same essential processes. This apparent similarity, however, does not mean that all tapes are equal in performance. Far from it! The differences between tapes are often considerable and result from the varying degree of perfection achieved in the overall design, ingredients, construction, and manufacturing. Several of these important differences are readily visible, others will become obvious to the ear, and still others would require special test equipment which is out of reach of the typical home recordist.

## CONSTRUCTION AND MATERIALS

All magnetic tapes consist of a coating or emulsion, permanently bonded to a plastic film or base. The coating contains the magnetic material, the "active" ingredient which makes recording and reproduction possible. The base film acts as the physical support which determines the mechanical properties of the tape.

Open-reel tapes are always wound so the coating faces the hub. In cassettes and 8-track cartridges, the opposite is true—the coating faces out to allow it to run in contact with the heads.

In the majority of cases, it is very easy to distinguish the coating from the base, because the base is shinier than the relatively dull coating. Many more modern tapes, however, particularly cassette tapes, have a coating which is nearly as shiny as the base, making it difficult to tell them apart. There have been cases where the tape in a cassette has flipped over so the base was facing out, resulting in a complaint that, "this cassette will not record—it's non-magnetic."

Recent tape developments have brought more variations into the picture, primarily through the introduction of backcoatings such as Capitol's "Cushionaire". These coatings, which are dull black in appearance, are applied to the back of the tape so the base is no longer visible. As result, the appearance of these tapes is opposite that of more conventional types, namely, a shiny magnetic coating and a dull backside.

The color of the coating has been undergoing some changes as well. The normal coating color is brown, the normal color of iron-oxide. Chromium-dioxide, on the other hand, is a black powder; thus the tapes made from it are always black. This does not mean that all black tapes are made from chromium-dioxide. Many iron-oxide tapes are black, too, or at least dark grey, because of the addition of black carbon particles to reduce electrostatic charges in the tape.

The color of the *coating* has sometimes been associated with tape quality, the feeling being that the black tapes are superior to brown ones. This is not entirely correct. Today, some very fine tapes have a brown coating, while there are black ones which are barely adequate. A case in point is Capitol 2 high-output, low-noise line of open-reel and cassette tapes where the brown coating is a distinct asset, resulting in both higher output and longer wear. The potential static problem has been effectively resolved by a highly conductive backcoating. These tapes have a unique appearance in that the coating is a very shiny brown and the back is dull black, making the distinction readily obvious.

## BASE MATERIALS

The two most popular base materials for magnetic tape are: 1. Cellulose acetate, often called acetate. 2. Polyester, sometimes referred to as Mylar. (Mylar is a DuPont tradename for its polyester film, but there are several other manufacturers producing polyester, using their own tradenames. The term Mylar, therefore, can be used correctly, only if manufactured by DuPont.)

A good base material must be strong enough for its intended use, flexible, very smooth, and dimensionally stable. Both acetate and polyester are good base materials and have gained wide acceptance. Of the two materials, polyester is better, especially when used or stored under unfavorable conditions. The specific advantage of polyester are:

1. It is twice as strong as acetate for the same

thickness, in terms of force required to break it.

2. It is about 50% stronger as far as the force required to stretch it.

3. These strength ratios become still higher when the tapes are exposed to high humidities.

4. The dimensional changes caused by temperature variations are about five times less than acetate and those caused by humidity are 15 times smaller. Higher temperatures and humidities cause the tape to expand very slightly and lower ones cause it to contract. This is one reason why tapes stored in unfavorable environments, such as attics or basements, often show spoking, curled edges, or other evidences of physical distortion. Tapes wound unevenly or at too high a tension are particularly vulnerable to such deformations. Fortunately, increase in temperature is usually accompanied by a reduction in humidity, tending to cancel some of the effects. Nevertheless, with proper winding and storage, acetate will keep nearly as well as polyester. The ideal tape, of course, is one coated on polyester, particularly with backcoating which acts as an air cushion to absorb some of the distortion-producing stresses.

5. It is more tear resistant by a factor of three times. This figure applies to tapes where the tear is already started, perhaps with a nick at the edge. Anybody who has ever tried to tear a piece of polyester tape knows very well, though, how difficult it is to *start* a tear in polyester.

6. Polyester is chemically more stable resulting in better aging properties. Acetate contains plasticizers which very slowly leave it, causing brittleness and cracking. Polyester is also more resistant to damage by many common solvents and chemicals.

Despite the negative comparison, cellulose acetate is a good base material for magnetic tape and meets all the necessary requirements, providing the thick 1½-mil gauge is used. (This gauge allows 1200 feet of tape to be wound on a 7-inch reel.) Thinner tapes should be coated on polyester.

Acetate base, in addition to its lower cost, has an important advantage which has made it very popular with some professional recording studios. Acetate breaks cleaner when snapped, with little or no stretch at the break point. Polyester, on the other hand, stretches by 100% or more before breaking, making it impossible to repair a recorded tape without losing some of the information.

Polyester base, incidentally, is also available in a "tensilized" form, also known as T-polyester. This material is subjected to a special prestretching process by the base manufacturer, increasing the break strength and the stretch resistance by nearly two times. Long-playing cassettes with very thin tapes were made possible through the use of T-polyester.

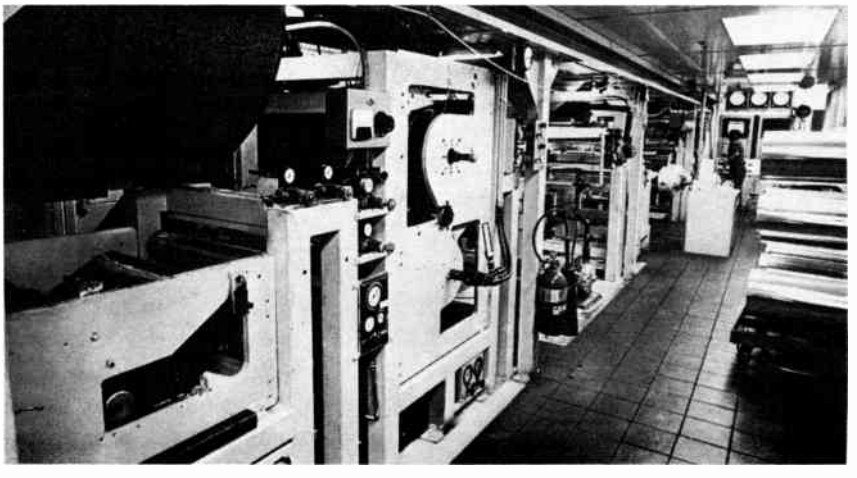
The differing properties of base materials make them peculiarly suitable for specific tape types. The following table summarizes the products made from the various bases and thicknesses. (The thickness referred to is always that of the base alone without the coating.)

| BASE MATERIAL & THICKNESS | MAJOR TAPE USE |
|---|---|
| 1.5-mil cellulose acetate | Reel-to-reel, standard play |
| 1.5-mil polyester | Reel-to-reel, standard play |
| 1.0-mil polyester | Reel-to-reel, long play; cartridge tape |
| 0.5-mil polyester | Reel-to-reel, double play |
| 0.5-mil T-polyester | Reel-to-reel, double and triple play; cassettes up to 60 minutes |
| 0.30-mil T-polyester | 90-minute cassettes |
| 0.25-mil T-polyester | 120-minute cassettes |

The final thought on the subject of base materials: to tell a reel of acetate from a reel of polyester, hold it up to a light. Acetate is translucent while polyester is opaque.

### MAGNETIC COATING

The magnetic coating consists of several ingredients which are carefully and uniformly mixed and dispersed to produce a homogeneous unit. A good coating must meet all the many physical and electromagnetic requirements for its intended end use. It is not easy to meet all these requirements because very often they are conflicting and a very careful compromise design must be worked out for best results. For instance, the coating must be tough and durable to resist wear and degradation from prolonged use yet, at the same time, it must not be abrasive to the heads. It must be dense and scratch-



*A small section of a giant coating machine. This is the front end which contains the take-off, coating, and orientation sections.*

resistant, but not brittle or stiff which would eventually cause edge damage and dropouts. The friction must be low to eliminate drag or squeal, but not so low as to cause slippage on some transports. The coating should be matched to the base so they expand and contract together with temperature and humidity changes, otherwise cupping, curling, long edges, and other physical problems will develop. This means that the coating for an acetate base may be different from the one used on polyester unless it is designed to be elastic enough to work with both. These are only a few examples from a list that literally covers dozens of areas which call for intelligent compromise. It takes know-how and experience to design and manufacture a tape which does all things well. Such tapes are available, but there are others which may be fine or even outstanding in several aspects but poor in others, resulting in an out-of-balance performance.

Electromagnetically, too, the coating must provide the necessary recording performance with a minimum of undesirable side effects such as noise, dropouts, or print-through. To the engineer a balanced design is of paramount importance here as well, if the tape is to provide state-of-the art performance without sacrificing compatibility with existing recorders.

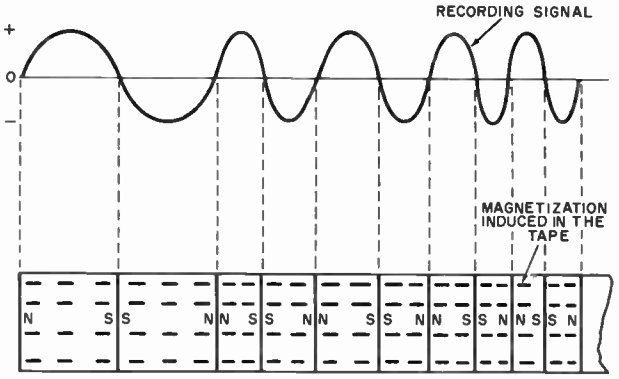
These examples of coating requirements are mentioned to stress the importance of choosing the right materials, using them in the right proportions, and processing them in a controlled manner.

The basic coating ingredients are: 1. magnetic material, such as iron oxide; 2. binder; and 3. additives. Let us review each of them briefly.

### MAGNETIC MATERIALS

The key ingredient in magnetic tape is the material which makes it magnetic. In most tapes, this material is iron-oxide. Other materials like chromium-dioxide and cobalt-"doped" iron-oxides have been introduced for cassette applications, but their use is still limited because they require special recorders (chromium-dioxide), suffer from certain instabilities, or have some shortcomings not present in good iron-oxides. While these new materials have a somewhat higher potential energy, the newest iron-oxides, coupled with some novel processing methods, have produced recorder-compatible tapes with a performance almost equal to the higher energy tapes.

The typical iron-oxide particle used for tape recording is a tiny needle-shaped crystal, approximately six times longer than its diameter. The particles come in various sizes even though the length-to-diameter ratio is similar. Standard tapes use a




*The iron-oxide particles, in the tape coating, are magnetized by the record head in one of two directions (polarities) in exact accordance with the polarity of the recording signal. All particles within a region (as shown by the vertical lines) are magnetized in same direction.*

relatively "large" particle (about 25 millionths of an inch long by 4 millionths in diameter). The oxides used for low-noise tapes are several times smaller, since it is the small size which contributes to the lower hiss (bias noise). Good high-output, low-noise tapes may use still other iron-oxides which in addition to smaller size, are smoother, more uniform, and are capable of being densely packed in the coating.

The needle shape of all these oxides offers a distinct advantage to tape performance by making them magnetically anisotropic, which literally means: having different properties in different directions. Anisotropic iron-oxides are much easier to magnetize and harder to demagnetize (important features for a good tape) in the long direction than in the short direction.

To take advantage of anisotropy, the oxide particles in the tape are rotated until they are lined up with their long sides in the direction in which the tape moves past the recording head. As a result of orientation, the tape has more output and efficiency in the desired direction because its magnetic properties are better in that direction.

### MAGNETIC PROPERTIES

Iron-oxide particles (and others as well) are, in reality, tiny permanent magnets, each with its own South and North poles. They behave like the familiar bar magnets in that they repel and attract each other and move readily under the influence of an external magnetic field. In the tape coating, of course, the particles are solidly bonded in place and cannot move around. They can, however, be magnetized in two directions or polarities, in exact accordance with the polarity of the external magnetic field as provided by the recording head.

The oxide particles are *permanent* magnets; the

word "permanent" indicating a resistance to change. Indeed, the particles do resist a change in their magnetization direction, a specific magnetic force being necessary to overcome this resistance. This force is called coercive force, indicating that the oxide must be coerced or forced to change its state.

Therefore, one of the magnetic properties used to describe iron-oxide is coercive force. This quality, expressed in units called oersteds, measures the minimum magnetic force which must be applied to the tape by the recording head before a recording is possible.

By the same token, a tape once recorded resists demagnetization and a magnetic force must be applied to the tape to erase it. The minimum erasing force is the same coercive force as well.

To sum up the role of coercive force: It determines the tape's resistance in impressing and removing a recording from it. A high-coercive-force tape, such as chromium-dioxide, requires more magnetic energy to record and erase than a lower coercive-force tape.

Another property of permanent magnets is their ability to store magnetism. A recorded tape has magnetic information stored on it, available for playback at any time. The magnetism is transferred to or induced in the oxide particles by the recording head. The quantity of magnetism which can be stored by a tape is called magnetic induction and is expressed in gauss. It is obvious that the higher the induction, the more output a tape could produce in the playback head. A high value of induction is very desirable in magnetic tapes, for this reason.

### BINDER

The binder in the magnetic coating accomplishes the following:

1. It provides the cohesion which keeps the iron-oxide particles together.
2. It provides the adhesion which keeps the entire coating securely bonded to the base.
3. It provides an optimum separation between individual oxide particles, ideally, by coating each particle with an extremely thin layer of binder. Particles which are not properly separated and actually touch one another will partially cancel each other's energy and reduce the potential output of which the tape is capable.
4. All the physical properties of the coating such as wear, friction, oxide deposits on the heads and many others are determined by the binder. In general, the coating is only as durable as its binder.

The binder must perform many exacting and difficult tasks and is thus one of the most critical components in magnetic tape. Indeed, one of the major differences between a good and not-so-good tape lies in the binder used and in efficiency of the dispersion. The basic binder materials are compositions of various plastic resins.

The use of binder naturally reduces the amount of space left for the oxide. Actually, oxide occupies only about 30 to 40% of the total coating volume, thus reducing the total induction and output quite significantly. Putting more oxide in, however, could result in weaker cohesion caused by the particles touching. This problem is especially serious with low-noise tapes, because here a larger number of smaller particles in the same space present a larger surface area for the binder to cover. High-output, low-noise tapes add another hurdle, because the concentration of particles in the coating is increased. It is quite a feat to build a high-output, low-noise tape with superior recording performance, yet with no sacrifice of the physical properties; there are very few tapes which meet these requirements.

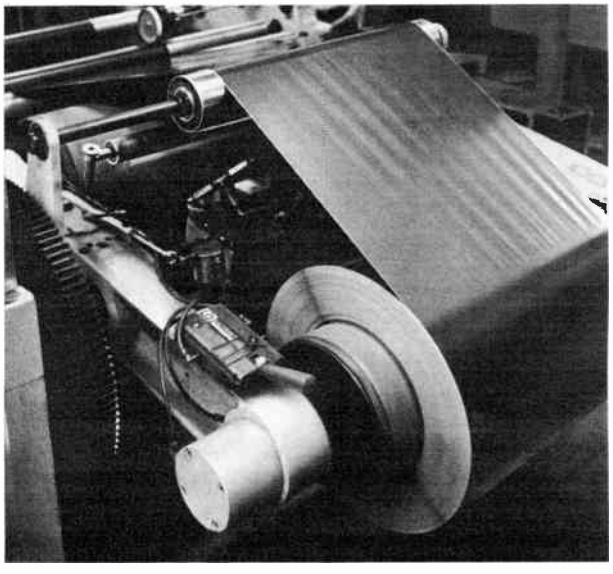
### BINDER ADDITIVES

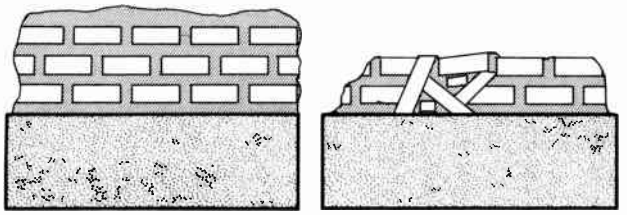
Some binder materials may need certain additives to change or improve certain properties. These additives may be used in some tapes, but not others, depending somewhat on the application.

*Plasticizers:* Some binders are rather stiff especially when the coating is thick. Plasticizers added to the binder will give the coatings the desired flexibility.

*Lubricants:* Lubricants are sometimes added to the binder to bring the coefficient of friction within the proper limits. There are many effective lubricants besides the much-advertised silicone. Not

*Take-up section of the coater. The finished tape coming out of drying tunnel is wound on large diameter cores into jumbo rolls.*





*In these illustrations, the binder is compared to mortar in a brick wall. Ideally, the oxide particles should be lined up uniformly like bricks. The mortar between the bricks supplies cohesion. The binder between the footing and wall supplies adhesion. The diagram on right shows an undispersed lump of many particles which may cause both physical strength as well as magnetic losses.*

every tape needs a lubricant; some use a low-friction binder which eliminates the need for another ingredient.

*Conductive agents:* Many tapes have a very high electrical resistivity being made largely of plastic. The normal motion of such a high-resistance tape on a recorder, may cause a buildup of electrostatic charges which, in turn, attracts dropout-producing dust, may produce popping noises, and even cause jamming in cassettes. Conductive agents such as carbon powder are added to increase the coating conductivity.

A superior method of increasing the conductivity is to remove all the carbon from the coating and to use it in a backcoating where it not only eliminates static much more efficiently but adds a number of mechanical features. Furthermore, the removal of the carbon from the coating leaves more room for oxide, thus raising the output level.

There are many other binder additives such as wetting agents, stabilizers, fungicides, etc., each performing self-explanatory functions. A well-designed tape, however, has as few additives as possible, because each additional ingredient must be chemically integrated into the coating without migrating or undergoing other undesirable changes.

## MANUFACTURING PROCESS

Magnetic tape is made by a process method rather than by an assembly method. In the assembly method, used among others by sound-equipment manufacturers, components are assembled together until the product is completed. If the final inspection uncovers a defective component, it is simply replaced and the equipment works as intended. In tape manufacturing, however, each step in the process must be exactly right the first time or the entire tape will be defective with no opportunity for correction. The familiar aphorism, "the chain is as strong as its weakest link," applies here quite accurately. It is clear, therefore, that very strict control must be exercised throughout the manufacturing process if the tape is to consistently meet tight specifications.

Control of quality begins with the incoming inspection of all the raw materials. Since all materials have some minor variations, this inspection must determine which ones meet the necessary tolerances.

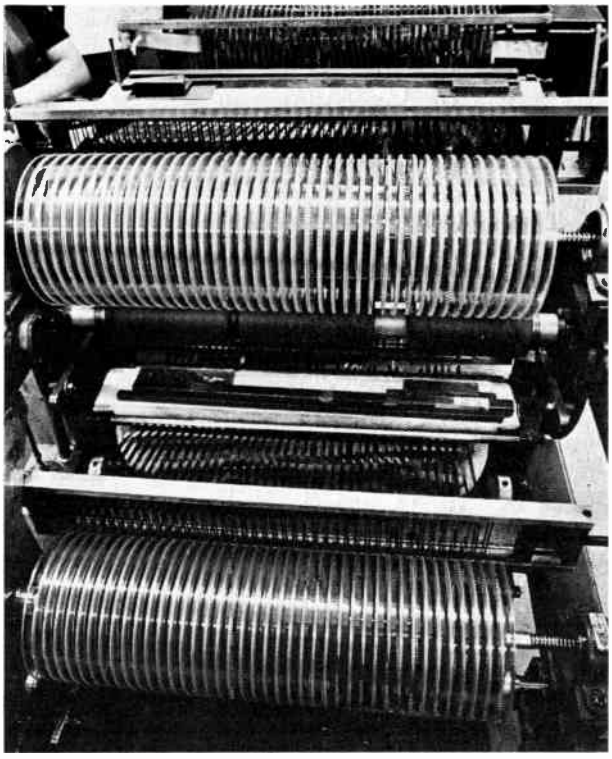
The magnetic material, for instance, is tested for its magnetic properties using such sophisticated equipment as vibrating sample magnetometers and hysteresis loop tracers. Electron microscopes are employed to examine the particles visually under magnification of many thousands of diameters. Properties such as particle dimensions, size distribution, and imperfections can be then readily observed and photographed.

All chemicals and solvents undergo chemical analysis using equipment like gas chromatographs, infrared spectrometers, and many others which scrutinize the composition for minute details and sniff out the smallest trace of an impurity. Even base film is examined for thickness uniformity, cleanliness, physical stresses, static, etc. Base materials also require special ambient conditioning before they are used, to assure that they are relaxed, wrinkle free, and, most important, that they are completely free of any debris.

Much effort and expense is involved in this inspection by reputable tape manufacturers. They realize, however, that shortcuts can result in a lack of reliability and repeatability and, in some cases, render entire batches quite useless. No such chances can be taken by a supplier of first-class tape, because the discerning user rightly expects the tape to be consistently good reel-after-reel as long as the product is available.

*Formulation:* Each major tape type may have its own formulation or recipe. In this respect, no two tape types in the world are alike. Any tape formulation is the result of extensive research and development effort and is carefully designed to meet all the specifications for the given tape product. A well-designed tape should produce the specified performance of which *any* tape recorder is capable and do so without any machine adjustments. A great tape will go even further by improving the performance beyond the recorder manufacturer's specifications.

Different tape types may require a special formulation for each. Computer tapes are different from video tapes which, in turn, are different from audio tapes. Even among the many audio tapes, optimum performance with no sacrifices may require not only different magnetic materials but often specially designed chemical formulations. Some manufacturers



*Tape for home use is slit and wound directly onto 7" reels.*

have one good formula and use it for all products. Occasionally, this compromise results in not developing the full potential of some of the items in their tape line.

*Milling and dispersion:* The first actual manufacturing step is the milling process which is a method of uniformly mixing and dispersing all the coating ingredients. The various formulation ingredients are loaded into a mill and a solvent, capable of dissolving the plastic binder material, is added. The entire composition is mixed thoroughly by the mill until it is homogeneously uniform and smooth. The ultimate purpose of the process is to have each iron-oxide particle wetted, coated with binder, and isolated from its neighbors. When the milling is finished, the result is a thickish liquid, called the "slurry," with paint-like consistency.

Milling can be accomplished by various means. The most familiar is the ball mill which is a very large rotating drum partially loaded with steel balls. hence the name. As the ball mill rotates, the balls tumble in the mixture creating the type of forces and agitation needed to achieve the proper dispersion.

Milling is critical because either too little or too much is harmful to the quality. Insufficient milling may result in undispersed groups of iron-oxide particles which cause increased hiss, noise bursts, considerably lower output, poorer amplitude uniformity, and weak spots which eventually develop into dropouts. On the other hand, overmilling breaks the needleshaped particles causing a loss of high frequencies, increase in print-through (echo between tape layers), frequently increased head wear, and some other problems.

Depending on the method of milling and the end product, the milling time ranges from several minutes' duration, all the way up to two weeks. Regardless of time, the slurry is ready for coating when it meets all specifications. Magnetic and physical tests are performed on the liquid slurry to determine the precise end point of the milling cycle.

*Coating:* After filtering and several other conditioning steps, the slurry is fed to the coater which is a giant machine resembling a rotary printing press. The minimum number of sections making up a coater are: 1. take off, 2. coating zone, 3. orientation, 4. drying, and 5. take up. Some coaters can perform more functions, but the five sections are essential to even the simplest machine.

A typical, high-speed coating machine may function like this: A large roll of base film, 15,000 feet or more long and several feet wide is loaded on the take-off side of the machine and is threaded through the entire complex until it comes out as a coated tape on the take-up side, many hundreds of feet away from the start. The coater, of course, is never stopped to load new rolls or to unload finished ones. Special equipment automatically starts new rolls on both ends, as needed, without ever slowing down.

After the take-off area, the base may pass through a base treatment and conditioning section to the coating zone where the slurry is applied to the base in a precise and highly uniform thickness.

The typical thickness of a reel-to-reel tape is less than 400 microinches (microinch is one millionth of an inch), but the thickness range of consumer sound tapes may run from 70 to 650 microinches, as used in some cassette tapes and high-output tapes, respectively. The thickness of certain backcoatings is as low as 20 microinches. On the same scale, a dollar bill is 4000 microinches thick which gives you some idea of how thin tape coatings are.

The thickness uniformity is monitored and controlled continuously throughout the length and the width of the roll while the coating is in progress. This is done without physical contact, by measuring the absorption of x-rays or radioactive sources by the coating. The control is vital because variations in uniformity will cause corresponding variations in low-frequency output, distortion. change optimum operating points for bias or record level, disturb the amplitude stability, and cause many other quality problems. Thin coatings place extremely difficult

demands on the coating equipment. A cassette tape, for instance, with an average coating thickness of 200 microinches may require a thickness control of ±5 microinches to maintain a ±2.5% thickness tolerance.

A good coating means much more than thickness uniformity alone. The coating must also be extremely smooth, completely free from streaks, voids and other, even microscopic, blemishes. Perfection of this kind is costly and difficult to achieve and not always necessary for home recording. It is of paramount importance, however, in computer tapes and studio mastering tapes. Tape manufacturers who produce such tapes must, therefore, have the capability of achieving the desired degree of perfection and are the ones who may be expected to also produce the "perfect" sound tape.

It should be clear, therefore, that the coating cannot possibly be applied by brushing or spraying as has been sometimes reported. Many methods are employed: one of them, in principle, resembles the spreading of soft butter on bread with a big knife. Another, could be likened to a precision paint roller, and a third one imitates a roll used in printing magazines like the one you are reading now. There are more than a dozen others which are capable of doing the job right.

*Orientation:* The oxide particles in the slurry are randomly arranged in all possible directions. It is desirable, however, to have all of them with their long dimensions parallel to the long dimension of the tape. To accomplish this, the coated base, while still wet and fluid, is passed through a powerful, directional, magnetic field which turns and lines up all the particles in one direction.

As the result of orientation, the coercive force and induction increase considerably. The improved magnetics, in turn, improve the signal-to-noise ratio by raising the output level and lowering the background noise.

In order for the orientation to be fully effective, the slurry must be properly dispersed during the milling process. The reason is that undispersed clumps of oxide contain many randomly arranged particles which cannot by individually oriented, since the magnetic field will act on the entire clump.

*Drying:* After orientation, the tape moves into the drying tunnels where heated air evaporates the solvent from the coating until it is completely dry. The drying cycle must also be carefully controlled to assure a correct drying rate. Drying which is too fast can cause some solvents to evaporate rapidly, leaving the coating with many noise and dropouts producing pits and pinholes. Conversely, an incompletely dried tape may stick to itself or gum up the heads. Both these problems can occur if the temperature, the air volume, and velocity are not closely controlled for the given tape.

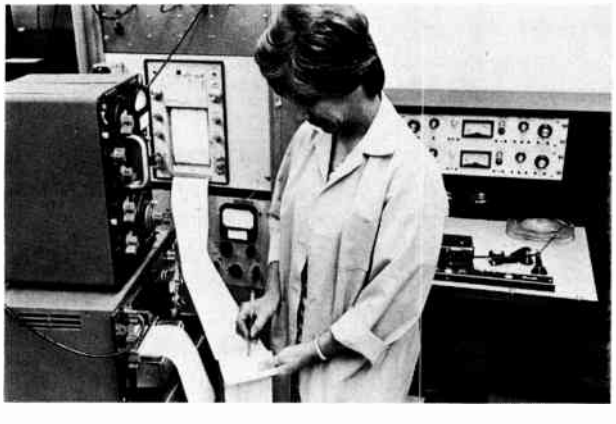
*Take-up:* The finished tape coming out of the tunnel is wound with controlled tension on large diameter cores to make up jumbo rolls. The large cores reduce the number of layers in the rolls and thus minimize stresses in the tape.

*Surface polishing:* While a well-dispersed slurry coated on a good machine is usually quite smooth, it is not sufficient for tapes where high-frequency response is an important requirement. A tape with a good high-frequency sensitivity must maintain intimate contact with the record and play heads, because the slightest spacing will introduce severe output losses. For example, if a 10-kHz signal is recorded on a cassette running at 1⅞ ips, a 6-dB output loss will take place if there is only a 10 microinch spacing between the tape and the head. Coating roughness results in an undesirable spacing even if the tape is pressed against the head. This is because the head does not contact the entire surface uniformly (certain lower sections being some distance away) which produces a decrease of output as well as variation in the output uniformity. A quality tape, for these reasons, should have a polished surface, at least to some degree.

The polishing surface treatment can be done in several ways. Brushing, burnishing, rubbing against another tape, have all been used with reasonable results. In one popular method, the tape is passed between two or more highly polished rolls which are heated and which can apply a high pressure to the tape. The combination of pressure and temperature imparts to the coating any degree of smoothness desired. Mirror-like smoothness is obtainable with this technique.

Not all tapes available today are polished. Some untreated economy tapes may have acceptable

*Quality-Control inspectors perform many tests on finished tapes to assure conformance to all specs. Here, tape is tested for uniformity and noise, using automatic plotting equipment.*



sound quality, especially in reel-to-reel recording at 7½ ips, but they are never as good as well-polished tapes. High-frequency differences of up to 14 dB were observed between a popular nonpolished open-reel tape and a new supersmooth Ultra High-Output, Low-Noise tape. The differences in cassettes are even greater, emphasizing the point that unpolished or poorly polished cassette tapes are not very good for recording music.

Surface smoothness is one area where simple visual comparison may prove worthwhile. In comparing two tapes, the one with the shinier surface should have a better high-frequency response. This is not an absolute rule, especially when comparing slight differences in shininess, because there are other, invisible factors which influence high-frequency response. However, it is a good rule of thumb when the visual differences are pronounced or one of the tapes is not polished at all.

Another benefit of polishing is the stability of high-frequency response which does not change with repeated use. Unpolished tapes may improve their frequency response after a number of passes, even though the improvement will not equal the output of a polished tape. Such an improvement is of doubtful value anyway, since recordings are made on the very first pass when the response of the tape is the lowest.

Dropouts are also reduced by polishing, because any protrusions from the surface which cause instantaneous head-to-tape separations are flattened out.

*Slitting:* Slitting is the final manufacturing operation, necessary to reduce the wide web to standard widths used for the given tape type. All audio tapes for home use, with the exception of cassette tapes, are slit to ¼" width or more precisely to 0.248 inch. Cassette tapes are 0.149 inch wide.

Slitting is, in essence, a scissor-like action performed by rotary cutters at high speeds. In most cases, the entire wide web is slit simultaneously, producing as many as 100 or more reels at a time. In spite of the mass-production nature of the process, slitting is certainly a precision operation because of the critical demands of the end product.

Some of the demands are:

1. The tape width must be very accurate. The width tolerance on a cassette tape being ±1 mil, for instance. The tape which is too wide will stick in the recorder guides and damage the edges by folding or scraping. A narrow tape may not track properly and cause output variations on edge channels and in some cases, contribute to crosstalk.

2. The tape must not exhibit skew or "snakiness." This phenomenon occurs if the tape is not slit in a perfectly straight line, even if the width is correct. This will cause the tape to move past the heads at a constantly changing angle with respect to the gap, creating a continuously varying azimuth misadjustment. As a good high-frequency response is critically dependent on precise and constant azimuth, snakiness can produce considerable variations in the high-frequency output.

3. The slit edges must be cut cleanly with no evidence of tearing such as chips, slivers, or other edge debris. A poorly slit edge will generate dirt and dropouts and affect the sound quality on the edge tracks. On the other hand, it should be noted that edges can never be as smooth as the coating and, consequently, a slight polishing takes place continuously as the edges rub against the guides and reel flanges while transported on a machine. The material thus removed from the edges frequently deposits on rubber pinch rollers or even on the heads, appearing as two thin lines of oxide, a tape width apart. This occurrence is not abnormal providing it is not excessive and is one of the reasons why a periodic cleaning and maintenance of the recorder is necessary.

*Other processes:* There are a number of other processes in tape manufacturing which will not be

*(Left) A hysteresis-loop tracer measures magnetic properties. Note a hysteresis loop of a magnetic tape on scope. (Right) The author examining iron-oxide particles on electron microscope.*

described here. These are such things as the application of back-coatings for 8-track tape and "Cushion-aire," attaching leaders and switching foils, preparation of tapes for loading into cartridges and cassettes, and more. The requirements and manufacturing of cassettes and cartridges, owing to their increasing popularity, is also a subject within the scope of this article, but because of its extent is better left for another time.

Most reel-to-reel tapes, however, are completed at slitting, after which they are tested, demagnetized down to the virgin noise level, and packaged for shipment.

*Testing:* The extent of testing of magnetic tape varies with different manufacturers. It would not be accurate, therefore, to simply describe how tape is tested, in general terms. The description given here applies only to Audio Devices.

Magnetic tapes undergo much scrutiny and inspection to ensure that all products meet all of the many specifications. A large percentage of technical personnel devote their time to inspection, process control, quality control, and quality assurance functions. Throughout the manufacturing process, inspectors, aided by automatic monitoring devices, keep an eye on quality.

Finished tapes are subjected to many tough, but realistic, test procedures which duplicate any recording, handling, or storage situation encountered by the home recordist. The performance tests are made on a variety of tape recorders from all parts of the world, taking into consideration their age, wear, and even improper or negligent maintenance practices.

The tests are performed in several well-equipped laboratories chock full of test gear. The important quality of surface smoothness, for instance, could be evaluated by eye or by running a frequency-response test; but to measure quantitatively, a precision surface analyzer is used which produces a chart of the actual tape profile with a sensitivity of 1 microinch!

The basic tests performed by Q.C. are: 1. Physical, *e.g.*: dimension, strength, smoothness, life, head wear, temperature stability, etc.; 2. magnetic tests measuring the coercive force, induction and other purely magnetic properties; and 3. recording performance tests, *e.g.*: bias characteristics, frequency response at different tape speeds, distortion, uniformity, noise, dropouts, print-through, and others.

In addition, the R&D staff performs more elaborate studies on tape performance with an eye to improvement. They plot performance curves and charts, measure effects of bias changes, run spectrum analyses on several types of noise and distortion, and subject the tape to torturous temperature-humidity cycles for days or weeks.

*Precision surface analyzer measures tape smoothness profile and plots it on chart with a 1-millionth of an inch sensitivity.*

The quality assurance group checks finished tape after it has arrived in the warehouse or even the dealer's shelves. They look at the tapes very critically from the customer's point of view. The Q.A. group may ship cartons of tape across the country by various means, and then ship them back to see how well they travel and store, or if the packaging is sturdy enough. All information is analyzed and fed back to proper authorities, resulting in continuous improvement and upgrading of the already amazingly good recording medium.

## CONCLUSION

It takes much effort, experience, and facilities to produce the "perfect" tape which does all it should, reliably and consistently reel-after-reel, year-after-year. It is certainly hoped that the reader now has a better concept and appreciation of how tape is made, what goes into it, and how all this affects the performance at home.

Such knowledge will assuredly equip the serious home recordist to select and use magnetic tape with more understanding and thus multiply the pleasures of recording. □

# DIRECTORY OF 4-CHANNEL RECORDED TAPES

Your choice is between 8-track cartridge or reel-to-reel formats. Some of the reel-to-reel tapes are Dolbyized.

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"Purlie"—Original Broadway Cast ..... AMR 70101L
Classical Film Themes ..... AMR 71129L
Roots—Mayfield ..... CUR 78009L
Surround Stereo Sampler ..... VAN 71L
Country Joe's Greatest Hits ..... VAN 714L
Mama Lion ..... FAM 72702L
Children of France ..... LON 77150L
Frank Chacksfield Plays Bacharach ..... LON 77158L
Latin King—Edmundo Ros ..... LON 77169L
The Epic, Vol. 4—Stanley Black ..... LON 77173L
Invitation to Love—Ronnie Aldrich ..... LON 77176L
Tchaikovsky—Symphony #4, Stokowski ..... VAN 715L
The Chi-Lites' Greatest Hits ..... BRU 74184L
Music of the People—Stanley Black ..... LON 77060L
Sousa Marches—Band of The Grenadier Guards ..... LON 77103L
Love—Caterina Valente ..... LON 77181L
Tribute to Charlie Chaplin—Stanley Black .... LON 77184L
Music of Cole Porter—Frank Chacksfield .... LON 77185L
Salute to Glen Miller—Ted Heath ..... LON 77186L
Christmas with the Children of France ..... LON 77188L
This is My World—Edmundo Ros ..... LON 77189L
Wonderful World of Broadway ..... LON 77191L
Quadraphonic World of Phase 4 Stereo ..... LON 77192L
Montovani—Annunzio Paolo ..... LON 77193L
Ethel Merman Sings Merman ..... LON 77901L
Movin' On—Dick Schory ..... OVT 7199L
Paul Horn and the Concert Ensemble ..... OVT 7293L
Warm, Wild, Wonderful—Tony Mottola ..... PRJ 75025L
Enoch Light and the Brass Menagerie ..... PRJ 75036L
Brass Menagerie, Vol. 2 ..... PRJ 75042L
Spaced Out—Enoch Light ..... PRJ 75043L
Permissive Polyphonics—Enoch Light ..... PRJ 75048L
Big Band Hits of the 30's—Enoch Light ..... PRJ 75049L
Spanish Strings—Enoch Light ..... PRJ 75000L
Hit Movie Themes—Enoch Light ..... PRJ 75051L
Big Band Hits of the 30's and 40's—Enoch Light ..... PRJ 75056L
Superstar Guitar—Tony Mottola ..... PRJ 75062L
Demo 4 Channel—Enoch Light ..... PRJ 7700L
Movie Hits—Enoch Light and the Light Brigade PRJ 75063L
Bein' Green—Urbie Green ..... PRJ 75066L
The Brass Ring—Featuring Phil Bodner ..... PRJ 75067L
4 Channel Dynamite Quadraphonic ..... PRJ 75068L
Tony and Strings—Tony Mottola ..... PRJ 75069

**APPLE**

Lennon/Ono—Imagine ..... Q8W-3379

**ATLANTIC**

Modern Jazz Quartet—Plastic Dream ..... L71589
Franklin, Aretha—Aretha Live at the Fillmore ..... T77205
Santamaria, Mongo—Mongo at Montreux ..... L71593

**BARNABY**

Stevens, Ray—Greatest Hits ..... ZAQ30770
Stevens, Ray—Turn Your Radio On ..... ZAQ30809

**COLUMBIA**

All releases available on 4-channel discs under this label are offered as 4-channel, 8-track cartridges as well. See page 60.

**EPIC**

All releases available on 4-channel discs under this label are offered as 4-channel, 8-track cartridges as well. See page 60.

**GRUNT**

Jefferson Airplane—Bark ..... PQFT-1001
Kantner/Slick—Sunfighter ..... PQFT-1002
_____Papa John Creach ..... PQFT-1003
Hot Tuna—Burgers ..... PQFT-1004

**KIRSHNER**

Archies, The—Sugar, Sugar ..... PQKO-1002

**OVATION**
All releases available on 4-channel discs under this same label are offered as 4-channel, 8-track cartridges as well. See page 60.

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Hackett Bobby—A Time for Love ..... 5016
Free Design—Kites are Fun ..... 5019
Green Urbie—Twenty-One Trombones ..... 5024
Mottola Tony—Warm, Wild & Wonderful ..... 5025
Bellson Louie—Breakthrough! ..... 5029
Mottola Tony—Roma Oggi ..... 5032
Lawson & Haggart—World's Greatest Jazzband ..... 5033
Light Enoch—TheBrass Menagerie ..... 5036
World's Greatest Jazzband—Extra ..... 5039
Mottola Tony—The Tony Touch ..... 5041
Light Enoch—The Brass Menagerie, Vol. 2 ..... 5042
_____Spaced Out ..... 5043
Light Enoch—Best of the Movie Themes ..... 5046
Light Enoch—Permissive Polyphonics ..... 5048
Light Enoch—Big Band Hits of the 30's ..... 5049
Light Enoch—Big "Hit Movie" Themes ..... 5051
Light Enoch—Big Band Hits of the 30's and 40's .... 5056
Light Enoch—Big Band Hits of the 20's ..... 5059
Light Enoch—The Brass Menagerie 1973 ..... 5060
Mottola Tony—Superstar Guitar ..... 5062
Light Enoch—Movie Hits! ..... 5063
Kaye Sammy—If You've Got the Time ..... 5065
Green Urbie—Bein' Green ..... 5066
_____The Brass Ring featuring Phil Bodner ..... 5067
Light Enoch—4-Channel Dynamite ..... 5068
Mottola Tony—Tony & Strings ..... 5069
Jurgins Dick—Here's That Band Again ..... 5071
Light Enoch—Charge ..... 5073
_____4 Channel Demonstration ..... D700

**QUAD-SPECTRUM**
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**RCA**
Tchaikovsky—Concerto No. 1 *Van Cliburn* ..... RQ8-1002
_____Music from Million Dollar Movies *Fiedler/Boston Pops* ..... RQ8-1010
Rodgers—Victory at Sea (Vol. 1) *Bennett* ..... RQ8-1027
_____Best of Fiedler and Boston Pops ..... RQ8-1047
Puccini—Madama Butterfly (excerpts) *Price/Elias/Tucker/Leinsdorf* ..... RQ8-1048
Rodrigo/Vivaldi/Britten—Concierto de Arangjuez for Guitar & Orch., Concerto in D for Lute & Strings, Courtly Dances from "Gloriana" *Julian Bream* ..... RQ8-1052
Puccini—La Boheme (highlights) *Moffo/Costa/Tucker/Merrill/Tozzi/Maero/Leinsdorf* ..... RQ8-1077
_____Up Up and Away with Fiedler and Boston Pops ..... RQ8-1103
Chopin—Concerto No. 2 in F Minor, Grand Fantasy on Polish Airs *Rubenstein/Ormandy* ..... RQ8-1110
Tchaikovsky/Rachmaninoff—1812 Overture, Spring Cantata, Three Russian Folksongs *Buketoff* ..... RQ8-1115
Liszt/Dvorak—Selections from Bartered Bride, Scherzo Capriccioso *Ormandy* ..... RQ8-1123
_____The Moog Strikes Bach, Chopin, Mozart, Rachmaninoff, Paganini, Prokofiev *Wurman* ..... RQ8-1137
Bizet—Shchedrin—Carmen Ballet *Fiedler/Boston Pops* ..... RQ8-1141
Dvorak—Symphony No. 9 ("New World") *Fiedler/Boston Symphony* ..... RQ8-1160
_____Chopin a la Moog *Wurman* ..... RQ8-1162
Stravinsky—Firebird Suite, Petrouchka *Ozawa/Boston* ..... RQ8-1164
Saint-Saens/Falla—Concerto No. 2, Nights in the Gardens of Spain *Rubenstein/Ormandy* ..... RQ8-1165
Strauss, Richard—Also Sprach Zarathustra *Reiner/Chicago* ..... RQ8-1168
Copland—Billy the Kid Suite, Applachian Spring *Ormandy* ..... RQ8-1170
Handel—Messiah (excerpts), Water Music Suite *Ormandy* ..... RQ8-1198
_____Love Story *Ormandy* ..... RQ8-1179
Tchaikovsky—Symphony No. 6 ("Pathetique") *Ormandy* ..... RQ8-1112
Best of Al Hirt ..... PQ8-1011
My World—Eddy Arnold ..... PQ8-1088
Best of Mancini ..... PQ8-1128
Best of Eddy Arnold ..... PQ8-1185
The Youngbloods—Get Together ..... PQ8-1221
Concert Sound of Henry Mancini ..... PQ8-1226
Chet Atkins Picks the Best ..... PQ8-1261
Montenegro, Hugo—Music from Fistful of Dollars, etc. ..... PQ8-1301
Best of Mancini (Vol. 2) ..... PQ8-1315
Feliciano, Jose—Feliciano! ..... PQ8-1377
Mancini, Henry—Warm Shade of Ivory ..... PQ8-1441
The Guess Who—Wheatfield Soul ..... PQ8-1442
Friends of Distinction—Grazin' ..... PQ8-1443
Sensational Charley Pride ..... PQ8-1452
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Nashville Brass—More Nashville Sounds ..... PQ8-1470
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Best of Ed Ames ..... PQ8-1476
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Friends of Distinction—Highly Distinct ..... PQ8-1489
Best of Charley Pride ..... PQ8-1505
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Feliciano, Jose—Alive Alive O! (Part 1) ..... PQ8-1537
Feliciano, Jose—(Part 2) ..... PQ8-1538
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Friends of Distinction—Real Friends ..... PQ8-1555
Nashville Brass/Davis—You Ain't Heard Nothin' Yet ..... PQ8-1568
Mancini, Henry—Theme from "Z" and others ... PQ8-1583
The Guess Who—Share the Land ..... PQ8-1590
Best of Hugo Montenegro ..... PQ8-1591
Floyd Cramer with The Music City Pops ..... PQ8-1592
Charley Pride's 10th Album ..... PQ8-1593
Presley, Elvis—On Stage (February 1970) ..... PQ8-1594
Feliciano, Jose—Fireworks ..... PQ8-1595
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Commo, Perry—In Person at the International, Las Vegas ..... PQ8-1608
Hot Tuna ..... PQ8-1613
Best of the Youngbloods ..... PQ8-1617
Friends of Distinction or Whatever—Whatever .. PQ8-1622
Nesmith & First National Band—Magnetic South ..... PQ8-1636
Cramer Floyd—Class of '70 ..... PQ8-1640
Belafonte, Harry—Belafonte at Carnegie Hall ... OQ8-5002
Best of Guess Who ..... PQ8-1710
Charley Pride—Just Plain Charley ..... PQ8-1536
Nesmith & First National Band—Loose Salute ... PQ8-1633
Presley, Elvis—Elvis, That's the Way It is ..... PQ8-1652
_____The Worst of Jefferson Airplane ..... PQ8-1653
Davis & Nashville Brass—Somethin' Else ..... PQ8-1692
Denver, John—Poems, Prayers and Promises ... PQ8-1711
_____Nilsson Schmilsson ..... PQ8-1734
Hot Tuna Electric—Recorded Live ..... PQ8-1762
Jefferson Airplane—Volunteers ..... PQ8-1507
The Guess Who—Rockin' ..... PQ8-1828
_____Brass on Ivory *Mancini/Severinsen* .... PQ8-1862
_____Rich in London *Buddy Rich at Ronnie Scott's* ..... PQ8-1895
Presley, Elvis—Elvis Recorded at Madison Square Garden .. PQ8-2054
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Montenegro, Hugo—Mammy Blue ..... PQ8-1861
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Best of Nina Simone ..... PQ8-1597
"Sound of Music" Original Sound Track ..... OQ8-1001
"Fiddler on the Roof" Original Broadway Cast .. OQ8-1005
"Hello, Dolly!" Original Broadway Cast ..... OQ8-1006
"Hair" Original Broadway Cast ..... OQ8-1038
Pride, Charley—Just Plain Charley ..... PQ8-1536
_____I Will See You in Hawaii Leon Addeo ... PQ8-1959
_____Turn on Some Happy! Danny Davis .... PQ8-2090
_____Love Theme from "The Godfather" Mancini ..... APT1-0001
_____Mancini Salutes Sousa Mancini ..... APT1-0013
_____Scenes and Themes Montenegro ..... APT1-0025
Pride, Charley—Songs of Love Charley Pride ... PQ8-2120
_____Artificial Paradise The Guess Who ..... PQ8-2114

*(Continued on page 65)*

# DIRECTORY OF QUADRIPHONIC PHONO RECORDS

You still have to choose between the CBS "SQ" and the Sansui "QS" matrix systems. But, when it comes to the discrete disc format, RCA's "Quadradisc" stands alone.

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Stevens, Ray—Greatest Hits ..... ZQ30770
Stevens, Ray—Turn Your Radio On ..... ZQ30809

**CAPITOL**
New Country-Pop Favorites ..... QL6736
Great Hit Songs from "Fiddler on the Roof" *Hollywood Pops* ..... *QL6765*
New Brass Sound of the Hits *San Fernando Brass* . QL6789
Songs of the Seventies *Sounds of the 70's Orchestra* ..... QL6774
Great Songs of the Beatles ..... QL6735
Great Songs of Bacharach & David ..... QL6734
Instrumental Hit Sounds *John Morell* ..... QL6836
New Songs of the 70's *Sounds of 70's Orchestra* .. QL6876

**COLUMBIA**
Carlos, Walter—Switched-On Bach ..... MQ31018
Strauss, Richard—Also Sprach Zarathustra *Bernstein* ..... MQ30443
Stravinsky—Boulez Conducts Stravinsky *Pierre Boulez* .... MQ31076
Subotnick, Morton—Touch ..... MQ31019
Tchaikovsky—Swan Lake Ballet *Bernstein* ..... MQ30056
Verdi—Requiem *Bernstein* ..... M2Q30060
Ten Years After—A Space in Time ..... CQ30801
Santana—Santana III ..... CQ30595
Firesign Theatre—I Think We're All Bozos ..... CQ30737
Ellis, Don—Tears of Joy ..... GQ30927
Mathis, Johnny—In-Person at Caesar's Palace ... GQ30979
Mathis, Johnny—You've Got a Friend ..... CQ30740
Nero, Peter—Summer of '42 ..... CQ31105
Santana—Abraxas ..... CQ30130
Price, Ray—For The Good Times ..... CQ30106
Joplin, Janis—Pearl ..... CQ30322
Streisand, Barbra—Stoney End ..... CQ30378
Anderson, Lynn—Rose Garden ..... CQ30411
Williams, Andy—Love Story ..... CQ30497
Conniff, Ray—Love Story ..... CQ30498
Raiders, The—Indian Reservation ..... CQ30768
Nabors, Jim—Help Me Make it Through the Night . CQ30810
Faith, Percy—Romeo and Juliet Theme ..... CQ31004
Davis, Miles—Bitches Brew ..... GQ30997
Bloomfield, Kooper, Stills—Super Session ..... CQ30991
"Company"—Original Cast Recording ..... SQ30993
"No, No, Nannette"—Original Cast Recording ... SQ30563
"Funny Girl"—Original Sound Track ..... SQ30992
Cash, Johnny—Johnny Cash at San Quentin ..... CQ30961
Parch, Harry—World of Harry Parch ..... MQ31227
Simon, Paul—Paul Simon ..... CQ30750
Streisand, Barbra Joan—Barbra Joan Streisand .. CQ30792
Simon & Garfunkel—Bridge Over Troubled Water CQ30995
Blood, Sweat & Tears—Greatest Hits ..... CQ31170
Matz, Peter—Quadraphonic Spectacular ..... CQ31247
Faith, Percy—Joy ..... CQ31301
Williams, Andy—Love Theme from "The Godfather" ..... CQ31303
Mathis, Johnny—The First Time Ever ..... CQ31342
Mormon Tabernacle Choir—Climb Every Mountain ..... MQ30647
Subotnick, Morton—Sidewinder on Electric Music Box .... MQ30683
Bernstein, Leonard—Mass ..... M2Q31008
London Symphonic Band—Bach for Band ..... MQ31126
Biggs, E. Power—Music for Organ, Brass & Percussion ... MQ31193
Columbia Brass Ensemble—Quadraphonic Music for Brass ..... MQ31289
Tchaikovsky—1812 Overture/Romeo & Juliet ... MQ31276
_____Introduction to World of Quadraphonic Sound ... QX31403
Williams, Andy—You've Got a Friend ..... CQ30797
Faith, Percy—Black Magic Women ..... CQ30800
Davis, Miles—Live-Evil ..... GQ30954
Nabors, Jim—"Man of La Mancha" ..... SQ31237
Santana & Miles—Live! ..... CQ31308
Conniff, Ray—Love Theme from "The Godfather" CQ31473
Santana—Caravanserai ..... CQ31610
Williams, Andy—Alone Again (Naturally) ..... CQ31625
Mathis, Johnny—Song Sung Blue ..... CQ31626
Faith, Percy—Day By Day ..... CQ31627
Conniff, Ray—Alone Again (Naturally) ..... CQ31629
_____World of SQ Quadraphonic Sound ..... QX31403
Bartok—Boulez Conducts Bartok ..... MQ31368
Mozart—Sinfonia Concertante *Stern/Zuckerman/Barenboim* ..... MQ31369
Bach—Six Brandenburg Concertos *Newman & Friends* ..... M2Q31398
Bach—Bach Organ Favorites, Vol. 5 *E. Power Biggs* ..... MQ31424
_____Romance *Stern* ..... MQ31425

Stravinsky—Le Sacre du Printemps *Bernstein* ... MQ31520
_____Monster Concert *Eugene List & Friends* MQ31726
Vivaldi—Four Seasons *Zuckerman* ..... MQ31798
Berlioz—Boulez Conducts Berlioz Overtures ... MQ31799
Ramsey Lewis Trio—Upendo Ni Pamoja ..... CQ31096
Blood, Sweat & Tears—Greatest Hits ..... CQ31170
Khachaturian/Liszt—Piano Concerto/Hungarian Fantasia *Entremont/Ozawa* ..... MQ31075

**EPIC**
Wynette & Jones—We Go Together ..... EQ30802
Beck, Jeff Group—Rough and Ready ..... EQ30973
Wynette, Tammy—We Sure Can Love ..... EQ30658
Poco—Deliverin' ..... EQ30209
Chase— ..... EQ30472
Sly & The Family Stone—Greatest Hits ..... EQ30325
Redbone—Message From a Drum ..... EQ30815
E. Winters' White Trash—Roadwork ..... EGQ31249

**GOLDEN CREST**
Fillmore—A Salute to Henry Fillmore *Univ. of Illinois Symphonic Band* ..... GC CRS-4112
Finnegan—Happy Fingers ..... GC-31027
_____Those Swedish Meatballs, Stan & Doug ..... GC CRS-31026

**MONUMENT**
Kristofferson, Kris—Silver Tongued Devil & I ..... ZQ30679
Kristofferson, Kris—Border Lord ..... ZQ31302

**PROJECT 3**
Light Enoch—The Brass Menagerie 1973 ..... PR5060
_____The Brass Ring featuring Phil Bodner .... PR5067
Light Enoch—4 Channel Dynamite ..... PR5068
_____4 Channel Demonstration ..... PRD700

**VANGUARD**
Berlioz—Requiem *Abravanel* ..... VSQ-30006/7
Handel—Messiah *Somary* ..... VSQ-30003/4/5
Handel—Messiah (excerpts) *Somary* ..... VSQ-30002
Mahler— Symphony No. 3 in D *Abravanel* .... VSQ-30008/9
Mozart—Divertimento in B Flat, Divertimento in F *Blum* ... VSQ-30010
Tchaikovsky—Symphony No. 4 in F *Stokowski* . VSQ-30001
_____—Virtuoso Trumpet *Berinbaum* ..... VSQ-30012
Handel—Judas Maccabeus *Somary* ..... VSQ-300013/4/5
Dvorak/Arensky—Serenade Op. 22/Variations *Somary* .... VSQ-30011
Tchaikovsky/Prokofiev—Serenade Op. 48/Classical Symphony *Somary* ..... VSQ-30016
Cherubini—Missa Solemnis *Jenkins* ..... VSQ-30017/18
_____Las Cantigas de Santa Maria *Waverly Consort* ..... VSQ-30019
Handel—Royal Fireworks/Water Music *Somary* VSQ-30020
Stravinsky—Petrouchka *MacKerras* ..... VSQ-30021
_____Red Buddah *Yamashita* ..... VSQ-30022
Baez, Joan—Blessed Are ..... VSQ-40001/2
Country Joe & the Fish—From Haight-Ashbury to Woodstock ..... VSQ-40004/5
St. Marie, Buffy—Moonshot ..... VSQ40003
Coryell, Larry—At the Village Gate ..... VSQ-40006
Schickele—Wurst of P.D.Q. Bach ..... VSQ-40007
Quadraphonic Demo Discs ..... VSQ 1X/2X/3X/4X

## COMPATIBLE (SQ/QS)

**OVATION**
Quadraphonic Sound Demo Disc ..... OD/1
Experience 4-Channel Quadraphonic Sound ..... OD/2
Morello Joe—Another Step Forward ..... OVQD/1402
Schory, Dick—Movin' On ..... OVQD/1403
Paul Horn & The Concert Ensemble ..... OVQD/1405
Christian, Bobby—Vibe-Rations ..... OVQD/1406
Hollins & Starr—Sidewalks Talking ..... OVQD/1407
Steele, Ron—Chicago Guitar ..... OVQD/1408
Laura- ..... OVQD/1411
Rich Mountain Tower- ..... OVQD/1412
Don Tweedy Chorus & Orchestra ..... OVQD/1413
Jones, Tommy—Tommy's Place ..... OVQD/1420
Koloc, Bonnie—After All This Time ..... OVQD/1421
Wm. Fisher Orchestra—Make Believe ..... OVQD/1422
Koloc. Bonnie—Hold On to Me ..... OVQD/1426
Laura—Comin' Apart ..... OVQD/1427
Heaven & Earth—Refuge ..... OVQD/1428
Koloc, Bonnie ..... OVQD/1429
Sounds of the City ..... OVQD/1501
Sounds of Railroad Nostalgia ..... OVQD/1502
Sounds of Today & Tomorrow ..... OVQD/1503
Sounds of the Road ..... OVQD/1504
Sounds of Nature ..... OVQD/1505
Schory, Dick—Carnegie Hall (2 discs½ ..... OVQD/1410
_____Hollywood Gold, Vol. 1 Montenegro (2 discs) ..... OVQD/1601
_____Hollywood Gold, Vol. 2 Montenegro (2 discs) ..... OVQD/1602

## RCA QUADRADISC

**Red Seal**
_____The Fantastic Philadelphians, Vol. 1 *Ormandy* .... ARD1-0002
_____The Fantastic Philadelphians, Vol. 2 *Ormandy* .... ARD1-0017
_____Stolen Goods *Dr. Teleny's Orchestra* .. ARD1-0015
Shostakovich—Symphony No. 15 *Ormandy* .... ARD1-0014
Sibelius—Symphony No. 2 *Ormandy* ..... ARD1-0018
Bach—Greatest Fugues *Ormandy* ..... ARD1-0026
Rimsky-Korsakov—Scheherazade *Ormandy* ... ARD1-0029
Debussy/Ravel—La Mer *Ormandy* ..... ARD1-0028
Rachmaninoff—Concerto No. 2 *Rubinstein/Ormandy* ..... ARD1-0031

**Popular**
_____Love Theme from "The Godfather" *Montenegro* ... APD1-0001
_____Mancini Salutes Sousa *Mancini* ..... APD1-0013
_____Scenes and Themes *Montenegro* ..... APD1-0025
_____Elvis-Aloha from Hawaii Via Satellite *Presley* ..... VPSX-6089

## SANSUI ENCODED

**ABC**
Hooker, John Lee—Never Get Out of These Blues ..... ABCX-736
King, B. B.—L. A. Midnight ..... ABCX-743
King, B. B.—Guess Who ..... ABCX-759
Hooker, John Lee—Live at Soledad Prison ..... ABCX-761
King, B. B.—Greatest Hits ..... ABCX-767
Hooker, John Lee—Born in Mississippi ..... ABCX-768

**AUDIO TREASURY**
Donizetti—Roberto Devereaux (excerpts) *Sills* . ATQD-24001
_____—Welcome to Vienna *Sills* ..... ATQD-24002

**BLACK JAZZ**
The Awakening—Hear, Sense and Feel ..... BJQD/9
Carn, Doug—Spirit of the New Land ..... BJQD/8
Franklin, Henry—The Skipper ..... BJQD/7
Russell, Gene—Talk to My Lady ..... BJQD/10
Johnson, Rudolph—Second Coming ..... BJQD/11
Patterson, Kellee—Maiden Voyage ..... BJQD/12
Bishop, Walter, Jr.—Keeper of My Soul ..... BJQD/14
_____The Awakening ..... BJQD/15
_____Doug Carn ..... BJQD/16

**BLUESWAY**
Hooker, John Lee—Kabuki Wuki ..... BLS6052
Charles, Ray—Genius Live in Concert ..... BLS6053
Odom, Voice—Farther On Down the Road ..... BLS6055
McGhee/Terry/Hooker—I Couldn't Believe My Eyes ..... BLS6059

**COMMAND**
Ray Charles Singers—Love Me With All Your Heart ..... CDQ-40005
Light, Enoch—Great Cole Porter Songs ..... CDQ-40002
Mattola, Tony—Guitar-Paris ..... CDQ-40001
_____—Persuasive Percussion ..... CDQ-40000
Count Basie—Broadway Basie's Way ..... CDQ-40004
Doc Severinsen—Fever ..... CDQ-40003
Light, Enoch—A New Concept ..... CQD-40002

**ODE**
King, Carole—Music ..... 4A-2.

**IMPULSE/ABC**
Coltrane, Alice—World Galaxy ..... AS-9187
Coltrane, Alice—World Galaxy ..... AS-9817
Klemmer, John—Waterfalls ..... AS-9220
White, Michael—Pneuma ..... AS-9221
Shepp, Archie—Attica Blues ..... AS-9222
Coltrane, Alice—Lord of Lords ..... AS-9224
Coltrane, John—Infinity ..... AS-9225
Sanders, Pharoah—Live at the East ..... AS-9227
Jackson & Brown—Just the Way It Had To Be .... AS-9230
Shepp, Archie—The Cry of My People ..... AS-9231
_____Best of Alice Coltrane ..... AS-9232
_____Pharoah Sanders ..... AS-9233
Jamal, Ahmad—Tranquility ..... AS-9234

**LONGINES SYMPHONETTE**
_____Country Brass (six discs) .....

**PROJECT 3**
Light Enoch—Spanish Strings ..... PR5000QD
Hackett Bobby—A Time for Love ..... PR5016QD
Free Design—Kites are Fun ..... PR5019QD
Green Urbie—Twenty-One Trombones, Vol. 2 .. PR5024QD
Mottola Tony—Warm, Wild & Wonderful ..... PR5025QD
Bellson Louie—Breakthrough! ..... PR5029QD
Mottola Tony—Roma Oggi ..... PR5032QD
Lawson & Haggart—World's Greatest Jazzband PR5033QD
Light Enoch—The Brass Menagerie ..... PR5036QD
World's Greatest Jazzband—Extra ..... PR5039QD
Mottola Tony—The Tony Touch ..... PR5041QD
Light Enoch—The Brass Menagerie, Vol. 2 .... PR5042QD
_____Spaced Out ..... PR5043QD
Light Enoch—Best of the Movie Themes ..... PR5046QD
Light Enoch—Permissive Polyphonics- ..... PR5048QD
Light Enoch—Big Band Hits of the 30's ..... PR5049QD
Light Enoch—Big "Hit Movie" Themes ..... PR5051QD
Light Enoch—Big Band Hits of the 30's and 40's PR5056QD
Light Enoch—Big Band Hits of the 20's ..... PR5059QD
Light Enoch—Brass Menagerie 1973 ..... PR5060QD
Mottola Tony—Superstar Guitar ..... PR5062QD
Light Enoch—Movie Hits! ..... PR5063QD
Kaye Sammy—If You've Got the Time ..... PR5065QD
Green Urbie—Bein' Green ..... PR5066QD
_____The Brass Ring featuring Phil Bodner . PR5067QD
Light Enoch—4 Channel Dynamite ..... PR5068QD
Mottola Tony—Tony & Strings ..... PR5069QD
Jurgens Dick—Here's That Band Again ..... PR5071QD
Light Enoch—Charge ..... PR5073QD
_____4 Channel Demonstration ..... PRD700QD
Rain—Rain ..... PR5072QD

**QUAD-SPECTRUM**
_____Soul of Spain (Vol. 3) *101 Strings Orchestra* . QS-1
_____Exciting Sounds *101 Strings Orchestra* ..... QS-2
_____Multiple Guitars *Thatcher* ..... QS-3
_____Today's Hits *101 Strings Orchestra* ..... QS-4
_____Movie Themes *101 Strings Orchestra* ..... QS-5
_____Bob Jackson "Boots" The Sax ..... QS-6
Doe, Johnny—Sings the Songs of Johnny Cash ..... QS-7
_____Country Hall of Fame *101 Strings Orchestra* . QS-8
_____California Poppy Pickers Play & Sing ..... QS-9
_____Soul of Israel *101 Strings Orchestra* ..... QS-10
_____101 Strings Orchestra Plus Guitars ..... QS-11
_____Golden Age of the Dance Bands *Buddy Cole* QS-12
_____Movie Hits *101 Strings Orchestra* ..... QS-13
_____Music from "Cabaret" *101 Strings Orchestra* QS-14
_____Music from "Fiddler on the Roof" *101 Strings Orchestra* ..... QS-15
_____101 Strings Orchestra *Riddle* ..... QS-16
_____Latin Holiday *101 Strings Orchestra/Baxter* . QS-17
_____Today's Sound *101 Strings Orchestra/Kelly* . QS-18
_____Hits of Bacharach & Webb *101 Strings Orchestra* ..... QS-19
_____Dynamic Sounds *101 Strings Orchestra* .... QS-20
_____Symphonic Fireworks *Nord Deutches Symphonie* ..... QS-21
_____Songs by Carole King *101 Strings Orchestra* . QS-22
_____Music from "Lost Horizon" *101 Strings Orchestra* ..... QS-23
_____Movie Themes *101 Strings Orchestra* ..... QS-24

## Directory Of Manufacturers

*(Continued from page 11)*

**SANYO ELECTRIC INC.** ..... **83, 103**
*1200 W. Walnut St., Compton, Calif. 90220*
**SCINTREX, INC.** ..... **112**
*400 Creekside Dr., Tonawanda, N.Y. 14150*
**SCOTCH,** 3M Co. Magnetic Products Div. ..... **124**
*3M Center, St. Paul, Minn. 55101*
**SCOTT, H. H., INC.** ..... **104**
*111 Powder Mill Rd., Maynard, Mass. 01754*
**SENNHEISER ELECTRONIC CORP.** ..... **112, 118**
*40 E. 49th St., New York, N.Y. 10017*
**SHURE BROS., INC.** ..... **119, 129**
*222 Hartrey Ave., Evanston, Ill. 60204*
**SIGNAL SCIENCE, INC.** ..... **129**
*140 Lowlands St., Holliston, Mass. 01746*
**SONY CORP. OF AMERICA** ..... **83, 90, 104**
*47-47 Van Dam St., Long Island City, N.Y. 11101*
**SONY/SUPERSCOPE**
Superscope, Inc. ..... **70, 83, 91, 104, 120, 124, 129**
*8150 Vineland Ave., Sun Valley, Calif. 91352*
**SOUNDCRAFT,** Columbia Magnetics, CBS, Inc. ..... **125, 130**
*51 W. 52nd St., New York, N.Y. 10019*
**SOUNDCRAFTSMEN** ..... **130**
*1320 E. Wakeham Ave., Santa Ana, Calif. 92705*
**SPECTROSONIC** ..... **105**
*6601 Bay St., Emeryville, Calif. 94608*
**STANTON MAGNETICS, INC.** ..... **112**
*Terminal Dr., Plainview, N.Y. 11803*
**STAX,** Audiophile Imports ..... **115**
*8 E. Erie St., Chicago, Ill. 60611*
**STELLAVOX,** Gotham Audio Corp. ..... **72**
*741 Washington St., New York, N.Y. 10014*
**SUPEREX ELECTRONICS CORP.** ..... **105, 115**
*151 Ludlow St., Yonkers, N.Y. 10705*
**SYLVANIA INC.**
Entertainment Products Group ..... **84, 91, 105**
*700 Ellicott St., Batavia, N.Y. 14020*
**TANDBERG OF AMERICA, INC.** ..... **72, 84**
*8 Third Ave., Pelham, N.Y. 10803*
**TAPESONIC,** Premier Electronic Labs ..... **72**
*382 Lafayette St., New York, N.Y. 10003*
**TDK ELECTRONICS CORP.** ..... **125**
*23-73 48th St., Long Island City, N.Y. 11103*
**TEAC CORP. OF AMERICA** ..... **74, 84, 105, 116, 120, 130**
*7733 Telegraph Rd., Montebello, Calif. 90640*
**TECHNICS BY PANASONIC,** Matsushita Electric Corp. of America ..... **74, 86, 106**
*200 Park Ave., New York, N.Y. 10017*
**TELEDYNE,** Olson Electronics, Inc. ..... **107, 116, 120**
*260 S. Forge St., Akron, Ohio 44327*
**TELEDYNE PACKARD BELL** ..... **86, 107**
*12333 W. Olympic Blvd., Los Angeles, Calif. 90064*
**TELEX COMMUNICATIONS DIV.** ..... **75, 91, 108, 116**
*9600 Aldrich Ave., S., Minneapolis, Minn. 55420*
**TOSHIBA AMERICA, INC.** ..... **86, 108**
*41-06 DeLong St., Flushing, N.Y. 11355*
**TURNER CO., INC.,** Div. Conrac Corp. ..... **120**
*909 17th St., N.E., Cedar Rapids, Iowa 52402*
**UNIVERSITY SOUND,** Altec Corp. ..... **121**
*1515 S. Manchester Ave., Anaheim, Calif. 92803*
**V-M CORP.** ..... **91, 108**
*P.O. Box 1247, Benton Harbor, Mich. 49022*
**WABASH TAPE CORP.** ..... **125**
*2720 Des Plaines Ave., Des Plaines, Ill. 60018*
**WEBCOR,** Div. U.S. Industries, Inc. ..... **92**
*59-50 Queens Midtown Expressway, Maspeth, N.Y. 11378*
**WESTBURY,** Div. Mercury Electronics Corp. ..... **92, 108**
315 Roslyn Rd., Mineola, N.Y. 11501
**WOLLENSAK,** 3M Co. ..... **75, 86, 92, 108**
*3M Center, St. Paul, Minn. 55101*

BY HARRY E. MAYNARD*

# THE "PRO'S" TALK ABOUT 4-CHANNEL SOUND

They're all excited—
but each has his own philosophy
on how it should be recorded.

TODAY there are approximately one thousand four-channel recordings available in various formats if you own four-channel equipment for playing them. Soon there will be an avalanche of four-channel recordings in various formats—records, tape cartridges, and to a lesser extent open-reel. Just three years after Livingston Electronics announced "2-Channel Stereo Recordings for Sale" there were 650 recordings, all in the open-reel format.

Record producers, artists, and recording engineers have learned a great deal about four-channel recording since it was first put on the market in 1970. It has taken nineteen years (since 1954) to develop the 2-channel stereo recording to its present state but there is every evidence that four-channel will develop much faster.

There are basically two approaches to 4-channel recording; the first is obvious and traditional. Stereo gave us breadth but not depth. So, the first thing that we can do with 4-channel is to give the listener the full ambience of the concert hall—a sense of presence, a "you are there" quality, a startling sense of involvement which allows the sound "to breathe."

Max Wilcox, producer of some of RCA's first commercially available four-channel recordings with Eugene Ormandy and the Philadelphia Orchestra, believes in the traditional approach of putting ambience in the rear channels. RCA's new "Quadradisc" (using the CD-4 system) of the Shostakovich Symphony No. 15, is a dramatic example of the state-of-the-art of four-channel recording (ARD1-0014). Not all of Max Wilcox's latest recordings are as successful in demonstrating the virtues of "Quadradisc" sound. Wilcox believes that the medium should not overpower the message and, other than allowing a little bit of the extreme left and right sides of the orchestra to drop into the rear channels, he followed a traditional approach with these recordings.

The second approach to 4-channel reproduction is more unconventional and controversial, sometimes called "Surround Sound" by its proponents. Surround sound will be debated by the industry and public for years; especially those used to a proscenium orientation in listening to recorded sound. The surround-sound approach is to immerse the listener in sound coming from all direc-

*Moderator/Producer of "Men of Hi Fi," a weekly program heard in the New York area over WNYC-FM (93.9 MHz) Sundays from 10:00 to 10:55 p.m.

tions—to create new listening experiences which cannot be easily duplicated in most conventional live musical encounters. No, you don't have to sit in the middle of the room to listen to a four-channel recording!

When the author first discussed four-channel recordings with Tom Frost, Director of Columbia Masterworks, Frost leaned toward the traditional approach to the four-channel recording of classical music—orchestra up front and concert-hall ambience in the rear channels. Now Mr. Frost believes you *can* tamper with the traditional arrangement of orchestra and microphone—"if you do it judiciously and with good taste." What convinced him is the extraordinarily successful Columbia 4-channel recording of Stravinsky's "Le Sacre du Printemps" with Leonard Bernstein and the London Symphony (MQ-31520). Here John McClure, Bernstein's personal record producer, *has arranged the orchestra around the conductor.* Strings and woodwinds are up front, French horns on the left, brass on the right, and percussion in the rear. The recording has earned wide critical acclaim. The author's own reviews described it as "hair-raising, thrilling . . points the way to how 4-channel recording can breathe new life into some of the classical warhorses of recorded repertoire. John McClure and Columbia have broken new ground in the sharp delineation of musical line and texture."

Tom Frost believes strongly that the record producer should be allowed to experiment with the distinguished chestnuts of the classical repertoire and that tradition should not hamper us in the creation of new and exciting musical experiences.

Jack Pfieffer, an Executive Producer with RCA, who has created some of its first four-channel recordings, believes that the listener "wants not only the music of his choice, but wants a vivid illusion of the event happening in an optimum live surrounding, plus the intimacy which reveals the detail, separation, the clarity and balance which is virtually impossible to obtain in the live encounter. And more and more he is getting it." Pfieffer sees the essential case for four-channel as an illusion that transcends the concert hall, where there are no bad seats, no poor acoustics, and everybody programs his nervous system with repertoire of his own choice.

One of the most exciting innovators in sound is Enoch Light, whose early stereo records in both popular and classical formats were best sellers and tradition busters. Light has produced some of the most effective popular 4-channel records. He is all for the innovative approach. "We rearranged the orchestra for recording. Why can't we rearrange the musical elements for listening in the home. My Brahms and Beethoven (recordings) achieved wide critical acclaim, and many of them are still described as some of the best classical recordings done in stereo. I'm not talking of putting the violin in the rear, but of clarifying musical line, and compositional texture. Composers don't hear their compositions in a concert hall, but in their heads. With four-channel recording we can enhance the original intent of a composer."

Light's early stereo recordings outraged some people, but many of his recording techniques were widely emulated, particularly when his early stereo recordings turned into best sellers. Leopold Stokowski's early recordings also created a furor when he rearranged the orchestra for recording. His recordings turned into best sellers and his recording techniques were copied by other record producers.

Most of the 4-channel record producers the author has talked to mix down from a multi-channel master tape (8 or 16 tracks). They mix for whatever sounds exciting, gives a sense of immediacy, and is involving. No recording can ever be more than a simulation of reality with speaker listening in the home.

John Woram, formerly Chief Engineer of Vanguard, the company that released the first commercially available four-channel recording, believes that a four-channel recording can be a creative medium in itself for some types of material and gives the artist, composer, and engineer new flexibilities, just as the multi-track tape recorder has given them new sonic capabilities for introducing all sorts of "electronic additives." "But they must be used with discretion and good taste," he comments.

John McClure reports that when he set up for his unorthodox recording of "Le Sacre," the artists and conductor had trouble hearing one another and were, at first, upset by the small changes in placement of artists, instruments, and microphones. At first, the musicians found it difficult to blend with each other. Bernstein, although skeptical at first was pleased with what he later heard in playback. McClure found E. Power Biggs an instant champion of four-channel recording because he had heard some experimental "takes" in four channel and was amazed at the advantages of four channel over stereo in capturing the huge reverberant sound of an organ in a church or large recording area.

Anthony Newman, harpsichordist, who has made several four-channel recordings for Columbia, sees four channel creating a new problem for the artist—namely the invidious comparison between the superior close-miked four-channel sound and the often

poor sound of many concert halls. "The concert hall demands the same acoustically supplemented sound as the recording. Rock musicians and artists have known this for years."

Hugo Montenegro, who with Jack Pfieffer produced one of RCA's first four-channel records (Love Theme from "The Godfather"—APD1-0001, a display piece for new four-channel recording techniques), believes that there must be joint experimentation among artist, recording engineer, and, when possible, composer. "We'll make mistakes just as we did in stereo, but we'll come out on a higher plateau knowing what we can or can't do with four-channel recordings. Successful recordings don't just happen—you have to plan for them."

Max Wilcox who produces only classical records for RCA, represents the more conservative point of view toward four-channel sound. Do what we have always done, but do it better by adding ambient information in the rear speakers. But classical music represents less than 5% of total record sales. It is in the area of non-classical recordings that recorded sound has long since departed from the goal of replicating a live musical encounter, and the non-classical record has clearly established itself as a creative medium in its own right.

Other than avant-garde electronic compositions like "Touch," especially commissioned as a four-channel composition (which I happen to like) by Columbia from Morton Subotnick, the greatest future for four-channel records seems to lie in the non-classical field. Here the recording has very little connection with reality and it is possible to employ the echo chamber, tape delay, equalization, and other electronic manipulations.

But if four channel has a justification, traditional or not, it is because it can bring new and positive values to recorded music and to the trans-action between humans and music. This calls for full exploitation of our binaural listening capabilities. Research has disclosed that if our binaural listening abilities are to be fully exploited, both direct and reflected sound must reach our ears from different directions for our binaural sense to operate fully.

At the level of recording—before the listener trans-action takes place—many current four-channel recordings have shown that it is possible to bring new excitement to home listening—and more involvement by the listener. Perhaps the criticism of four-channel sound voiced most often is that it is "too involving." But isn't involvement an essential with any art form? □

## Directory of 4-Channel Recorded Tapes

*(Continued from page 59)*

_____Hot A' Mighty! Jerry Reed ..... PQ8-2121
_____Love Can Make It Easier Friends of Distinction ..... PQ8-2113
_____We Found It Wagoner/Parton ..... PQ8-2124
_____Elvis-Aloha, Vol. 1 Elvis Presley ..... PQ8-2140
_____Elvis-Aloha, Vol. 2 Elvis Presley ..... PQ8-2141

**VANGUARD**
Country Joe & The Fish—Greatest Hits ..... L714
Surround Stereo Sound Demo Cartridge ..... L71

### 4-CHANNEL REEL-TO-REEL RELEASES

**OVATION**
All selections available on this label as compatible stereo discs are available in the 4-channel, reel-to-reel format. See page 60.

**PROJECT 3**
Light Enoch—Spanish Strings ..... PR4C-5000
Light Enoch—Brass Menagerie (Vol. 1) ..... PR4C-5036
Light Enoch—Brass Menagerie (Vol. 2) ..... PR4C-5042
Light Enoch—Spaced Out ..... PR4C-5043
Light Enoch—Permissive Polyphonics ..... PR4C-5048
Light Enoch—Big Band Hits of the 30's ..... PR4C-5049
Light Enoch—Hit Movie Themes ..... PR4C-5051
Light Enoch—Big Band Hits of the 30's & 40's ..... PR4C-5056
Light Enoch—Big Hits of the 20's ..... PR4C-5059
Light Enoch—The Brass Menagerie 1973 ..... PR4C-5060
Light Enoch—Movie Hits ..... PR4C-5063
Mottola Tony—Warm, Wild & Wonderful ..... PR4C-5025
Mottola Tony—Roma Oggi ..... PR4C-5032
Mottola Tony—Superstar Guitar ..... PR4C-5062
_____—Free Design/Kites are Fun ..... PR4C-5019
_____—World s Greatest Jazzband (Vol. 2) .. PR4C-5039
_____—4-Channel Stereo Demo Tape ..... PR4C-D700
_____—Best of the Movie Themes 1970 ..... PR4C-5046
Kaye, Sammy—Brand New Recordings ..... PR4C-5065
Green, Urbie—Bein' Green ..... PR4C-5066
Bodner, Phil—The Brass Ring ..... PR4C-5067
Light, Enoch—4-Channel Dynamite ..... PR4C-5068
Mottola, Tony—Tony & Strings ..... PR4C-5069
Hackett Bobby—A Time for Love ..... PR4C-5016
Green Urbie—Twenty-One Trombones ..... PR4C-5024
Bellson Louie—Breakthrough! ..... PR4C-5029
Lawson & Haggart—World's Greatest Jazzband ..... PR4C-5033
Mottola Tony—The Tony Touch ..... PR4C-5041
Jurgens Dick—Here's That Band Again ..... PR4C-5071
Light Enoch—Charge ..... PR4C-5073

**VANGUARD**
Berlioz—Requiem *Abravanel* ..... VSS-2/3
Mahler—Symphony No. 3 *Abravanel* ..... VSS-4/5
Mahler—Symphony No. 9 *Abravanel* ..... VSS-6/7
Handel—Jephtha (highlights) *Somary* ..... VSS-11
Baez, Joan—David's Album ..... VSS-8
St.-Marie, Buffy—Illuminations ..... VSS-9
Perrey Jean Jacques—Amazing Electronic Sound . VSS-10
Country Joe & The Fish—Greatest Hits ..... VSS-14
_____—Surround Stereo Sampler ..... VSS-1
*Baez, Joan—Blessed Are (Vol. 1) ..... VSS-12
*Baez, Joan—Blessed Are (Vol. 2) ..... VSS-13
*Tchaikovsky—Symphony No. 4 *Stokowski* ..... VSS-15
*Handel—Messiah (highlights) *Somary* ..... VSS-16
*Country Joe & The Fish—Life and Times (abridged) VSS-17
*_____—Quadraphonic Demo Tape ..... VSS-18
*Aquarius—Musical Hit Tunes ..... VSS-19
*Bach—Organ Recital ..... VSS-20
*St.-Marie, Buffy—Moonshot (highlights) ..... VSS-21
*_____—Quadraphonic Demo Tape ..... VSS-22
*Dolby-B processed.

# Tandberg tops Tandberg three ways

## With the new 9000X 3-motor tape deck, the new 3300X medium-price deck. And the new TCD-300 stereo cassette deck.

At Tandberg we aim for just one level of quality . . . the highest. Now we've topped ourselves. With three new tape machines unmatched in sound and specifications.

Our new top-of-the-line is the three motor 9000X with the most sophisticated logic control system in tape recorder history. 15 integrated circuits do the work of almost 700 transistors to assure flawless, fingertip operation and proper sequential functions. True one hand tape threading.


And a rugged new remote controllable transport, with servo brakes, tape tension arms for maximum stability and gentle tape handling.

We have even improved our unexcelled Crossfield recording technique, that provides startlingly true full frequency response and noise free recording at 3¾ ips. In fact, the 9000X is limited only by the quality of tape you record with. Linear motion input/output potentiometers, sound on sound, echo, mono mixing, monitoring, front panel 8 ohm headphone output.

The 9000X is a professional quality machine for home use. Just $649.50


Tandberg's brilliant new 3300X will set a new standard of excellence in the medium price field. A slightly less sophisticated version of the 9000X, it features a rugged new transport, with improved Tandberg Crossfield recording. Its record/playback response and signal/noise ratio are better at 3¾ ips than most other recorders at twice the price and at *twice the speed*. The 3300X features easy to use illuminated peak reading meters to eliminate guesswork, slide potentiometers, echo, sound on sound, mixing, front panel headphone jack and monitoring facilities with photoelectric end-stop. All for just $399.90

And now—the world's first three motor, dual capstan, ferrite head, dolbyized cassette recording deck—The Tandberg TCD-300.


That's right—three motors. One precise hysteresis synchronous drive motor for constant tape speed. Two D.C. reel motors which let you wind or rewind a C-60 in 40 seconds. Dual capstans to provide maximum stability and minimum wow and flutter—even with poor cassette tapes. Dolby*, $CrO_2$ tape switches to optimize performance and produce an incredible 63 dB s/n ratio. Real head room to minimize distortion.

Dual Peak Reading meters, electronic push button control, servo-controlled wind, rewind and autostop, built in microphone preamplifiers, and a recording/playback quality equal to many reel-to-reel recorders.

At last a true music fidelity cassette recorder. Sound exciting? You bet, and only $399.90.

So there you have them—a Tandberg trio of newsmakers. And they're made the only way we know how...better.

*DOLBY is a registered trademark of DOLBY LABORATORIES, INC.

# TANDBERG

**We're our only competitor.**

TANDBERG OF AMERICA, 8 THIRD AVENUE, PELHAM, NEW YORK 10803
**A. Allen Pringle Ltd., Ontario, Canada**



CIRCLE NO. 26 ON READER SERVICE CARD

# SECTION 1 Reel-to-reel tape machines

## AKAI

### GX-260D Reel-to-Reel Tape Deck

Stereo design featuring four heads, three motors, reverse in both record & playback, rear-

panel playback volume control, line/mike mixing, and sound-on-sound. Two speeds (7½ & 3¾ ips); (S + N)/N 48 dB; wow & flutter 0.1%; distortion 2.0%, all at 7½ ips. Normal and SRT tape selector switch ..... $474.95

### 4440D Reel-to-Reel Tape Deck

Stereo design featuring three heads, two speeds (7½ & 3¾ ips), one motor, dual monitor-

ing, SOS, SWS and sound mixing, automatic shutoff, and pause control. (S + N)/N 50 dB; wow & flutter 0.12%; distortion 1.5%, all at 7½ ips ..... $299.95

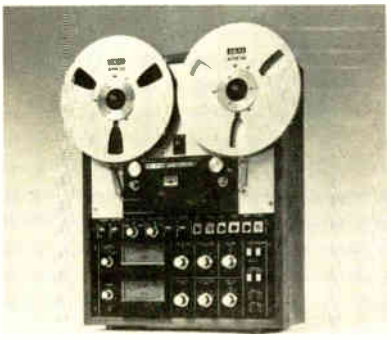
### 4400 Reel-to-Reel "Convert-a-Deck"

Stereo design featuring front-panel converter

switch which changes unit from recorder to deck. Has SOS, SWS, sound mixing, dual monitoring, output level control, pause control with start button release, automatic shutoff. Two speeds (7½ & 3¾ ips), three heads, one motor. (S + N)/N 50 dB; wow & flutter 0.15%; distortion 1.5%, all at 7½ ips ..... $299.95

### GX-400D Reel-to-Reel Tape Deck

Stereo design featuring four heads, servo capstan motor with two outer rotor motors, reverse



in both record & playback, pause control, playback volume control, line/mike mixing, SOS, normal and SRT tape selector switch, automatic shutoff/stop. Features Akai's automatic distortion-reduction system. Three speeds (15, 7½, 3¾ ips); (S + N)/N 55 dB; wow & flutter 0.04%; distortion 1.0%, all at 15 ips. Takes 10½" reel ..... $899.95

### GX-220D Stereo Tape Deck

Three-speed (7½, 3¾, 1⅞ ips), 4-track, 3-motor, 3 head design with glass encased crystal ferrite heads. Will handle up to 7" reels. Response 30-24,000 Hz ±3 dB, wow & flutter 0.08%, (S + N)/N 50 dB, all at 7½ ips. Has VU meters, and counter. Features automatic reverse and shutoff, pause control, and sound-on-sound facilities. 17¼" × 17" W × 9¼" D ..... $399.95

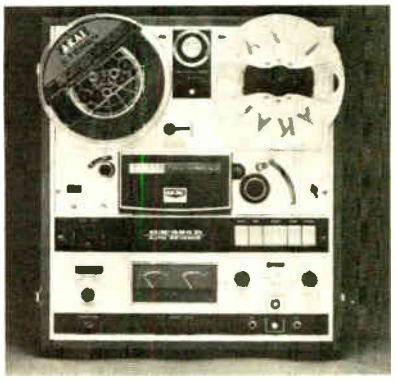
### GX-280D Stereo Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-motor, 3 head design with glass encased crystal ferrite

heads. Will handle up to 7" reels. Response 30-24,000 Hz ±3 dB, wow & flutter 0.08%, (S + N)/N 50 dB, all at 7½ ips. Has VU meters, counter, and remote control (optional extra). Features automatic reverse and shutoff, pause control, and sound-on-sound facilities. 17" × 18" W × 10" D ..... $499.95

### GX-365D Stereo Tape Deck

Four-speed (15, 7½, 3¾, 1⅞ ips), 4-track, 3-motor, 3 head design with glass encased crystal



ferrite heads. Will handle up to 7" reels. Response 30-24,000 Hz ±3 dB, wow & flutter 0.08%, (S + N)/N 55 dB, all at 7½ ips. Features instant stop, braking, automatic reverse and shutoff, pause control, sound-on-sound facilities, sound-with-sound, and monitor facilities. Has VU meters, counter, and remote control (optional extra). 18½" × 16¼" × 11⅞" D ..... $549.95

### 1721W Tape Recorder

Two-speed (3¾ & 7½ ips), 4-track, 2-channel stereo or mono design. Wow & flutter 0.14%

rms at 7½ ips. Response 30-21,000 Hz ±3 dB at 7½ ips. THD 2%. 5 W/ch dynamic power at 8 ohms (3 W/ch continuous). (S + N)/N −50 dB. Bias frequency 63 kHz. Has one record/playback & one erase head. Inputs: mike (0.5 mV) & line (150 mV). Two built-in 5" × 7" speakers. Features p.a. capability, automatic shutoff, equalizer preamp for direct phono input,

# 1 Reel-to-reel tape machines

selector switch for regular or low-noise tape, and tape monitoring facilities. Comes with pair of dynamic mikes with stands. 14⅛" × 14½" × 9⅞" ..... $269.95
**1721L.** Same except leatherette carrying case instead of wood ..... $259.95

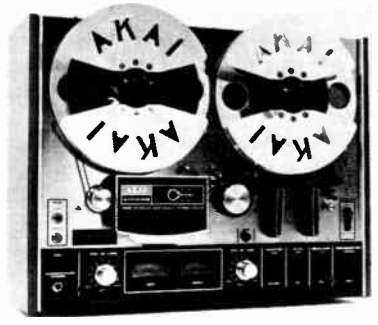
### GX-370D Tape Recorder Deck

Two-speed (3¾ & 7½ ips), 4-track, 2-channel stereo or mono design. Wow & flutter 0.15%

rms at 7½ ips. Response 30-21,000 Hz ±3 dB. at 7½ ips. THD 1.5%. (S + N)/N −50 dB. Bias frequency 100 kHz. Has two record/erase heads & one playback head. Line output 1.23 V. Inputs: mike (0.8 mV) & line (150 mV). Features selector switch for regular or low-noise tape; automatic or manual reverse record/playback; three motors; automatic gain controls; automatic stop & shut-off; sound-on-sound and mixing facilities. Has universal power supply. 17¾" × 20" × 9⅞" D ..... $699.95

### 4000DS Tape Recorder Deck

Two-speed (3¾ & 7½ ips), 4-track, 2-channel stereo or mono design. Wow & flutter 0.07%



rms at 7½ ips. Response 30-26,000 Hz ±3 dB at 7½ ips. THD 1.5%. (S + N)/N −50 dB. Bias frequency 100 kHz. Has separate record, bias, and erase heads. Line output 1.23 V. Inputs: mike (0.8 mV) & line (60 mV). Features dual selector switch for regular or low-noise tape; sound-on-sound; sound-with-sound; mixing; automatic shut-off; pause control. Universal power supply. 16" × 12½" × 7⅝" .... $229.95

### X-1800SD Reel-to-Reel/8-Track Recorder

Combines a three-speed (1⅞, 3¾ & 7½ ips) 4-track stereo/mono crossfield bias system reel-to-reel recorder with an 8-track stereo tape recorder. Wow & flutter 0.12% rms at 7½ ips. Response 30-23,000 Hz ±3 dB at 7½ ips; (S + N)/N −50 dB. Has mike (0.5 mV) & line (60 mV) inputs. 6 W/ch dynamic power output. Has self-contained speakers & universal power supply. 13½" × 15" × 9½" D ..... $399.95

### X-1810D Reel-to-Reel/8-Track Deck

Combines a three-speed (1⅞, 3¾ & 7½ ips) 4-track stereo reel-to-reel tape recorder with an 8-track stereo tape recorder. Wow & flutter 0.08% rms at 7½ ips. Response 30-22,000 Hz ±3 dB at 7½ ips. THD 2%. (S + N)/N −50 dB. Bias frequency 65 kHz. Has three heads (4-track, 2-channel record/playback, 4-track erase & bias); 3 motors. Line output 1.23 V. Input: mike (0.5 mV) & line (60 mV). Features crossfield head, automatic reverse, reel-to-reel automatic shut-off, pause control, switch for regular or low-noise tape, and universal power supply. With dust cover. 17½" × 18" × 9⅝" D . $449.95

### GX-1900D Reel/Cassette Deck

Combines a two-speed (3¾ & 7½ ips), 4-track, 2-channel stereo/mono reel-to-reel tape recorder and a cassette stereo recorder. Will record both ways. Wow & flutter 0.12% rms at 7½ ips. Response 30-22,000 Hz ±3 dB at 7½ ips. THD 2%. (S + N)/N −50 dB. Has two heads (record/playback & erase). Output 1.23 V. Input: mike (0.5 V) & line (50 mV). Features automatic stop & shut-off, pause lever, and universal power supply. 15" × 18½" × 10" .. $499.95

### X-2000SD Reel/Cassette/8-Track

Combines a 3-speed (1⅞, 3¾ & 7½ ips), 4-track stereo/mono record/play reel-to-reel tape

recorder with crossfield heads; an 8-track stereo recorder; and a cassette stereo recorder. Records three ways. Wow & flutter 0.2% rms at 7½ ips. Response 30-20,000 Hz ±3 dB at 7½ ips. (S + N)/N −48 dB. Input: mike (0.5 V) & line (50 mV). Output 7 W/ch dynamic power (5 W/ch continuous). Bias frequency 80 kHz. Features automatic shut-off, pause control. 10⅝" × 13⅞" × 18⅜" D. Walnut cabinet ..... $549.95

## ASTROCOM/MARLUX

### 407A Stereo Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-motor, 4-head deck. Will handle up to 7" reel. Response

30-20,000 Hz, wow & flutter 0.07% at 7½ ips, (S + N)/N 50 dB. Has VU meters, automatic reverse and shutoff, pause control, echo effects, sound-on-sound, sound-with-sound, counter, solenoid control, and monitoring facilities. 14½" H × 21" W × 10½" D ..... $459.95

## BRAUN

### TG1000/2 Stereo Deck

Three-speed (7½, 3¾, 1⅞ ips) stereo record/playback unit. Has three separate heads (erase, record, and playback), and headphone monitoring jack. Features electro-mechanical brake system; electronically controlled tape motion; photoelectrically controlled tape tension on both reels. Has high-speed fast-forward and rewind operation with controlled tape tension. Will handle up to 8¾" reel. Includes four-digit automatic counter with reset button, two peak-reading meters, track indication by lighted level instruments, and remote control of all drive functions. Response 20-25,000 Hz; (S + N)/N 60 dB; wow & flutter 0.05%, all at 7½ ips. Stereo channel separation 55 dB. Two-track version ..... $850.00
**TG1000/4.** Same as TG1000/2 except four-track version ..... $850.00
**TQE1000.** Plug-in adapter for four-channel operation ..... $157.00

## CROWN INTERNATIONAL

### CX722 Tape Recorder

Three-speed (15, 7½, 3¾ ips), 2-track, 3-motor design. Will handle up to 10½" reels. Has three heads. Response 20-20,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. Features braking, automatic shut-off, two VU meters, pause control, and optional counter ..... $1295.00
**CX724.** Same except 4-track version; response 20-25,000 Hz ± 2 dB ..... $1295.00

### CX822 Tape Recorder

Three-speed (15, 7½, 3¾ ips), 2-track, 3-motor design. Will handle up to 10½" reels. Response 30-30,000 Hz ±2.0 dB. Wow & flutter 0.06% at 15 ips. (S + N)/N 60 dB. Has braking, two VU meters, automatic shut-off, pause control, optional counter, optional remote control, and monitoring facilities. ..... $1790.00
Four track version ..... $1790.00
Four-channel in-line version ..... $2880.00

### SX724 Tape Recorder

Two-speed (7½, 3¾ ips), 2-track, 3-motor design. Will handle up to 10½" reels. Response 20-25,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. (S + N)/N 60 dB. Has braking, two VU meters, automatic shut-off, monitoring facilities, pause control, and optional counter. 15 and 1⅞ ips available ..... $995.00
**SX724-P4C.** 2- and 4-track version; plays 4-channel in-line ..... $1425.00

## DOKORDER

### 7100 Reel-to-Reel Tape Deck

Two-speed (7½ & 3¾ ips), 3-head, 4-track ste-

**ALWAYS.....**

take along your copy of this Directory when shopping for hi-fi components. It is a comprehensive reference to complete technical details and prices.

reo tape deck. Features a four-pole induction and 2 six-pole eddy-current type induction motors; automatic tape lifters; automatic shut-off; tape selector switch; echo & sound-on-sound; tape/source monitor. Wow & flutter 0.08% W rms at 7½ ips. (S + N)/N 55 dB. Response 40-21,000 Hz at 7½ ips ..... $399.95

### 6020 Tape Recorder Deck

4-track, 2-speed (7½ & 3¾ ips) stereo design. Response 20-20,000 Hz at 7½ ips; (S + N)/N

–50 dB at 7½ ips. HD 2.5% at 1 W output. Wow & flutter 0.12% (W rms) at 7½ ips. Bias 70 kHz. Inputs: mike (1 mV) & line (100 mV). Line output 0.775 V. Features bidirectional record/play with automatic repeat, four heads (2 record/play & 2 erase), 3 motors. 14½" × 15¾" × 7½" D ..... $279.95

### 7500 Tape Recorder Deck

Two-speed (7½ & 3¾ ips), 4-track record/play design. Wow & flutter 0.08% at 7½ ips. Response 40-20,000 Hz ±3 dB at 7½ ips. (S + N)/N –55 dB at 7½ ips. Bias 130 kHz. Has mike (0.8

mV) & line (80 mV) inputs. Output 0.775 V. Features bidirectional recording and automatic repeat playback. Six heads (2 each erase, record, playback). Has 3 motors. Tape bias switch for standard or low-noise tapes. Features sound-on-sound, sound-with-sound, echo, and tape monitoring. 16⅞" × 17¾" × 6¾" D. $579.95

### 9100 Tape Recorder Deck

Two-speed (7½ & 3¾ ips), 4-track record/play design. Response 40-21,000 Hz ±3 dB at 7½ ips. (S + N)/N –55 dB at 7½ ips. Wow & flutter 0.06% at 7½ ips. Bias 100 kHz. Has mike (0.5 mV), line (77.5 mV), and mag. phono (2.5 mV) inputs. Line output 0.775 V. Features automatic reverse & repeat for record & playback. Has built-in head demagnetizer; 3 motors; six heads (2 each erase, record, playback); tape counter memory; photoelectric automatic shut-off. Bias control for various tapes with separate right & left channel adjustments. Has tape select switch; line, mike, or phono mixing; sound-on-sound facilities; echo; provision for optional remote control. Tape monitoring facilities. Uni-

versal power supply. 17¾" × 20" H × 15¼" D ..... $699.95

### 7200 Tape Recorder Deck

Two-speed (7½ & 3¾ ips), 4-track stereo record/play design. Wow & flutter 0.8% at 7½ ips. Response 40-20,000 Hz ±3 dB at 7½ ips. (S + N)/N –53 dB. Bias 130 kHz. Has mike (0.8 mV) & line (80 mV) inputs. Line output 0.775 V. Features automatic continuous playback, both directions; four heads (erase, record, forward play, reverse play); three motors; tape bias select switch for standard or low-noise tape; sound-on-sound; echo; sound-with-sound. Has tape monitoring facilities and pause switch. 16⅞" × 17¾" × 6¾" D ..... $469.95

## FERROGRAPH

### Series 7 Tape Recorders

Three speeds (7½, 3¾, 1⅞ ips), 4 tracks. Has three heads and three motors, braking, VU meters, automatic shutoff, pause, sound-on-sound capability, bias adjust, and counter. Available in half-track and mono versions, with or without power amplifiers and portable cases. Cabinet available extra ..... $650.00 to $850.00

## GRUNDIG

### TK-244U/HiFi Tape Recorder

Four-track, 2-speed (3¾ & 7½ ips) design. Response 40-16,000 Hz at 7½ ips. Output 4 W/ch dynamic power at 5% HD. Has mike (1 mV), phono (50 mV), and radio (1 mV) inputs & 4-ohm speaker outputs. Features auto record-level control, fade-in & fade-out studio control, "synchro-play" facilities, end-of-tape stop, and built-in speakers. 17" × 14" × 7" ..... $299.95

### TK-600 Tape Recorder

Four-track, 2-speed (3¾ & 7½ ips) stereo/mono record/playback design. Features dual VU meter, auto record-level, sound-on-sound, end-of-tape stop, and built-in tape splicing channel. Response 30-18,000 Hz ±2 dB; wow & flutter ±0.15% at 7½ ips, (S + N)/N 50 dB at 7½ ips. Has mike (450 mV), radio (450 mV), and phono (23 mV) inputs. Power output 20 W/ch dynamic at 5% HD. 16½" × 14¼" × 7¼" ..... $369.95
**TS-600.** Same except deck only. Line outputs 0.5 to 1.5 V adjustable ..... $299.95

## JVC

### RD-1450 Tape Recorder Deck

4-track, 2-speed (7½ & 3¾ ips), 2-channel stereo design. Similar in appearance to Model RD-1695. Response 30-20,000 Hz ±3 dB at 7½ ips; (S + N)/N –52 dB; wow & flutter 0.10% rms at 7½ ips. Has 95 kHz bias & erase; three heads (erase, record, playback). Input sensitivity: mike 0.3 mV; aux. 77.5 mV. Line output 0-1.2 V. Features sound-on-sound, automatic stop, tape monitoring, and special switch for low-noise or standard tape. 12¾" × 15¾" × 6⅞" D. $229.95

### RD-1555 Stereo Recorder Deck

Four-track, 2-speed (7½ & 3¾ ips), 2-channel stereo design with automatic reverse. Response 30-20,000 Hz ±3 dB at 7½ ips; (S + N)/N –50 dB; wow & flutter 0.16% rms. Has three motors and four heads. Features direct-coupled preamps, solenoid motion controls, jack for optional remote control, sound-on-sound, and tape-selector switch. 17" × 16" × 8¼" D.... $499.95

### RD-1553 Tape Recorder Deck

4-track, 2-speed (7½ & 3¾ ips), 2-channel stereo design. Similar in style to Model RD-1552. Response 20-24,000 Hz ±3 dB at 7½ ips; (S + N)/N –53 dB; wow & flutter 0.10% at 7½ ips. HD 1.5% at 1 kHz. Has 95 kHz record bias & erase; three motors (capstan drive, supply, and takeup reels); mike (0.3 mV) & aux. (80 mV) inputs; and 0-1 V line output. Features built-in 1000-Hz signal oscillator for bias adjust; solenoid motion controls; jack for optional remote control; sound-on-sound and input mixing facilities. 17½" × 16½" × 8" D ..... $499.95

### RD-1552 Tape Recorder Deck

4-track, 2-speed (7½ & 3¾ ips), 2-channel ster-

eo design. Response 20-24,000 Hz ±3 dB at 7½ ips; (S + N)/N –52 dB; wow & flutter 0.1% rms at 7½ ips. HD 1.5%. Has 95 kHz record & erase bias. Inputs: mike (0.3 mV) & aux. (80 mV). Line output 0-1 V. Features three heads (record, erase & playback) and 3 motors (capstan drive, supply & take-up reels). Has solenoid motion controls, pause button, sound-on-sound, bias switch for low-noise or standard tapes, and input mixing facilities. 15¾" × 17¾" W × 8½" D. ..... $399.95

### RD-1695 Tape Recorder Deck

4-track, 3-speed (7½, 3¾ & 1⅞ ips), 2-channel stereo design. Response 30-18,000 Hz ±3 dB at

7½ ips; (S + N)/N –52 dB; wow & flutter 0.13% rms at 7½ ips. Has mike (0.5 mV) & aux. (80 mV) inputs. Line output 0-1 V. Has switch for either low-noise or standard tape; two heads (record/play and erase). 7½" × 15¾" W × 12¾" D ..... $169.95

## MAGNAVOX

### K8877 Tape Recorder Deck

Three-speed (1⅞, 3¾, 7½ ips) stereo design. 4-

# 1 Reel-to-reel tape machines

tracks, 3 heads. Will handle up to 7" reels. Has hysteresis motor. Response 50-15,000 Hz ±2 dB; wow & flutter 0.15%; (S + N)/N 45 dB. Features tape monitor, bias select, sound-on-

sound, echo, and dual record-level meters. 15½" × 10" × 14". Walnut cabinet ... $239.95

### K8980 Tape Recorder Deck

Three-speed (1⅞, 3¾, 7½ ips) stereo design. Will handle up to 7" reels. Has two heads, four tracks. Induction motor. Response 50-15,000 Hz ±3 dB. Wow & flutter 0.15%. S/N 45 dB. Has two record-level meters. Features sound-with-sound. 15¾" × 7¼" × 13". Walnut cabinet. ..... $159.95

**K8981.** Same except features low-noise/normal tape selection and sound-on-sound .. $179.95

### K8982 Tape Recorder Deck

Two-speed (3¾, 7½ ips) stereo design. Has 4-heads, 4-tracks. Will handle up to 7" reels. Induction motor. Response 40-16,000 Hz +3 dB; wow & flutter 0.12%; (S + N)/N 45 dB. Features dual record-level meters, automatic reverse, automatic repeat, low-noise/normal tape switch, sound-with-sound. 16⅜" × 7⅝" × 18¼" ..... ..... $279.95

## MOTOROLA

### RA20GW Tape Recorder

Three speeds (7½, 3¾, 1⅞ ips), 4 track stereo design. Will handle up to 7" reels. Features VU meters, automatic shutoff, and counter. Supplied with microphones. Walnut enclosure .... ..... $129.95

## PIONEER

### T-6600 Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 4-head, single-motor stereo unit. Will handle up to 7" reels. Response 50-15,000 Hz ±2 dB, wow & flutter less than 0.12% at 7½ ips, (S + N)/N 55 dB. Has VU meters, automatic reverse and shutoff, pause control, and counter. 17" H × 17³⁄₁₆" W × 7¼" D ..... $299.95

### T-8800 Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 4-head, two-

motor stereo unit. Will handle up to 7" reels. Response 40-15,000 Hz ±2 dB, wow & flutter less than 0.08% at 7½ ips, (S + N)/N 55 dB. Has VU meters, automatic reverse and shutoff, pause control, echo effects, sound-on-sound, bias adjustment possible, counter, remote-control, monitoring facilities. Dust cover included. 9½" H × 21¾" W × 16¾" D ..... $549.95

### T-6100 Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-head, single-motor stereo unit. Will handle up to 7"

reels. Response 50-15,000 Hz ±2 dB, wow & flutter 0.12% at 7½ ips, (S + N)/N 55 dB. Has VU meters, automatic reverse and shutoff, pause control, and counter. 14⅞" × 15⁵⁄₁₆" W × 6¾" D ..... $249.95

## RADIO SHACK

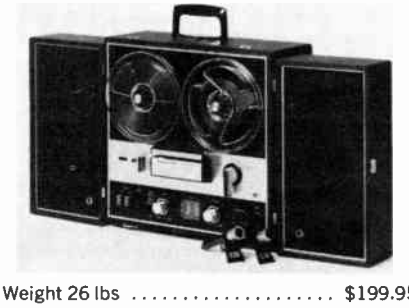
### 999B Stereo Tape Deck

Three speeds (7½, 3¾, 1⅞ ips); 4 tracks; 3 heads. Has two VU meters and level controls.

Provisions for professional sound-on-sound recordings. Tape/source monitor. Response 40-20,000 Hz at 7½ ips; wow & flutter 0.2% rms at 7½ ips. Overall size 16" × 13¼" × 7⅜" ..... ..... $179.95

### 909B Stereo Tape Recorder

Three speeds (7½, 3¾, 1⅞ ips); 4 tracks. Will take up to 7" reel. Response 50-18,000 Hz; wow & flutter 0.25% at 7½ ips. Has built-in electronics with 3½ W/ch output. Supplied with speakers, microphones, VU meters, and counter. Permits sound-with-sound recording. Overall dimensions 14" H × 24¼" W × 7⅛" D.

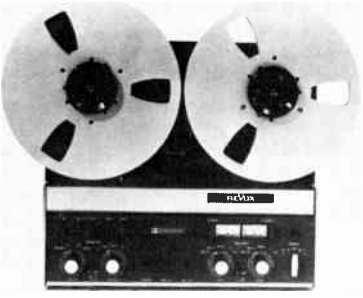


Weight 26 lbs ..... $199.95

## REVOX

### A77 MkIII 1102 Tape Deck

Two-speed (3¾ & 7½ ips or 7½ & 15 ips), 2-track, 3-motor, 3-head deck. Will handle up to 10½" reels. Response 30-20,000 Hz ±2.5 dB at 7½ ips. Wow & flutter 0.08% peak at 7½ ips. (S + N)/N 61 dB at 7½ ips. Has a servo braking system, VU meters, automatic shut-off, relay



and solenoid operation, full remote control, and off-the-tape monitoring. Options include plug-in 10 W/ch continuous power amplifiers, a suitcase version with built-in speakers, metal cage for rack or custom mounting. 16⅜" H × 14³⁄₁₆" W × 7⅛" D ..... $749.00

**Model A77 MkIII 1104.** A 4-track version of Model 1102. Same options available .. $749.00

**A77 MkIII Dolby B Deck.** Same as 1102 or 1104 but with Dolby B noise-reduction system. Has separate compressors and expanders for each channel. (S + N)/N 70 dB (ASA A curve weighted) at 7½ ips, 2-track. Corresponding improvements at other speeds and track width accompanied by a reduction in distortion .. $969.00

## SANSUI

### SD-7000 Stereo Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-motor, 4-head deck. Will handle up to 7" reels. Response 20-20,000 Hz ±2 dB, wow & flutter 0.06% at 7½ ips, (S + N)/N 60 dB. Has VU meters, automatic reverse and shutoff, pause control, sound-on-sound, sound-with-sound, counter, monitoring facilities, and solenoid operation. Also features automatic rewind, a sleep switch, and tape-tension adjustment. Remote control optional extra. Comes with dust cover. 21⅛" H × 17⅛" W × 10½" D. ..... $549.95

## SONY/SUPERSCOPE

### TC-270 Stereo Tape Recorder

Economy design featuring quarter-track stereo/mono play & record, three speeds (7½, 3¾

& 1⅞ ips), straight-line record & playback level controls, two VU meters, automatic end-of-tape shutoff, and sound-on-sound. 5 W/ch continuous power. Response 30-18,000 Hz ±3 dB at 7½ ips. (S + N)/N 50 dB; wow & flutter 0.12% at 7½ ips. Sensitivity: aux. 0.06 V; low-imp. mike −72 dB (can be used as phono input with optional RK-66 adapter). Has line output 0.43 V at 0 VU; two lid speakers. 8 ohms. 20¼" W × 15¼" D. Comes with carrying case ..... $299.95

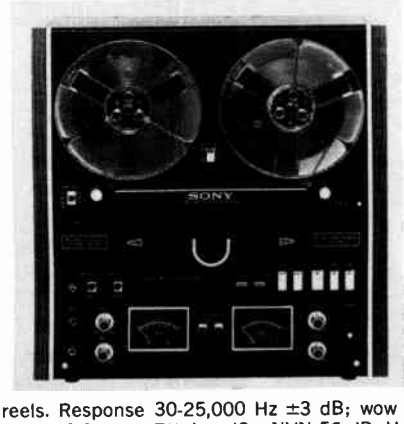
### TC-280 Stereo Tape Recorder Deck

Economy quarter-track stereo/mono design featuring three speeds (7½, 3¾ & 1⅞ ips), tape select switch, sound-with-sound, sound-on-sound, dual VU record meters, pause control. May be operated vertically or horizontally. Re-

sponse 40-18,000 Hz ±3 dB at 7½ ips with regular tape (40-21,000 Hz ±3 dB with SLH-180 tape). (S + N)/N 52 dB with standard tape (55 dB with SLH-180 tape). Sensitivity:aux. 0.06V; mike (low-imp) −72 dB (mike input can be used as mag. phono input with RK-66 optional adapter). Line output 0.775 V at 0 VU. Wow & flutter 0.10% at 7½ ips. 15¾" × 7⅜" × 14⅛" D. Comes with walnut base ..... $199.95

### TC-580 Tape Deck

Three-speed (7½, 3¾, 1⅞ ips), 4-track, 3-head, 3-motor stereo unit. Will handle up to 7"



reels. Response 30-25,000 Hz ±3 dB; wow & flutter 0.06% at 7½ ips; (S + N)/N 56 dB. Has VU meters, automatic reverse and shutoff, counter, monitoring facilities, solenoid operation. 18¹⁄₁₆" H × 17½" W × 8⅞" D..... $499.95

### TC-630 Tape Recorder System

Three-speed (7½, 3¾, 1⅞ ips), 4-track, 3-head, one-motor stereo unit. Will handle up to

7" reels. Response 30-22,000 Hz; wow & flutter 0.09% at 7½ ips; Built-in electronics with 20 W/ch output. Supplied with speakers and microphones. Has VU meters, automatic shutoff, pause control, echo effects, sound-on-sound, counter, phono input, tone controls, monitoring facilities. Carrying handle included. 20" H × 17⅞" W × 11⅝" D ..... $449.95

### TC-353-D Stereo Tape Deck

Features three speeds (7½, 3¾, 1⅞ ips) and three heads. Has line & mike mixing, pause control, automatic shutoff, VU meters. Sound-on-sound with optional Sony MX-6S mixer ..... $229.95

### TC-640B Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-head stereo unit. Will handle up to 7" reels. Response

30-20,000 Hz ±3 dB; wow & flutter 0.07% at 7½ ips; (S + N)/N 55 dB. Features VU meters, braking, automatic shutoff, pause control, echo effects, sound-on-sound, counter, monitoring facilities, and solenoid operation. 15½" H × 14½" W × 9½" D ..... $399.95

### TC-353 Stereo Tape Recorder/Speakers

Three-speed (7½, 3¾, 1⅞ ips), 3-head stereo tape recorder with integrated speakers. 7 W/ch dynamic power. Features separate record/playback preamps, sound-on-sound and echo,

tape/source monitoring facilities, and a tape-select switch for use of high-output low noise tape or standard tape. Has VU meters, retractable pinch roller for easy tape threading, automatic tape lifters to protect heads during fast-forward and rewind, non-magnetizing record head. Full complement of controls. Has p.a. capabilities, pause control with lock, built-in reel locks, four-digit tape counter, stereo headphone monitor jack. Can be operated vertically or horizontally. 20⅝" × 13⅜" × 10⅜" D..... ..... $369.95

### TC-377 Stereo Recorder Deck

Features 3-speed (1⅞, 3¾ & 7½ ips), 3-head, 4-track design. Response 30-20,000 Hz ±3 dB

at 7½ ips (S + N)/N 52 dB (standard tape) 55 dB (SLH-180 tape). Has aux. (0.06 V sensitivity) & mike (−72 dB sensitivity) inputs & line output (0.775 V). Bias frequency 160 kHz. Wow & flutter 0.09% at 7½ ips. Has two VU meters, one induction motor. Features mike-line record level mixing controls, tape select switch for Sony standard or low-noise, high-output tape. Has pause control and an automatic total mechanism shut-off. Reversible walnut base for vertical or horizontal operation. Sound-on-sound capability with the MX-6S mixer. 16½" × 8⅜" × 15½" ..... $299.95

### TC-850-4 Tape Deck

Three-speed (15, 7½, 3¾ ips), 4-track, 4-head, 3-motor stereo unit. Will handle up to 10½" reels. Response 30-22,000 Hz ±2 dB; wow &

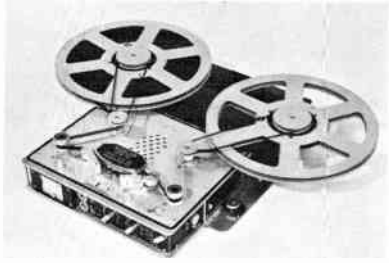
# 1 Reel-to-reel tape machines

flutter 0.03% at 7½ ips; (S+N)N 57 dB. Has VU meters, automatic shutoff, pause control, echo effects, sound-on-sound, bias adjust, counter, solenoid operation, monitoring facilities. Remote control optional extra. 19¾" H × 17½" W × 10" D. ..... $895.00
**Model 850-2.** Same as Model 850-4 except two-track ..... $895.00

## STELLAVOX

### Sp 7 Portable Recorder

Professional 4-speed (3¾, 7½, 15, 30 ips) battery-operated portable recorder with numerous



options. 3 heads plus fourth synchronizing head. 5" max. reel size (up to 10½" reels with ABR adapter as shown). Numerous mono and stereo head assemblies available, equalized for various tape speeds. Has modulometers, built-in speaker, and 1 W amp. A.c.-d.c. operation. Response 30-16,000 Hz ±2 dB (at 7½ ips, stereo), wow & flutter 0.1%, (S+N)/N 60 dB stereo, 65 dB mono. Weight with tape and batteries 8 pounds. 8½" H × 10½" W × 3" D. ..... $1692.00 and up

## TANDBERG

### Series 11 Tape Recorder

Portable (15 V, ten 1½-V cells), mono design. Three speeds (7½, 3¾, 1⅞ ips), and has three

heads. Will handle up to 7" reels. Has automatic level-input controls, mike & line mixing, and built-in speaker. Response 40-16,000 Hz ±2 dB at 7½ ips, wow 0.1% at 7½ ips, (S+N)/N 58 dB unweighted. 13" W × 10" D × 4".

**Model 11-1.** Full-track ..... $449.95
**Model 11-2.** Two-track ..... $499.80
**Model 11-1-P.** Full-track with "Pilotone" head for film camera sync. Connects cable to camera, providing starting signal tone. Can also be used with Jensen 205S Synchronizer ..... $699.00
A.c. power supply ..... $79.50

### Series 15 Tape Recorder

Mono design with built-in 4" × 7" speaker.

Three speeds (7½, 3¾, 1⅞ ips). Response 40-16,000 Hz ±2 dB at 7½ ips, wow 0.1% at 7½ ips, (S+N)/N at max. record level 55 dB. 5 W/ch continuous output both channels driven. Has 0.75 V preamp outputs, low-Z mike & high- and low-level inputs. 13⅜" W × 11⅞" D × 6¾".
**Model 1541.** Four-track ..... $313.50
**Model 1541F** With foot remote control ..... $418.00
**Model 1521.** Two-track ..... $287.00
**Model 1521F.** With foot remote control ..... $399.00

### Series 14 Tape Recorder

Same as Series 15 except 2-speed (3¾ & 1⅞ ips) design.
**Model 1441.** Four-track without case ..... $270.00
**Model 1421.** Two-track without case . $250.00

### Series 4000X Tape Recorder

Stereo design with two built-in 7" × 4" speakers. Three speeds (7½, 3¾, 1⅞" ips). Has 4 heads including crossfield bias head. Features source/tape monitoring, sound-on-sound, add-a-track, full mono mixing, end-of-tape stop, mag. or ceramic phono inputs. Response 40-20,000 Hz ±2 dB, wow & flutter 0.07%, (S+N)/N 62 dB, ½-track weighted, all at 7½ ips and 5% distortion. 10 W/ch continuous power output with both channels driven. 15½" W × 12½" D × 6½". Walnut cabinet.
**Model 4041X.** Four-track ..... $469.00
**Model 4021X.** Two-track ..... $485.50

### Series 6000X Tape Deck

Stereo record/play design with four heads, including crossfield bias head. Features VU meters, automatic start/stop/pause, remote control, record/playback monitoring, cueing, stereo/mono mixing, A-B testing, sound-on-sound, add-a-track, echo. Has automatic overload input protection, line, tuner, mike, and mag. or ceramic phono inputs, and line (1.5V) outputs. Three speeds (7½, 3¾, 1⅞ ips). Response 40-22,000 Hz ±2.5 dB, flutter & wow 0.1%, (S+N)/N 62 dB, ¼-track weighted, all at 7½ ips. 15½" W × 12⅜" D × 6½" H. Walnut cabinet.

**Model 6041.** Four-track ..... $529.80

### 9000X Tape Recorder Deck

Three-speed (1⅞, 3¾ & 7½ ips) play/record stereo design. Wow (Wrms) 0.07% at 7½ ips.

Response 40-22,000 Hz ±2 dB at 7½ ips. Sensitivity: mike (low imp.) 50 μV; radio 5 mV; line 30 mV. Output: radio 0.75 V; line 1.5 V. Features crossfield heads; remote control of start/stop, fast forward/rewind, record & playback, mono mixing; A-B test; sound-on-sound; echo; peak record/playback meters; adjusted for low-noise, high-output tape. Supplied in half- and quarter-track versions. On request, can be equipped for 4-channel playback. Walnut cabinet. 15¾" × 7" × 16⅛" D .... $649.50

### 3300X Tape Recorder Deck

Three-speed (1⅞, 3¾ & 7½ ips) design featuring crossfield recording techniques; peak-reading record meters; four heads for sound-on-sound, sound-with-sound, and echo; input mixing; and photoelectric end stop. Has inputs for dynamic mike, receiver/tuner, and record player. Supplied in half- or quarter-track versions. On request, can be equipped for 4-chan-

nel playback. Walnut cabinet (rosewood on special request). 15¾" × 7" × 16⅛" D. $399.00

## TAPESONIC

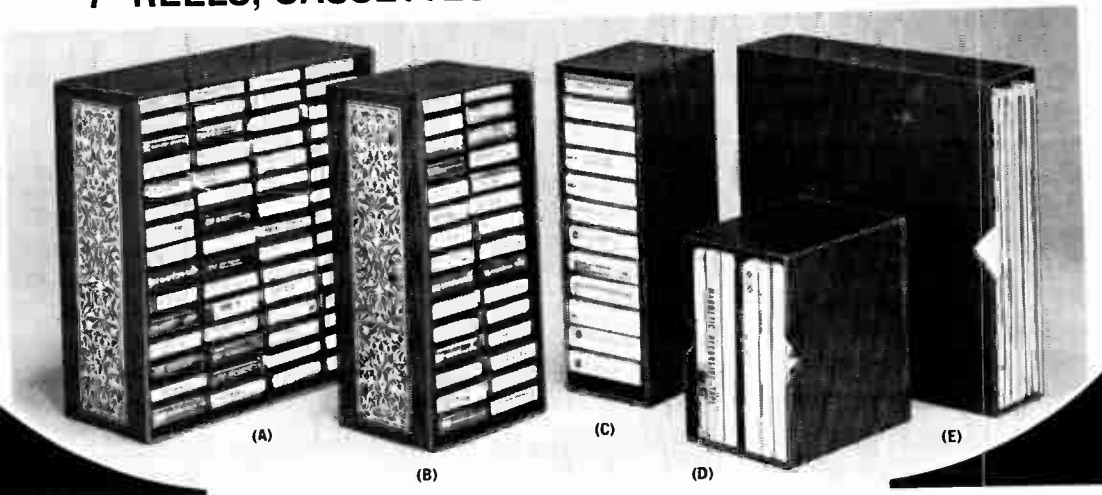
### 70A Tape Recorder

Three-speed (15, 7½, 3¾ ips), 4-track or 2-track stereo, 3-head, 3-motor stereo design. Will handle up to 10½" reels. Response 30-20,000 Hz ±2 dB, wow & flutter 0.008% at 7½

# Stereo Review Magazine Presents . . .

## THE 'STORAGE PROBLEM' SOLVERS

### DELUXE MATCHING STORAGE CASES FOR YOUR 12" RECORDS, 7" REELS, CASSETTES AND 8-TRACK CARTRIDGES.




(A) **60-unit cassette case.** 13½" h. x 12⅝" d. x 5½" w. Compartments are tilted back to prevent spillage. Includes pressure-sensitive labels for titling. $15.95 each; 3 for $45.00

(B) **30-unit cassette case.** 13½" high x 6½" deep x 5½" wide. Tilted compartments, labels included. $11.95 each; 3 for $33.00

(C) **12-unit cartridge case.** 13¼" high x 6½" deep x 4¼" wide. Tilted compartments, labels included. $7.95 each; 3 for $22.00

(D) **6-unit 7" reel case.** 8" high x 7½" deep x 5" wide. Holds reels in original boxes. $5.25 each; 3 for $15.00

(E) **20-unit 12" record case.** 13¼" high x 12½" deep x 3½" wide. Holds records in original jackets. $5.95 each; 3 for $17.00

Here's the ideal solution to the problem of keeping all your records and tapes stored neatly, safely, conveniently and attractively. A complete set of matched storage cases, designed by the editors of STEREO REVIEW magazine, for your records and all your tapes: cassette, cartridge and 7" reel. Now you can keep them side-by-side on your bookshelf or cabinet, easy to identify and readily available.

These cases are sturdily constructed and covered in a handsome leatherette. The outer case is elegantly embossed in gold and comes in your choice of three popular decorator colors—black, brown and green—so that they lend themselves readily to the decor of any room.

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_____ 60-unit Cassette Cases @ $15.95 each; 3 for $45.00

_____ 30-unit Cassette Cases @ $11.95 each; 3 for $33.00

_____ 12-unit 8-Track Cartridge Cases @ $7.95 each; 3 for $22.00

_____ 6-unit 7" Reel Cases @ $5.25 each; 3 for $15.00

_____ 20-unit 12" Record Cases @ $5.95 each; 3 for $17.00

Add 50c per unit ordered for postage and handling. Outside U.S.A. add $1.00 per unit ordered. Payment must be enclosed with order if not charged.

Check color choice for back of case (sides in black only):
☐ Brown ☐ Green ☐ Black

Print name _____

Address _____

City _____ State _____ Zip _____

# 1 Reel-to-reel tape machines

ips. Features VU meters, braking, automatic

shutoff, bias check, solenoid operation, and monitoring facilities. Cabinet optional extra.
**70ATRSH.** ½ track ..... $675.00
**70ATRSQ.** ¼ track ..... $675.00
Portable case ..... $37.00

## TEAC

### 1230 Stereo Tape Deck

Two-speed (7½ & 3¾ ips), 4-track, 3-motor, 3-head stereo design. Response 40-18,000 Hz ±3

dB, wow & flutter 0.08% at 7½ ips, (S + N)/N 50 dB. Will handle up to 7" reels. Has VU meters, automatic shutoff, pause control, bias adjustment, counter, solenoid operation, and monitoring facilities. 14¼" H × 17⁵⁄₁₆" W × 8" D ..... $359.50
**Model 1250.** Same as Model 1230 except includes automatic reverse ..... $459.50

### 4010GSL Stereo Tape Deck

Two-speed (7½ & 3¾ ips), 4-track, 3-motor stereo design. Has four hyperbolic ferrite heads. Will handle up to 7" reel. Response 30-22,000 Hz ±3 dB, wow & flutter 0.08%, at 7½

ips, (S + N)/N 55 dB. Has VU meters, automatic reverse and shutoff, echo effects, sound-on-sound, bias adjustment, counter; pause control, and monitoring facilities. Remote control available optional extra. 17¼" H × 17½" W × 9¾" D ..... $599.50

### 6010GSL Stereo Tape Deck

Two-speed (7½ & 3¾ ips), 4-track, 3-motor stereo design. Has four ferrite heads. 7" reel.

Response 30-20,000 Hz ±3 dB, wow & flutter 0.06% at 7½ ips, (S + N)/N 58 dB. Has separate bias & equalization selector switches, VU meters, automatic reverse and shutoff, pause control, echo effects and sound-on-sound (optional extras), counter, solenoid operation, and monitoring facilities. Remote control available optional extra. 20⁷⁄₈" H × 17½" W × 6⁷⁄₈" D ..... $799.50

### 7010GSL Auto-Reverse Tape Deck

4-track, 2-channel stereo or mono with four heads (erase, record, playback, and reverse

playback). Two speeds (3¾ & 7½ ips), 3 motors. Will handle 7" & 10½" reels. Response 30-20,000 Hz ±3 dB at 7½ ips. (S + N)/N −58 dB; HD 1% at 1000 Hz at normal listening levels. Has mike (0.25 mV) and line (0.1 V) inputs. Line output 0.3 V. 21⅛" × 17⅝" W × 9½" D. $999.50

### 7030GSL Tape Deck

2-track, 2-channel stereo or mono with four heads (erase, record, playback, and 4-track playback). Two speeds (7½ & 15 ips), 3 motors. Will handle 7" & 10½" reels. Wow & flutter 0.06% at 7½ ips. Response 30-20,000 Hz ±3 dB at 7½ ips. (S + N)/N −60 dB. HD 1% at 1000 Hz at normal listening levels. Has mike (0.25 mV) and line (0.1 V) inputs. Line output 0.3 V. Similar in design and styling to Model 7010GSL. 21⅞" × 17⅝" × 9⅞" D .... $949.50

### 4070G Stereo Tape Deck

Two-speed (7½ & 3¾ ips), 4-track, 3-motor stereo design. Has four high-density ferrite

heads (6 head functions). Will handle up to 7" reel. Response 30-20,000 Hz ±3 dB, wow & flutter 0.05% at 7½ ips, (S + N)/N 58 dB. Has braking, VU meters, automatic reverse and shutoff, pause control, bias adjustment, counter, separate bias & equalizer switches and monitoring facilities. Remote control available optional extra. 17⅞" H × 18" W × 9⁵⁄₁₆" D. $599.50

### 3300-10 Tape Recorder Deck

4-track, 2-channel, 2-speed (7½ & 3¾ ips) stereo design. Response 30-20,000 Hz ±3 dB at

7½ ips, wow & flutter 0.06% at 7½ ips, (S + N)/N 58 dB. Has mike (0.25 mV) and two line inputs (0.1 V & 0.3 V), 3 heads (erase, record & play). Will handle up to 10½" reels. Features three motors (1 dual-speed hysteresis sync capstan motor and 2 eddy-current induction reel motors); VU meters; automatic shutoff; bias adjust; and monitoring facilities. 15⅜" × 15⅜" × 9¼" ..... $499.50
**Model 3300-11.** Same except 2-track, 2-channel, 2-speed (15 & 7½ ips) ..... $499.50
**Model 3300-12.** Same as Model 3300-11 except 2-speed (7½ & 3¾ ips) ..... $499.50

## TECHNICS BY PANASONIC

### RS-1030US 2/4 Track Tape Deck

Two-speeds (15 & 7½ ips). Response 20-26,000 Hz at 15 ips (30-22,000 Hz ±3 dB); 20-23,000

Hz at 7½ ips (30-20,000 Hz ±3 dB). Two-track record/play, four-track (stereo) playback. Wow & flutter 0.12% W rms at 7½ ips. (S + N)/N 55 dB (2-track). Accepts 10" or smaller reels. Four heads including three HPF ultra-longlife types. Low-noise/normal tape selector. Three motors, one dual-speed hysteresis synchronous for capstan drive. Tape tension selector, optional remote. Features automatic stop, tape pause, and 4-digit counter. 22" H × 17" W × 7⅞" D. . . . . $899.95

### RS-736US Tape Deck

4-track, 3-speed (15, 7½, 3¾ ips), 3-head stereo design. Wow & flutter 0.09% at 7½ ips.

Frequency response 20-28,000 Hz at 7½ ips. Inputs: mike 20,000 ohms, max. sensitivity 0.3 mV; Phono #1 xtal 1 megohm, max. sensitivity 100 mV; Phono #2 mag 47,000 ohms, max. sensitivity 2 mV; Aux. #1 250,000 ohms, max. sensitivity 30 mV (3 V max. input); Aux. #2 50,000 ohms, max. sensitivity 100 mV (10 V max. input). Dual outputs both 1 V & 50,000 ohms (1 fixed, 1 variable). Features equalization switch for normal or low-noise tape. Separate record & playback amplifiers for echo effects, cueing and pause controls, sound-on-sound. With dust cover and adapter for 15 ips operation . . . . . $329.95

### RS-714US Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-motor stereo design. Will handle up to 7" reels. Has 3 fer-

rite heads. Response 30-22,000 Hz at 7½ ips, wow & flutter less than 0.1% at 7½ ips, (S + N)/N better than 50 dB. Has VU meters, automatic shutoff, pause control, sound-on sound, counter, remote control (optional extra), solenoid operation, and monitoring. 20" H × 17" W × 7⅞" D . . . . . $499.95

**Model RS-715US.** Similar to RS-714US except this model includes an automatic reverse feature . . . . . $549.95

## TELEX

### Lab Series 2001 Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-head, 2-motor stereo design. Will handle up to 8¼"

reels. Response 45-18,000 Hz ±2 dB, wow & flutter 0.18% at 7½ ips, (S + N)/N 52 dB. Has VU meters, automatic shutoff, pause control, counter, solenoid operation, and monitoring facilities. 14½" × 19⅛" × 8" D . . . . . $799.95

### 433 Tape Recorder Deck

Quarter-track stereo design featuring sound-on-sound, reverb (echo), 2-channel input mixing, tape monitoring, and pause control. Three-speed (7½, 3¾, 1⅞ ips), 3-head, 3-motor design. Has automatic shutoff. Response 40-18,000 Hz ±3 dB at 7½ ips, (S + N)/N 54 dB, flutter & wow 0.2% at 7½ ips. 15¾" W × 14⅜" H × 8¾" . . . . . $379.95

### 423 Tape Deck

Basically same design as Model 433. Response


50-15,000 Hz ±3 dB, (S + N)/N 50 dB, wow & flutter 0.2%, all at 7½ ips. THD 1.5%. 12⅝" H . . . . . $274.95

## WOLLENSAK

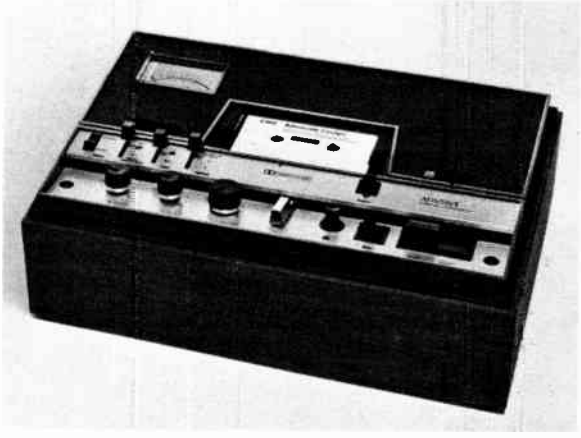
### 6150 Stereo Tape Deck

Three-speed (7½, 3¾, 1⅞ ips), 4-track, 3-head, 2-motor stereo deck. Response 35-20,000 Hz ±2 dB, wow & flutter 0.12% at 7½ ips, (S + N)/N 54 dB. Will handle up to 7" reels. Has VU meters, automatic shutoff, pause control, echo effects, sound-on-sound, sound-with-sound, bias adjust, counter, monitoring facilities, and phono input jack. 20½" H × 13½" W × 7½" D . . . . . $[illegible].95

**Don't forget . . .**

If you need additional information on any of the products listed in this Guide, do not hesitate to write directly to the manufacturers. (See company address list on page 11.)

# Eight Exceptionally Clear Quotes from Reviewers on the Advent Model 201 Cassette Deck:



*"The Advent 201 easily met its specifications and established itself—at least for now—as the best cassette recorder we know of. Having used it to evaluate the forty types of cassette tapes in a survey report, we have a familiarity with, and a respect for, its capabilities."*
Julian Hirsch, *STEREO REVIEW*

*"Well, I have tested it and used it. And I can state categorically that it represents the finest cassette deck available—one that is not likely to be surpassed in the near future."*
Larry Zide, *STEREO & HI-FI TIMES*

*"In addition to the Dolby circuitry and the special bias and equalization control for Crolyn, the deck was the first we had come across in which a properly recorded cassette could be made literally indistinguishable from the sound source."* *HIGH FIDELITY*

*"It is difficult to restrain our enthusiasm for the Advent 201. The unit came with a demonstration tape that had been dubbed onto Crolyn tape by that specific machine from a Dolby "A" master tape. The sound quality, especially with the finest playback amplifiers and speakers, was literally awesome, as was the total absence of hiss or other background noise."*
Julian Hirsch, *STEREO REVIEW*

*"The 201 is a superlative tape deck. That it is a cassette unit with these qualities is something that would not have been believed just one year ago."* Larry Zide, *STEREO & HI-FI TIMES*

*"In making recordings from discs and FM—both at the time of preparing the original report and in the intervening months—we find that the 201 documents the premise that the sound of state-of-the-art cassette equipment need make no apologies whatever to the better open-reel decks."* *HIGH FIDELITY*

*"Summarizing, the Advent 201 is a tape deck of superlative quality. It is difficult to imagine how its sonic performance could be substantially improved."*
Julian Hirsch, *STEREO REVIEW*

*"All told, the 201 represents the present state of the cassette art."*
Larry Zide, *STEREO & HI-FI TIMES*

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The only important fact that those quotes (and a dozen more like them) don't fully indicate is the special, almost addictive, pleasure that cassettes provide when used with a tape machine as good as the 201. There is something just right about being able to put the latest Stones recording or a Beethoven symphony into your shirt pocket. And there is a real joy in knowing that locked in these little cassettes is music of unsurpassed quality that you can hear again and again—easily, conveniently, and without concern about scratches, loss of quality and the other ills that discs are heir to.

We believe the Advent Model 201 will give you more pleasure than any piece of equipment you have bought (or are likely to buy) for a long, long time.

If you would like more information, including a list of Advent dealers, please write us at the address below.

Thank you.

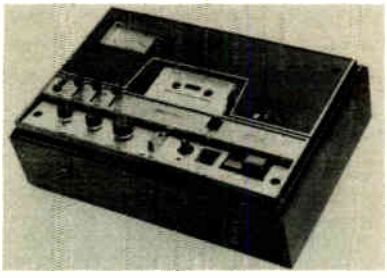
**Advent Corporation, 195 Albany Street, Cambridge, Massachusetts 02139.**

# SECTION 2 Cassette tape machines

## ADVENT

### 201 Dolbyized Cassette Deck

Play/record stereo design. Response 35-14,500 Hz at ±2 dB. THD less than 1½% with chro-



mium-dioxide tape; wow & flutter less than 0.15%; (S+N)/N 54 dB (Dolby off). Has VU meter, counter, automatic shutoff, pause control, and line inputs. 4⅞" H × 13¾" W × 9¼" D. Oiled-walnut cabinet ..... $280.00

### 202 Dolbyized Cassette Playback Deck

Stereo cassette player. Features Dolby circuitry and standard playback equalization for chromi-

um-dioxide tape (regular equalization also provided). Response 30-15,000 Hz ±2 dB; wow & flutter less than 0.2% DIN. Has hysteresis synchronous motor, automatic shut-off, digital counter. Overall size 3⅞" H × 9⅛" W × 10⅜" D ..... $130.00.

**Model 202hp.** Same except includes built-in headphone amplifier ..... $150.00

## AKAI

### GXC-40T Cassette Recorder/Tuner

Four-track, 2-channel stereo system. Glass and crystal ferrite head, over-level suppressor circuit, chromium-dioxide switch. (S+N)/N 45 dB; wow & flutter 0.2%; distortion 2%. Has AM-FM multiplex tuner. Unit can be converted into PA system. 16.5" × 5.5" × 12.8" D ..... $299.95

### GXC-41 Cassette Recorder

Features glass and crystal ferrite head, hysteresis motor, pause control with indicator lamp,

automatic stop, OLS switch, automatic distortion-reduction system (ADRS), tape selector switch for low noise & chromium-dioxide tapes. (S+N)/N 44 dB; wow & flutter 0.25%; distortion 2.0% ..... $274.95

### GXC-36D Cassette Deck

Features glass and crystal ferrite head; induction motor, pause control, tape selector switch

for low noise & chromium-dioxide tapes, automatic stop, OLS switch. (S+N)/N 44 dB; distortion 2.0%; wow & flutter 0.3% ..... $189.95

### GXC-38 Cassette Recorder

Features glass and crystal ferrite head, induction motor, Dolby, automatic stop, OLS switch,

pause control, tape selector switch for low noise & chromium-dioxide tapes. (S+N)/N 50 dB; wow & flutter 0.30%; distortion 2.0% ..... $289.95

**GXC-38D.** Same as GXC-38 except without power amplifiers ..... $229.95

### CS-35 Cassette Recorder

Features two heads, induction motor, tape selector switch for low noise & chromium-diox-

ide tapes, input and output jacks, plus DIN and speaker jacks, pause control, index counter with reset button. 16.2" × 4.8" × 8.7" D .$189.95

**CS-35D.** Same as CS-35 but without power amplifier ..... $149.95

### CS-55 D Cassette Recorder Deck

Four-track, 2-channel stereo/mono design. Wow & flutter 0.2% rms. Response 30-16,000 Hz ±3 dB. (S+N)/N 45 dB. Bias frequency 100 kHz. Has line output 1.23 V. Inputs: mike (0.2 mV) & line 50 mV. Has pause control and two VU meters. Features "Inverto-O-Matic" for continuous playback, automatic stop and repeat. 14¾" × 7⅞" × 11⅜" D ..... $199.95

### GXC-65D Dolbyized Cassette Recorder

Features glass and crystal ferrite head, automatic distortion-reduction system, Dolby auto-

matic change, "Invert-O-Matic" reverse cassette, tape selector (chromium-dioxide or low-noise), pause control, and two VU meters. Frequency response 30-16,000 Hz; wow & flutter 0.2% rms. (S+N)/N 50 dB. Overall distortion 1% ..... $299.95

### GXC-46D Dolbyized Cassette Recorder

Similar to Model GXC-65D in that it has Dolby, glass-encased crystal ferrite heads, and automatic noise-reduction system. Does not have "Invert-O-Matic." With signals over 8000 Hz circuit adjusts recording level to prevent distortion. Response 30-16,000 Hz. Wow & flutter 0.12% weighted rms. (S+N)/N 50 dB (58 dB with Dolby). Has universal power supply. 16½" × 5⅜" × 12" ..... $259.95

# 2 Cassette tape machines

## CONCORD

### Mark 7 Dolbyized Cassette Deck

Features stereo design with Dolby-type noise-reduction system providing (S + N)/N of 56 dB

(48 dB without Dolby). Response 30-15,000 Hz; HD 1.3% at −3 VU; bias 105 Hz; wow & flutter 0.13%. Input sensitivity: stereo mike 0.2 mV; stereo aux. 0.12 V. Output 1 V. Features "End-matic," which automatically disengages tape mechanism and will shut off motor in fast-forward or rewind operation; mechanical pause; dual bias (for standard & chromium-dioxide tapes); dual VU meter. 7¼" W × 11¾" D × 3½" ..... $199.95

**Mark 6.** Same as Mark 7 except without Dolby system ..... $139.95

### Mk IX Dolbyized Cassette Deck

Plays and records. Response 30-15,000 Hz, 1.5% THD, wow & flutter 0.2%, (S + N)/N 50 dB. Has VU meters, counter, eject button, automatic shutoff, pause control, monitoring facilities, mike and high- and low-level line inputs. For use with either chromium-dioxide or con-

ventional tapes. Comes with dust cover. 4½" H × 10⅝" W × 10⅝" D ..... $249.95

### F-106EB Stereo Cassette Deck

Features dual bias selection for standard or super-dynamic tapes, pause control, remote-control switch, automatic shutoff, automatic end-of-reel indicator, and dual record-level controls. Response 40-12,000 Hz, wow & flutter 0.2%, (S + N)/N 46 dB. Has mike & aux. inputs and line output. 10½" × 10¼" × 3½" H. .... ..... $109.95

## ELECTROPHONIC

### C-2 Cassette Recorder Deck

Stereo record/playback deck. Features push-

button pop-up cassette system for instant load and playback. Six push-button function controls for record, rewind, stop, play, fast-forward, and pause. Has automatic record-level control and tape counter. Two dynamic mikes with stands included ..... $79.95

## FISHER

### SR-110 Cassette Recorder Deck

Dolbyized record/play stereo design. Has separate control for chromium-dioxide tapes; ex-

panded-scale VU meters; independent record-level controls; auto-stop; counter on mike inputs. Response 30-12,000 Hz ($CrO_2$ 14,000 Hz); (S + N)/N 50 dB. Wow & flutter (weighted) 0.2% rms. Sensitivity: mike 0.2 mV (±3 dB) 0 VU at 1500 ohms; aux. 100 mV (±2 dB) for 0 VU at 5000 ohms. Output 1 volt (±2 dB) for 0 VU at 5000 ohms. 5½" × 15½" × 10½" D ... $249.95

### RC-80B Cassette Deck

Dolby-ized record/play stereo design. Has separate control for chromium-dioxide tapes, VU

meters. Response (standard tapes) 30-12,000 Hz. 7⅛" W × 3½" H × 11⅛" D. With pair M-5 dynamic mikes ..... $249.95
18-W Walnut base ..... $9.95

### 5056S Cassette/Phono/Tuner

Combines an AM/FM stereo tuner, a 4-speed automatic turntable with Pickering magnetic cartridge, a cassette stereo recorder, and a pair of XP-56S speaker systems. 50 W/ch dynamic (EIA) power @ 5% THD. Supplied with two M-5 dynamic microphones and dust cover. 23⅜" W × 16" × 8" ..... $499.95

## GENERAL ELECTRIC

### TA700 Cassette Recorder Deck

Features bias switch for either chromium-diox-

ide or standard tape and a noise-suppression switch. Has dual lighted VU meters. Response 125-8000 Hz; wow & flutter 0.35%. Has storage compartment for two dynamic mikes. 12¼" W × 3½" H × 8¾" D ..... $109.95

## HARMAN-KARDON

### HK1000 Dolbyized Cassette Deck

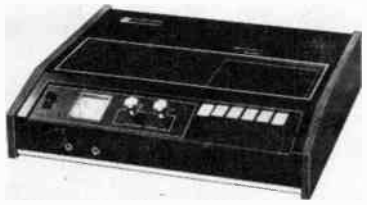
Stereo cassette recorder deck with built-in Dolby noise-reduction circuit. Has front-panel bias

switch for standard, low-noise, and chromium-dioxide tapes. Features memory relay, peak-reading VU meters, sliding controls for playback & record level, and microphone input. Response 30-15,000 Hz ±1.5 dB; wow & flutter 0.15 (weighted); speed variation 1%. Constant-current-drive record head ..... $299.95

## HEATH

### AD-110 Cassette Deck

Play/record stereo design. Response 30-12,000 Hz ±3 dB, 0.25% distortion, wow & flutter



less than 0.25%, (S + N)/N 45 dB. Has VU meters, eject button, pause control, mike & line inputs, and adjustable bias. 11" H × 13⅜" W × 3⅛" D. Walnut cabinet. Kit $129.95

### AD-1530 Dolbyized Cassette Deck

Combines a pre-assembled tape transport, a Dolby noise-reduction (B type) system, and

necessary preamps to record or play stereo cassette tapes. Has built-in test circuit to adjust Dolby system; a bias & equalizing switch for chromium-dioxide or standard tapes; VU meters; and mike inputs. Walnut cab ..... ..... Kit $249.95
Dust cover ..... $4.95

## HITACHI

### TRQ-262 Stereo Cassette Deck

Plays and records. 20-18,000 Hz response, wow & flutter 0.15%, (S + N)/N 50 dB. Has VU

meters, counter, eject button, automatic shut-off, pause control, monitoring facilities. Has provision for mike & line inputs. 3⅜" H × 13⅛" W × 9⅝" D ..... $149.95

**TRQ-282 Stereo Cassette Deck**
Plays and records. Response 40-12,000 Hz, wow & flutter 0.3%, (S + N)/N 46 dB. Has VU

meters, counter, eject button, pause control, monitoring facilities, mike & line inputs. 3⅝" H × 8⅛" W × 10¾" D ..... $119.95

**SDT-3420 AM-FM/Phono/Cassette Recorder**
Combines an AM-FM stereo receiver with 5 W/ch dynamic power at 5% THD, a BSR automatic record changer, a cassette recorder, and

a pair of air-suspension speaker systems. Has separate tape record-level controls and comes with a dust cover ..... $299.95

**TRQ-242 Stereo Cassette Deck**
Plays and records. Response 40-12,000 Hz,

(S + N)/N 45 dB. Has VU meters, counter, eject button, mike inputs. 3⁹⁄₁₆" H × 7⅜" W × 10¹³⁄₁₆" D. ..... $109.95

**ST-3401 AM-FM/Cassette Recorder/Player**
Combines an AM-FM stereo receiver with 5 W/ch dynamic power at 5% THD with a cassette tape recorder. Has separate record-level controls, sleep switch, two VU meters. Supplied with two 2-way speaker systems .... $279.95

**TRQ-2000 Dolbyized Cassette Deck**
Features a cassette stereo tape recorder/player with Dolby circuitry. Has two VU meters, slide-

type volume controls, and walnut cabinet. ..... $229.95

**JVC**

**CD-1665 Cassette Deck**
Economy stereo record/play design. Response 40-13,000 Hz ±3 dB. (S + N)/N −50 dB; wow &

flutter 0.15% rms. Has record/play and erase heads. Inputs: mike (0.7 mV) & line (80 mV). Line output 0 to 0.6 V. 4½" × 11⅛" W × 9⅜" D ..... $99.95

**CD-1655 Cassette Deck**
Stereo record/play design. Response 30-15,000 Hz ±3 dB. Ferrite record/play heads. Tape selector switch for chromium-dioxide and standard tapes. Built-in noise-suppressor circuit, automatic stop, two VU meters, calibrated step recording-level controls. 4½" × 14¹¹⁄₁₆" × 9⁵⁄₁₆" D ..... $119.95

**CD-1666 Cassette Deck**
Stereo record/play design. Response 30-16,000 Hz ±3 dB with chromium-dioxide tape (30-

13,000 Hz with standard tape). (S + N)/N −50 dB; wow & flutter 0.15% rms; bias record & erase 95 kHz. Has record/play and erase heads. Inputs: mike (0.7 mV) & line (80 mV). Line output 0 to 1 V. Features two VU meters and bias switch for chromium-dioxide and standard tape. 15" × 4⅝" × 10½" D ..... $169.95

**CD-1667 Cassette Deck**
Same as CD-1666 in design and styling except has an automatic noise-reduction system (ANRS). ..... $219.95

**CD-1669 Solenoid Cassette Deck**
Response 30-16,000 Hz ±3 dB. (S + N)/N −60 dB; wow & flutter 0.13% rms. Ferrite record/play heads. Features both equalizer and tape bias switches; built-in automatic noise-reduction system; memory counter; dual-drive mechanism; memory counter; calibrated step recording-level and playback controls. 5⁹⁄₁₆" ×

## 2 Cassette tape machines

16½" W × 12 1/16" D ..... $424.95

### CD-1668 Cassette Deck

Deluxe version of the Model CD-1667. Has dual drive mechanism to reduce wow & flutter

(0.13% rms). Memory counter, ferrite record/play heads, calibrated recording-level controls, automatic stop, and automatic eject. Overall size 17" × 5½" × 15" D ..... $299.95

## KENWOOD

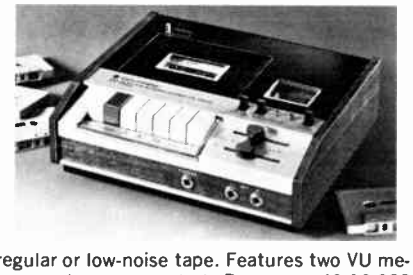
### KX-700 Dolby-ized Cassette Deck

Record/play stereo design with Dolby circuitry (improving S/N 10 dB). Features bias selector

switch for regular, low-noise, or chromium-dioxide type tapes, two VU meters, slide-type controls, pause control, and automatic shutoff. Response 25-13,000 Hz, wow & flutter 0.15%, S/N 55 dB with Dolby. Has two microphone (0.11 mV) and two line (24.5 mV) inputs. Outputs 0.775 V. Universal power supply. 4⅝" × 15½" × 11⅜" D ..... $259.95

### KX-7010A Cassette Recorder Deck

Record/play stereo design. Has hysteresis-synchronous motor and 2-position bias selector for



regular or low-noise tape. Features two VU meters and pause control. Response 40-10,000 Hz; wow & flutter 0.2%; (S + N)/N −45 dB. Input sensitivity: mike 0.25 mV (69 dB); output level 0.775 V (0 dB). 10½" × 4" × 9" D . $159.95

## LAFAYETTE

### LRK-900A Cassette/Receiver System

Deck with power amplifier and AM-FM stereo tuner. Plays and records. 10 W/ch output. Wow & flutter 0.25%; (S + N)/N 48 dB. Has bias switch for standard or chromium-dioxide tapes, VU meters, counter, eject button, tone controls,

automatic shutoff, pause control, monitoring facilities, mike inputs, phono input, bias adjust, sound-with-sound. Has built-in circuit for 4-channel synthesizing of conventional 2-channel sources. Requires two additional speakers for 4-channel use. 4" H × 10¾" W × 11⅞" D ..... $219.95

## MAGNAVOX

### 8840 Cassette Recorder Deck

Stereo design. Response 60-10,000 Hz ±4 dB; wow & flutter 0.25%; (S + N)/N 40 dB. Features

fast-forward and pause control, automatic eject, mike inputs, and two record-level meters. 13¼" × 9" × 4". Walnut cab. ..... $99.95

**8871.** Basically same as 8840 except has noise suppressor switch. Response 60-10,000 Hz ±3 dB; wow & flutter 0.2%; (S + N)/N 45 dB. 11¼" × 9" × 3½" ..... $239.95

**8842.** Basically same as 8877 except has automatic noise-reduction system and standard/chromium-dioxide bias sw. Response 40-13,000 Hz ±3 dB; wow & flutter 0.18%; (S + N)/

N 45 dB. 15¼" × 10¾" × 4¾" ..... $199.95

### 8843 Cassette Recorder Deck

Stereo design. Response 40-15,000 Hz ±3 dB;

wow & flutter 0.2%; (S + N)/N 45 dB. Features automatic reverse, four-source mixing, standard/chromium-dioxide tape bias switch, noise filter, and six-element head. 17¼" × 9½" × 5¾". Walnut cabinet ..... $249.95

### 8844 Cassette Changer Deck

Stereo design. Response 40-15,000 Hz ±3 dB; wow & flutter 0.2%; (S + N)/N 45 dB. Will auto-

matically change up to 12 cassette tapes. Has six-element head. Plays and records in two directions. 18½" × 10¼" × 9". Walnut cabinet. ..... $299.95

## MOTOROLA

### GA16GW Cassette Recorder Deck

Play/record stereo design. Comes with mikes, VU meters, counter, eject button. Features

automatic shutoff, pause control, microphone and line input ..... $129.95

### FH230HW AM-FM/Cassette Player

Combines a conventional stereo cassette player and an AM-FM stereo receiver with a pair of

separately housed speaker systems, each with 8" and 3½" speakers (cabinets measure 10" × 13¼" × 8⅜" D). Power output 15 W/ch dynamic (EIA) power at 5% THD. Walnut veneer cabinets. 22⅞" × 5⅛" × 11½" D ..... $259.95

## NORELCO

### 2000 Stereo Cassette Deck

Deck only. Plays and records. Has VU meters, counter, eject button, automatic shutoff, pause control, mike & line inputs. Response 100-8000 Hz, wow & flutter 0.3% rms, (S + N)/N 43 dB. Input sensitivity: mike 0.2 mV, phono 160 mV. Supplied with microphone. Walnut. 10¼" W × 8¾" D × 3⅛" H ..... $99.95

### 2100 Stereo Cassette Deck

Deck only. Plays and records. Has VU meters, counter, eject button, pause control, monitor-

ing facilities, mike & line inputs. Features Philips dynamic noise limiter. Provides for bias adjust. 3⅞" H × 12¾" W × 10½" D ... $219.95

### 2400 Stereo Cassette System

Plays and records. Response 60-10,000 Hz ±3 dB, (S + N)/N 45 dB. Has VU meter, counter, eject button, tone controls, automatic end-of-tape stop, pause control, monitoring facilities,

*Announcing the NEW STANDARD in Stereo Testing!*

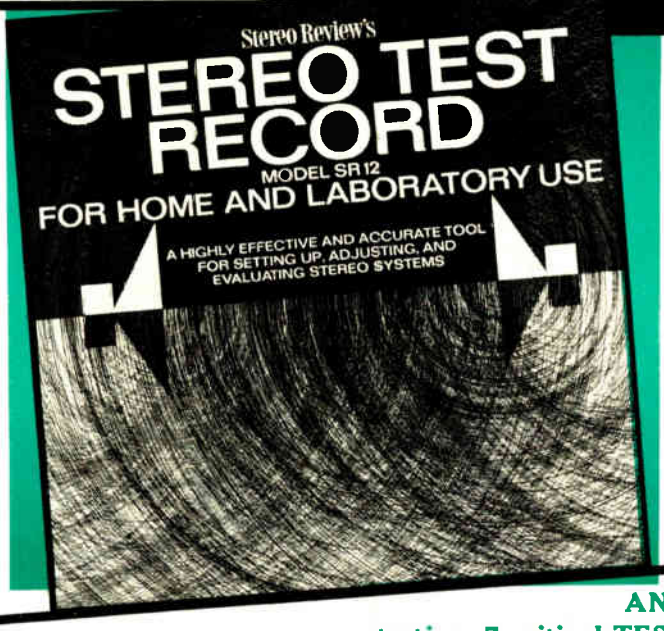
# Get the All-New Model SR12 STEREO TEST RECORD

**The most complete...most sophisticated...most versatile Test Disc available today...**

***For Just $5.98!***

## Who Needs the New Model SR12?

If you've read this far, *you* do. Whether you're an avid audiophile who'll settle for nothing but peak performance from his stereo components . . . a casual listener who'd like more insight into the challenging world of stereo reproduction . . . or a professional technician who needs precise standards for lab testing . . . the new MODEL SR12 will be the most important disc in your entire collection.




Like its predecessor Model 211, MODEL SR12 has been produced by Stereo Review Magazine (formerly HiFi/Stereo Review) as a labor of love — by music lovers . . . for music lovers who want immediate answers to questions about the performance of their stereo systems and how to get the best possible sound reproduction.

Now greatly expanded and updated with the most modern engineering techniques, MODEL SR12 is the most complete test record of its kind — containing the widest range of checks ever included on one test disc. An ear-opener for every serious listener!

## You'll make these important stereo checks BY EAR... (no test instruments of any kind required)

Frequency response—a direct warble-tone check of nineteen sections of the frequency spectrum, from 20 to 20,840 Hz, which will pinpoint any frequency response defects in your system.

Separation—an ingenious test which indicates whether you have adequate separation for good stereo.

Cartridge tracking—the most sophisticated tests ever devised for checking the performance of your cartridge, stylus and tone arm.

Channel balance—two broad-band, random-noise signals which permit you to eliminate any imbalances originating in cartridge, amplifier, speakers or room acoustics.

Hum and rumble—foolproof tests that help you evaluate the actual audible levels of rumble and hum in your system.

Flutter—a sensitive "musical" test to check whether your turntable's flutter is low, moderate, or high.

● Cartridge and Speaker Phasing ● Anti-Skating Adjustment ● "Gun Shot Test" for Stereo Spread ● Multi-purpose Musician's "A" ● Equal-tempered Chromatic Octave ● Guitar-tuning Tones.

## Don't waste another minute on less-than-perfect stereo—Order Your Model SR12 Stereo Test Record NOW!

Consider the hundreds—even thousands—you've spent on your set-up and you'll agree $5.98 is a small price to pay for the most valuable performance tool ever made. So to be sure your order is promptly filled from the supply available, mail the coupon at right with your remittance . . . today!

## AND, for the ultimate in stereo testing, 7 critical TEST EQUIPMENT checks . . .

Attention professionals: Stereo Review's new Model SR12 Stereo Test Record is also designed to be used as a highly efficient design and measurement tool. In the following tests, recorded levels, frequencies, etc. have been controlled to laboratory tolerances—affording accurate numerical evaluation when used with oscilloscope, chart recorder, output meter, intermodulation-distortion meter and flutter meter.

- 1,000-Hz square waves to test transient and high-frequency response of phono pickups.
- 500 to 20,000 Hz frequency-response sweep.
- Sine-wave tone-bursts to test transient response of pickup.
- Intermodulation test using simultaneous 400-Hz and 4,000-Hz signals.
- Intermodulation sweep to show distortion caused by excessive resonances in tone arm and cartridge.
- 1,000-Hz reference tones to determine groove velocity.
- 3,000-Hz tone for flutter and speed tests.

Sample waveforms—illustrating both accurate and faulty responses are provided in the Instruction Manual for comparison with the patterns appearing on your own oscilloscope screen.

## FREE Instruction Manual Includes Detailed Instructions, Charts, Tables and Diagrams.

Nothing is left to chance . . . or misinterpretation. Every segment of every band is fully, clearly, graphically explained. You'll know exactly what responses to listen for in each test. Which sounds and patterns indicate accurate performance . . . which ones spell trouble . . . as well as the cause of trouble and precise corrective measures to follow and help you pinpoint, analyze and cure your stereo headaches!

**RECORDS • Ziff-Davis Service Division** TRG-S73
**595 Broadway • New York, N.Y. 10012**

Please send _____ test records at $5.98 each, postpaid.

My check (or money order) for $ _____ is enclosed.

(Outside U.S.A. please send $8.00 per record ordered.) N. Y. State residents please add local sales tax.

Print Name _____

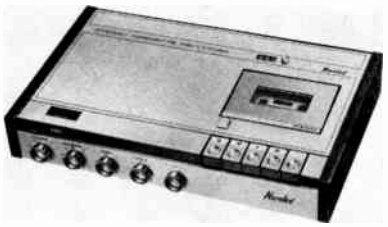
Address _____

City _____

State _____ Zip _____

**PAYMENT MUST BE ENCLOSED WITH ORDER**

## 2 Cassette tape machines



mike & line inputs, phono input. 4 W/ch continuous power output. Supplied with mike and two satellite speakers in walnut enclosures (10" W × 13¾" H × 7⅜" D). Control center 3" H × 14" W × 8½" D ..... $119.95

**2401 Automatic Stereo Cassette System**
Incorporates an automatic changer. Provides up to 6 hours playback using six C-120 cas-

settes. Simple push-button operation plus balance, tone, volume, and record controls. Comes with stereo microphone and speakers. Speakers 16¾" × 10½" × 7¾". Control center 15¼" × 9¼" × 4⅜" ..... $169.95
Continuous cassette circulator for non-stop playback ..... $19.95

**3170 Stereo Cassette System**
Combines a cassette play/record tape system with an AM-FM stereo receiver. Will operate from 117-volt a.c. or 8 "D" cells. Response 70-10,000 Hz, wow & flutter 0.25% rms, (S + N)/N 40 dB. FM max. sensitivity 100 μV. Has counter, eject button, tone controls, pause button. Supplied with two detachable speakers, each

8⅜" W × 9¼" H × 4" D. Has automatic record level control and inputs for mike, phono, and line. Control center 16⅝" W × 3¼" H × ½" D ... ..... $199.95

### PENNEY, J.C.

**1982 Phono/Cassette/Radio**
Combines an AM-FM stereo tuner, a cassette player/recorder, a BSR C-141 changer with diamond stylus, and two separately housed speaker systems, each with 8" woofer & 2½" tweeter. Has record level indicators and 20 W/ch continuous sine-wave output at 5% HD. Walnut wood-grain cabinets ..... $409.95

**3536 Cassette Tape Deck**
Stereo tape record/playback design with stop, play, record, fast-forward, and rewind controls; slide volume controls and dual mike and phono inputs ..... $89.95

### PIONEER

**CT-3131 Cassette Deck**
Stereo record/playback design featuring switch for standard or chromium-dioxide tape; automatic stop; a level memory marker; dual record-level meters; tape running pilot; and skip button. Wow & flutter 0.13%; (S + N)/N −48 dB for standard tape (50 dB for chromium-dioxide tape). Response 30-12,500 Hz for standard tape (30-15,000 Hz for chromium-dioxide tape). Sensitivity: line input 50 mV; mike 0.5 mV; line output 0.775 V. Has universal power-line inputs. 15⅜" × 3⅞" × 9⅝" D ..... $199.95

**CT-4141 Dolbyized Cassette Deck**
Stereo design featuring d.c. brushless motor.

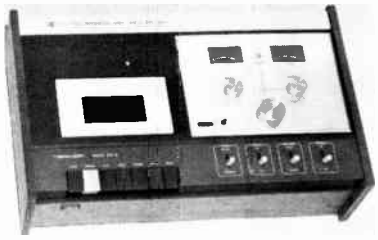
85 kHz bias & a.c. erase. Bias change for standard & chromium-dioxide tape. Response 30-13,000 Hz with standard tape (30-16,000 Hz with chromium-dioxide tape). (S + N)/N 58 dB with Dolby. Wow & flutter 0.13%. Inputs: line 50 mV; mike 0.5 mV. Line output 0.775 V. 15¾" W × 9½" D × 3⅞" H ..... $249.95

### RADIO SHACK

**SCT-3B Cassette Deck**
Stereo record/play design. Has individual channel record-level controls, VU meters, mike

and auxiliary inputs, and preamp outputs. Response 50-10,000 Hz ±3 dB (playback-only response 40-12,000 Hz ±2 dB). Wow & flutter 0.25% rms. Oiled-walnut case. 10⅝" × 7¼" × 4" ..... $99.95

**SCT-6 Cassette Deck**
Stereo record/play design. Has individual channel record-level controls, VU meters, mike and auxiliary inputs, preamp outputs. Has Dolby noise-reduction circuit, tape bias switch for recording chromium-dioxide cassettes. Capable of sound-on-sound recording. Has dual illuminated record-level meters, pause control, and automatic end-of-tape shut-off. Response 30-14,000 Hz (with chromium-dioxide tape) ±2 dB;

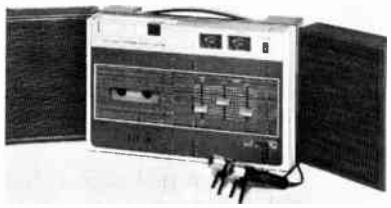


wow & flutter 0.14% rms. Oiled walnut cabinet with brushed aluminum trim. 16½" × 10¼" × 4½" ..... $199.95

**SCT-5 Cassette Recorder**
Stereo record/play design. Has dual VU meters. Response 50-12,000 Hz ±2 dB (playback-

only response 40-14,000 Hz ±2 dB). Wow & flutter 0.2%. Overall size 13⅜" × 9¾" × 3⅞" ..... $129.95

**SCT-2B Cassette Recorder**
Portable stereo design. Has dual VU meters, monitor switch, slide controls. Operates from



117-volt power source or six "D" cells. Supplied with two mikes (one with remote-control switch). Has two removable wing speaker systems. 11" × 8½" × 6½" ..... $129.95

### RCA

**VYC720 Stereo Compact/Cassette Recorder**
Four-piece home sound center with built-in stereo cassette player/recorder featuring digital counter, dual VU meters; two microphones, mike stands, neck cords, and blank cassette; solid-state AM-FM receiver with slide controls for bass, treble, stereo balance, loudness, a.f.c., and power; two 7" oval speakers in closed-back enclosures; and record changer. Has "Dimensia IV" spatial sound feature for enhanced stereo effect with two optional extra speakers. Control center 5" W × 19½" H × 13½" D. Changer 6¾" × 14" W × 12" D. Speakers each 13½" H × 10½" W × 6" D. ..... $279.95
**VYC520.** Same except with 8-track cartridge tape player ..... $229.95

**12R200 Car Cassette Recorder**
Stereo design. 4½ W dynamic power at 5%

THD. Response 50-10,000 Hz. 3 to 8 ohms impedance. Wow & flutter 0.44% rms. Will play stereo & monaural but will record in mono only. For 12-V d.c. negative-ground power sources. Supplied with remote mike and special theft-proof mounting bolts. 2⅞" × 8¾" × 7⅝" D. ..... $106.95

**VS6061 Cassette/Phono/Radio**
Combines a stereo cassette tape recorder, an AM-FM stereo receiver, a 4-speed changer with ceramic flip-over cartridge for LP's & 78 rpm records, and a pair of sealed speaker systems, each with 6" & 3½" speakers (cabinet size 10" × 20" × 7½" D). Has cueing control, dust cover, and 25 W/ch (EIA) dynamic power amp. at 5% THD. Walnut cabinet. Control center 10¼" × 23⅛" × 14⅝" D ..... $449.95-$479.95

**YZD572 Cassette Recorder/Radio**
Stereo cassette recorder with fast-forward, pause control, automatic shut-off, dual VU record-level meters, and push-button controls combined with an AM-FM stereo receiver featuring stereo indicator light, slide-rule vernier tuning, and a.f.c. plus two speakers (11⅞" × 11½" W × 6⅛" D) each with 8" woofer & tweeter. Control center 5¼" H × 18½" W × 11⅜" D. Cabinets of hardwood solids with walnut veneers ..... $239.95-$259.95

**MZD563 Cassette Recorder/Player**
Compact stereo unit featuring digital tape counter, VU record-level meters, push-button controls. Comes with blank cassette and two mikes ..... $79.95-$84.95

## SANSUI

**SC700 Cassette Recorder Deck**
Stereo design with Dolby noise-reduction system. Input sensitivity: mike 0.5 mV; line 70 mV. Wow & flutter 0.12% weighted rms. Response

40-13,000 Hz with standard tape; 40-16,000 Hz with chromium-dioxide tape. (S + N)/N with low-noise tape 50 dB (with Dolby 56-58 dB). Bias frequency 100 kHz. Features 3 mike mixing, dual VU meters, and universal power supply. 15¼" × 10⅛" × 4⅛" D ..... $299.95

## SANYO

**RD-4300 Dolbyized Cassette Deck**
Stereo design with pause control, equalization adjustments for choice of tape, and two record-

level meters. Has tape monitoring facilities, cue control, and automatic shut-off. Response 40-15,000 Hz ±3 dB. (S + N)/N 50 dB. Wow & flutter 0.15%. Has mike & line inputs and built-in memory counter (will automatically rewind & stop at point of start). 17" × 9" × 5" .. $279.95

**GXT-4500 AM-FM/Cassette System**
Combines an AM-FM stereo receiver, an automatic record changer with 8" turntable & ceramic cartridge, a cassette tape deck with 50-12,000 Hz response, (S + N)/N 45 dB, wow & flutter 0.25; and pair of speakers (9" × 6" × 13½") each with 6½" speaker. 12½ W/ch dynamic power at 5% HD. Supplied with dust cover and one microphone. 20" × 13" × 8" H ..... $199.95

## SONY

**HST-119 AM-FM/Cassette Recorder**
Combines an AM-FM stereo receiver with a cassette recorder. 5 W/ch dynamic (EIA) power at 5% THD. Input sensitivity: mag. phono 5 mV, ceramic phono 300 mV, Aux. 250 mV. 8 ohm output. FM sensitivity 2.2 μV for 30 dB quieting. Has automatic or manual tape-track switching. Walnut cabinet. 5¼" H × 21⅝" × 12¾" D. ..... $199.95
**HST-118.** Same except with 8-track tape player ..... $179.95

**HP-219A AM-FM/Phono/Cassette**
Combines an AM-FM stereo receiver, a cassette recorder, and a pair of SS-210A speaker systems (each with a 6½" woofer & 2" tweeter, 15" × 19¼" × 8⅜" D) with a BSR automatic turntable and Sony VX-18P stereo phono cartridge. 18 W/ch dynamic power at 5% THD at 8 ohms. Response 40-40,000 Hz ±3 dB at 1 W. FM sensitivity 2.5 μV for 30 dB quieting. Features automatic and manual tape program selection & tape monitor switch. Walnut cabinet. 9⅞"

H × 23⅛" W × 17¼" D. ..... $349.95

**HP-149A AM-FM/Phono/Cassette**
Combines an AM-FM stereo receiver, a cassette recorder, a BSR 4-speed micro-minichanger with ceramic stereo cartridge, with a pair of separately housed speaker systems (each with 6½" woofer & 2" tweeter, 14¾" H × 9¼" W × 5⅛" D). 5 W/ch dynamic (EIA) power at 5% THD at 8 ohms. Response 40-20,000 Hz ±3 dB at 1 W. 8" × 22¼" × 12" D. ..... $249.95
**HP-148A.** Same except with 8-track tape player. ..... $229.95

## SONY/SUPERSCOPE

**CF-620A Cassette Recorder/Radio**
Cassette recorder combined with AM/FM stereo tuner. Plays and records. Response 30-12,000 Hz, wow & flutter 0.22%, (S + N)/N 46 dB. Supplied with mikes and speakers. 6 W/ch continuous power at 5% HD. Features VU meters, counter, eject button, pause control, monitoring facilities, mike & line inputs, bias adjust and

automatic shut-off. 5⁷/₁₆" H × 16½" W × 12¼" D ..... $299.95

**CF-550 Cassette Recorder/Radio**
Combines AM/FM stereo receiver with cassette recorder. Has two built-in condenser mikes and

four built-in speakers, built-in battery charger for optional NiCad battery (6 V) and automatic shut-off. Will operate from a.c. power line. Response 50-10,000 Hz. Has two line (0.06 V) and two mike inputs. 1½ W/ch continuous power output at 5% THD. Portable design. 13¼" × 9⅝" H × 4¾" D ..... $239.95

**TC-124 Portable Cassette Recorder**
117-V a.c. or 6 V d.c. (four "C" cells) stereo de-

sign. Response 50-10,000 Hz, (S + N)/N 45 dB, wow & flutter 0.28%. Has battery-strength and record-level indicator, line (0.06 V) & mike inputs, built-in mono speaker (4" × 2¾"), and stereo speaker outputs. 1 W/ch continuous output. Supplied with F-99 microphone with remote

**AN IMPORTANT WORD ABOUT PRICES . . .**
**Although we have made every effort to obtain current prices on all products listed in this Guide, because of the dollar devaluation last February 13th and the "floating" of Japanese and European currencies, ALL prices are subject to some adjustment. The prices you will find listed are the latest manufacturers and/or importers were able to supply before press time . . . and are subject to change.**

## 2 Cassette tape machines

control, earphone, and carrying case. 6¾" × 2¾" × 9⅞" D. ..... $149.95

**TC-124CS.** Same as TC-124 except with pair of separately housed speaker systems. 5¾" × 9¾" × 2¾" D ..... $179.95

### TC-10 Car Cassette Player

Stereo design. 12-V negative ground operation. 6 W/ch continuous. Response 50-10,000 Hz.

Wow & flutter 0.25%; (S+N)/N 45 dB. 3.2 ohms impedance. 7¼" × 2⅝" × 7⅞" D. With mounting hardware but less speakers . $99.95

**TC-20.** Same except deluxe styling and for both negative & positive ground operation. Wow & flutter 0.28%. 7¼" × 2⅞" × 8¼" D ... $119.95

**TC-30.** Same as TC-10 except has automatic reverse. (S+N)/N 50 dB. 7¼" × 2⅞" × 9⅜" D. ..... $149.95

### TC-126CS Portable Cassette Recorder

Operates from 117 V a.c. line or four "C" cells. Response 50-10,000 Hz. Wow & flutter 0.26%. (S+N)/N 45 dB. Has mike or aux. inputs (0.06 V sensitivity). 1½ W/ch continuous output. Features automatic total mechanism shut-off, p.a. operation, built-in mono speaker (4" × 3"), and record level/battery strength meter. Supplied with pair of separately housed speaker systems, one microphone, earphones, and attaché carrying case. ..... $199.95

**TC-126.** Same except without speakers and carrying case ..... $169.95

### TC-134SD Dolbyized Cassette Deck

Features dual bias for standard or chromium-dioxide tape. Response 30-17,000 Hz with chromium-dioxide tape. (S+N)/N 54 dB at 1 kHz & 59 dB at 5 kHz. Bias frequency 85 kHz. Wow & flutter 0.2%. Has line & mike inputs (0.06 V sensitivity), dual VU meters, line outputs (0.775 V sensitivity). Walnut base. 16½" × 4⅝" × 8⅞" D ..... $238.95

### TC-161SD Dolbyized Cassette Deck

Features dual bias for standard or chromium-dioxide tape. Response 20-18,000 Hz with chromium-dioxide tape. (S+N)/N 54 dB at 1 kHz & 59 dB at 5 kHz. Wow & flutter 0.1%. Bias frequency 85 kHz. Has dual VU meters, illuminated cassette compartment, memory-type counter, headphone level switch. Has mike & line inputs (0.06 V sensitivity) and line output (0.775 V). Walnut base. 15¾" × 5" × 10⅞" D. ..... $299.95

## SYLVANIA

### MST2738W Phono/Cassette/Receiver

Combines a Garrard automatic turntable, a Pickering magnetic cartridge, viscous-damped cue/pause control, an anti-skating device; an AM-FM stereo receiver; a stereo cassette recorder; and a pair of sealed air-suspension speaker systems (18" × 11¼" × 9" D) each with

8" woofer & 3" tweeter. Has built-in Phase Q4 matrix to synthesize regular two-channel stereo program material. 20 W/ch dynamic power at 1% HD (12½ W/ch continuous). Power bandwidth 25-20,000 Hz; response 25-20,000 Hz ±1½ dB. FM sensitivity 2.5 μV; capture ratio 5.5 dB. Walnut cabinet with dust cover. Comes with pair of microphones. Control center 9¼" × 23½" × 15¾" D ..... $399.95

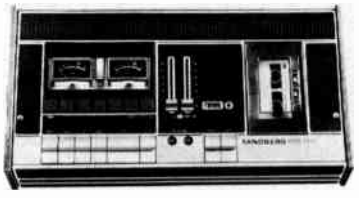
### CT160W Cassette Recorder Deck

Stereo design with dual VU level meters, automatic shut-off, and slide-type controls. Input sensitivity: mike 0.2 mV ±3 dB at 200 ohms; 100 mV ±3 dB at 100,000 ohms. Output 1 V ±3 dB. Response 30-12,000 Hz ±4 dB. Wow & flutter 0.2% rms. Supplied with two dynamic microphones & desk stands. 5⅝" × 11⅞" D × 8" H. Walnut cabinet. ..... $119.95

## TANDBERG

### TCD-300 Cassette Recorder Deck

Features Dolby noise-reduction system; three motors; two peak-reading record meters; chromium-dioxide/low-noise, high-output tape switch; automatic endstop. Wow & flutter 0.15% (Wrms). Response 50-12,000 Hz ±2 dB. Has mike (0.1 mV), radio (5 mV), and line (40 mV) inputs. Output 0.775 V. Wall mountable. Walnut cabinet. 19" × 4¼" × 9⅛" D .. $399.90



## TEAC

### 450 "Challenger" Cassette Deck

Features Dolby-B type noise-reduction system. Has switchable controls for bias and equalization for various tape types; mike/line inputs

(mixable); two separate erase and record/playback heads. S/(S + N) 51 dB (60 dB with Dolby); wow & flutter 0.07%. Response 30-10,000 Hz with standard tape (30-14,000 Hz with low-noise tape; 30-16,000 Hz with chromium-dioxide tape). Inputs: mike 0.25 mV; line 0.1 V. Output: 0.3 V. Has universal power-line inputs. 7" H × 17½" W × 10⅝" ..... $379.50

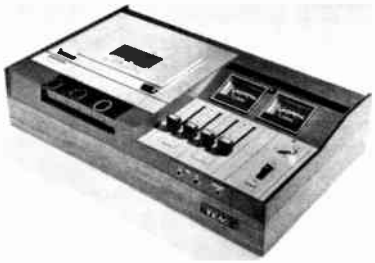
**AC-5 Car Cassette Player**

Features continuous stereo playback; automatic reverse; universal mounting; and servo-con-


trolled motor. Wow & flutter 0.25%. Frequency range 40-10,000 Hz. Output 6 W/ch dynamic (EIA) power at 5% THD. 12 V d.c. negative-ground operation. 2⅝" × 7" × 8⅜" D. Speaker optional ..... $139.50

**220 Cassette Deck**

Deluxe version of Model 210. Features tape selector switch for high density or chromium-dioxide tapes. Has four separate preamps (two



for record, two for playback) and automatic stop ..... $199.50

**250 Dolbyized Cassette Deck**

4-track, 2-channel stereo record/play design with Dolby noise-reduction circuits. Wow & flutter 0.15%. Response 30-13,000 Hz (30-16,000 Hz with chromium-dioxide tape. (S + N)/N −50

dB. Has mike (0.25 mV) and line (0.1 V) inputs and line output (0.3 V). Features selector switch for high density or chromium-dioxide tape. 4⅛" × 16⅛" × 9¾" D ..... $249.50

**350 Dolby-ized Cassette Deck**

Stereo design. Plays and records. Response 30-16,000 Hz, wow & flutter 0.13%, (S + N)/N

58 dB. Has hysteresis motor, VU meters, counter, eject button, automatic shutoff, pause con-



**ALWAYS** . . . . . take along your copy of this Directory when shopping for hi-fi components. It is a comprehensive reference to complete technical details and prices . . . and when writing to manufacturers, tell them you saw it in the Tape Recording & Buying Guide.

## 2 Cassette tape machines

trol, monitoring facilities, and mike & line inputs. 4⅜" H × 16 15/16" W × 9⅞" D ..... $289.50

### AC-9 Car Cassette Player

Similar to AC-5 except higher fidelity. Has tone controls; fast-wind in both directions; automat-

ic reverse; tape-travel indicating lamps. Speaker optional ..... $159.50

### 210 Cassette Deck

4-track, 2-channel stereo record/play. Wow & flutter 0.15%. Response 30-12,500 Hz. (S + N)/N −50 dB. Has mike (0.25 mV) & line (9.1 V) inputs and line output (0.3 V). Features illuminated strobe tape-run indicator, showing direction & mode of tape travel. 4⅛" × 16⅛" × 9¾". ..... $159.50

## TECHNICS BY PANASONIC

### RS-271US Cassette Recorder Deck

Dolbyized stereo design with standard and chromium-dioxide tape selection and HPF ul-

tra-longlife heads. Wow & flutter 0.2% (S + N) /N 55 dB (with Dolby), 45 dB (without). Response 20-13,000 Hz (standard tape), 20-14,-000 Hz (chromium-dioxide). Has two VU meters, memory rewind, lockable pause control, automatic stop, mike/line selector, electronically controlled motor speed. 15⅝" × 10⅞" × 5". . . ..... $249.95

### RS-279US Cassette Recorder Deck

Dolbyized stereo design with standard and chromium-dioxide tape selection and HPF ultra-longlife heads. Three-head system permits off-tape monitoring. Wow & flutter 0.1%. (S +N) /N 60 dB (with Dolby), 50 dB (without). Response 20-17,000 Hz (chromium-dioxide tape), 20-15,000 Hz (standard tape). Has two motors

including electronically controlled direct drive for capstan, optional remote control, memory rewind, pause control, electronic autostop. Mike/line input selection. 5⅜" H × 16⅝" W × 13½" D. ..... $529.95

### RS-276US Cassette Recorder Deck

Dolbyized with standard and chromium-dioxide tape selection. Wow & flutter 0.1%. (S + N)/N 50 dB (60 dB with Dolby). Response 20-15,000 Hz (standard tape), 20-17,000 Hz (chromium-dioxide tape). Has line & mike inputs, two-motor system including one direct drive, memory rewind, and optional remote control. 5⅜" × 16½" × 13¼" D ..... $399.95

### RS-263US Cassette Recorder Deck

Dolbyized stereo design with standard tape & chromium-dioxide selection. Wow & flutter 0.2%. Response 30-13,000 Hz (standard tape); 30-14,000 Hz (chromium-dioxide). (S + N)/N 45 dB (55 dB Dolby). Has mike & line inputs, automatic stop, memory rewind and pause control. 14" × 5" × 9⅝" D ..... $179.95

### RS-277US Cassette Recorder Deck

Similar to RS-263US in performance but has added features: automatic reverse, pause con-

trol, and output level adjust. 17¼" × 5⅛" × 11⅜" D ..... $299.95

## TELEDYNE PACKARD BELL

### G04201 "Opus" Cassette/Music System

Combines an AM-FM two-channel stereo receiver, a cassette tape recorder, and a built-in Gar-

rard 2025TC automatic turntable. Is supplied with four separately housed speaker systems. Has a synthesized circuit to develop 4-channel sound from conventional 2-channel sound sources. Features dual record-level meters, ceramic cartridge with diamond stylus. 10 W/ch (20 W total) dynamic power at 5% THD. Supplied with 2 mikes, dust cover. Receiver housing 23⅜" × 9⅛" × 15½" D. Speaker cabinets (front) 9⅛" × 14¼" × 5⅜" (each has 6" × 2" duo-cone speaker); (rear) 8¾" × 11½" × 4¾" D (each with 6" duo-cone speaker) .... $329.95

## TOSHIBA

### PT-415 Cassette Deck

Stereo design featuring a Dynamic Noise Limiter (DNL); tape selector (standard or chromium-dioxide). Output 0-1 V. Response 30-15,000 Hz, with chromium-dioxide tape. Wow & flutter 0.1% rms weighted; (S + N)/N 50 dB (unweighted). Sensitivity: line 80 mV; mike 0.56 mV. Fast-forward and rewind 100 sec. Has universal line inputs. 14½" × 4" × 10¼" . $189.95

### PT-490 Dolbyized Cassette Deck

Features stereo play/record; mechanical automatic shut-off; 3-step tape selector (adjusts bias and frequency response), two record-level meters, and automatic reverse. Output 0 to 1 V. Frequency response 30-15,000 Hz. Wow & flutter 0.1% weighted rms. (S + N)/N 50 dB (60 dB with Dolby). Input sensitivity: line 80 mV; mike 0.56 mV (10,000 ohms). 16⅞" × 5½" × 11½". ..... $299.95

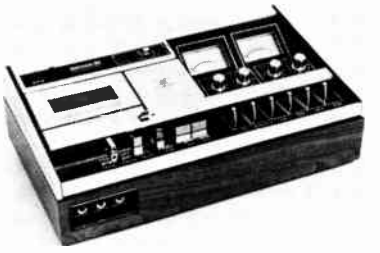
**PT-470.** Same as PT-490 except does not have

automatic reverse ..... $239.95

## WOLLENSAK

### 4765 Cassette Recorder Deck

Dolbyized design featuring beltless, direct dual-drive system; mike & line mixer switch for



sound-on-sound mixing; Dolby calibration oscillator; tape bias switch for standard and chromium-dioxide tapes; end-of-tape sensing; dual VU meters. Wow & flutter 0.15% (DIN) weighted. Sensitivity: mike 0.65 mV for 0 VU; line 150 mV; Output 1 V; headphone output 0.2 mV at 8 ohms. Response 35-14,000 Hz ±2 dB with standard tape. (S + N)/N 50 dB with Dolby off (60 dB at 4000 Hz with Dolby) ..... $299.95

### 4770 Cassette Recorder Deck

Has dynamic noise reduction circuit on playback and multi-function tape selector switch which adjusts bias, equalization, and VU meter level. Plays and records. Includes memory rewind, automatic shut-off, master record level, and pause lock ..... $199.95

### 4780 Cassette Recorder Deck

Has Dolby noise-suppression circuit and multi-function tape selector control which adjusts bias, equalization, and VU meter level. Plays and records. ..... $269.95

### 4350 Cassette Rcorder

Records and plays. Has memory rewind and built-in condenser microphone. Will operate from "D" cells, car/boat batteries, or a.c. power lines. The memory circuit permits automatic rewinding to a pre-selected point on tape. Features automatic shut-off, remote control, and standby switch for pause control ..... $99.95

# SECTION 3 8-Track tape machines

## AKAI

### CR-81D 8-Track Recorder Deck

Stereo design. Response 50-16,000 Hz ±3 dB; wow & flutter 0.25% rms; (S + N)/N 47 dB. Has

line output 1.23 V. Inputs: mike 0.5 mV & line 50 mV. Has automatic stop and continuous playback, two VU meters, and input for optional remote control. Universal power supply. 13⅝" × 5½" × 10⅜" D. ..... $169.95

### CR-81T 8-Track Recorder/Receiver

Same basic design as the CR-81D except has AM-FM stereo receiver added. FM sensitivity 3 μV for 30 dB quieting. 7 W/ch continuous power at 8 ohms (10 W/ch dynamic power at 5% THD). ..... $299.95

## BSR McDONALD

### RTS-28A 8-Track Player/Receiver

Cartridge player/AM-FM stereo receiver with 10 W/ch dynamic (IHF) power output. With two matching speaker systems ..... $209.95

### TD-8S 8-Track Playback Deck

Deck includes a 3-stage stereo preamp, 0.75 V output. Comes with cabinet and connecting

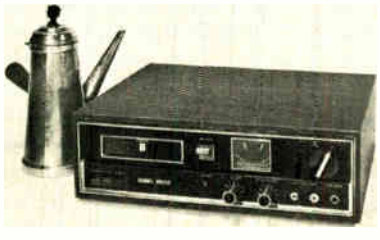
cables. 7⅜" W × 10½" × 3¾" ..... $49.95

**TD-8SW.** Same as TD-8S except has variable level-output control and wood-grain cabinet ..... $59.95

## CHANNEL MASTER

### 6327 8-Track Recorder Deck

Stereo design featuring a. c. bias & erase; re-

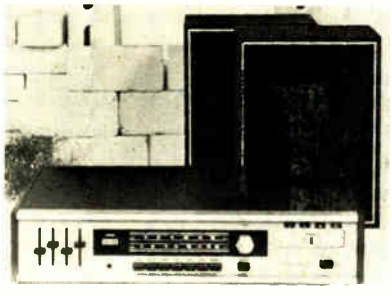


cording level meters; continuous play or eject; automatic shut-off; automatic repeat. Walnut cabinet ..... $129.95

**Model 6329.** Same as Model 6327 except has AM-FM stereo receiver and is supplied with two-way separately housed speaker system & two mikes ..... $239.95

### 6334 8-Track/Receiver System

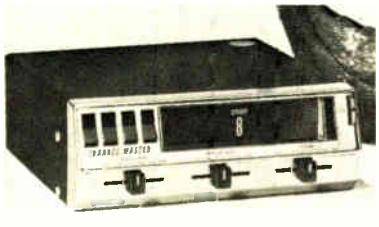
Combines an AM-FM stereo receiver, an 8-track



cartridge player, and a pair of separately housed two-way speaker systems. Has track indicator light and walnut cabinets .. $199.95

### 6292 8-Track Car Player

Stereo design. 8 W/ch dynamic power at 5% THD. Features slide-type controls, fine tuning



for tape head alignment, automatic & manual track change, track repeat, map lamp, and burglar-alarm switch ..... $69.95

## CLARICON

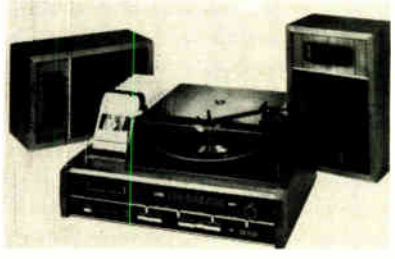
### 26-545 8-Track Player/Receiver

Combines an 8-track cartridge player with an AM-FM stereo receiver and two matched

speaker systems with exposed tweeters. Features nine push-button controls, four sliding controls, and full array of input/output connections. Output 30 W/ch dynamic power. FM sensitivity 3μV. Response 30-25,000 Hz. Feed slot has dust cover. Spkr. size 15" × 10" × 7". Control center 19" × 12" × 5". ..... $169.95

### 34-200 Player/Phono/Receiver

Combines an automatic turntable with magnetic cartridge and diamond stylus with a 30 W/ch dynamic power amp, AM-FM stereo tuner, 8-track cartridge player, and a pair of two-way air-suspension speaker systems (each with 8" woofer & tweeter with horn dispersion system).



Speaker cabinets 15" × 10" × 7" D. Control center 21" × 16" × 8½" D. Oiled walnut finish. Dust cover ..... $229.95

### 21-050 8-Track Recorder/Receiver

Combines an 8-track cartridge player with an AM-FM stereo receiver (30 W/ch dynamic pow-

er, 3 μV sensitivity, 30-25,000 Hz response), and two 2-way air-suspension speaker systems (8" woofer, tweeter, high-frequency dispersion horn). Speaker cabinets 15" × 10" × 7". Has inputs for mag. & ceramic cartridges; slide-type controls. Includes mike inputs for recording ..... $249.95

### 33-840 8-Track Player/Receiver

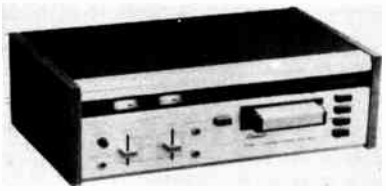
Combines an 8-track cartridge player with an AM-FM stereo receiver. Features 45 W/ch dynamic power; slide-type controls; main/remote speaker outputs. 2 μV FM sensitivity; response 20-30,000 Hz. Has mag. & ceramic phono inputs. 18" × 12" × 5". Walnut finished enclosure. ..... $219.95

## CONCORD

### F-128 8-Track Stereo Deck

Records and plays. Has two VU meters, a three-digit tape counter, slide record-level con-

# 3 8-Track tape machines



trols, fast-forward control, and headphone jack. Response 50-10,000 Hz, wow & flutter 0.3% rms, (S + N)/N 45 dB ..... $149.95

**CD-8 8-Track Player Deck**
Conventional design. Will play stereo cartridges. Has automatic & manual program selector and cartridge ejection. Wow & flutter 0.2%. Frequency range 100-8000 Hz. (S + N)/N 43 dB. Adjustable output 120 mV to 550 mV. 4¼" × 9½" × 9⅝" D ..... $49.95

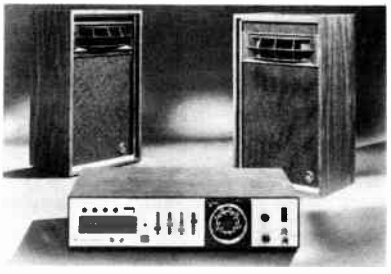
## DOKORDER

**MC-60 8-Track Recorder Deck**
Stereo design. Response 30-12,000 Hz; (S + N)/N 47 dB; wow & flutter 0.3% rms. Line input 60 mV; output 0.775 V. Circuit uses 12 transistors, two IC's, and 16 diodes. Universal power sup-

ply. 18½" × 14½" D × 8⅞" ..... $139.95

## ELECTROPHONIC

**947C 8-Track Recorder/Receiver**
Combines an 8-track record/playback stereo tape system and an AM-FM stereo receiver. 25



W/ch dynamic power into 8 ohms at 5% HD. Supplied with two separately housed speaker systems (10½" × 17⅝" × 7½" D) each with duo-cone speaker and horn diffuser. Walnut-grain finish. 17¾" × 4⅜" × 9⅞" D ..... $219.95

**TG472006 8-Track Playback System**
Combines an 8-track stereo tape system, an AM-FM stereo receiver, and a Garrard record changer. 50 W/ch dynamic power into 8 ohms at

5% HD. Supplied with two separately housed, pedestal-sphere speaker systems (19" H × 13" dia.) each with 8" high-compliance and 3½" duo-cone speakers. 24¼" × 10¼" × 16" D ..... $339.95

**MAGT820F 8-Track Playback System**
Combines an 8-track stereo tape player, an AM-FM stereo receiver, and a separately mounted (15⅝" × 14¼" D × 7⅛" H) Garrard record changer with magnetic cartridge. 50 W/ch dynamic power into 8 ohms and at 5% HD. Sup-

plied with separately housed speaker systems (13⅛" × 22⅝" × 10½" D) each with 10" duo-cone woofer, a 5¼" midrange, and a 4" horn tweeter. Walnut-grain finish. 19⅛" × 4⅝" × 11¾" D ..... $359.95

**TRD61 8-Track Tape Deck**
Record/playback stereo design. Features two record-level meters, tape monitor jack, and digital readout automatic channel indicator. With two dynamic mikes and stands. Walnut woodgrain finish. 13⅛" × 4⅛" × 7⅝" D ... $129.95

## GENERAL ELECTRIC

**SC1080 8-Track Tape System**
Combines an AM/FM stereo receiver, an 8-track tape player, and a pair of separately

housed speaker systems each with 6½" dual-cone speaker. 3½ W/ch dynamic (EIA) power at 5% HD ..... $129.95

**M8614 8-Track Portable Player**

Has built-in 3-way power (117 V a.c., 8 "D" cells, or car battery). 1.6 W/ch dynamic (EIA) power at 5% HD. Portable-type carrying case with removable lid & built-in stereo speakers ..... $79.95
**M8615.** Same but with AM/FM stereo tuner. 10⅛" × 13" × 7" ..... $129.95

**SC2300 8-Track System**
Combines an AM-FM stereo receiver, an 8-track tape recorder, and a pair of separately housed speaker systems. 7 W/ch (EIA) dynamic power at 5% THD. Has built-in automatic record level controls. Air-suspension enclosures (17" × 11" × 7") each house 8" woofer & 3" tweeter. Wow & flutter 0.3%. FM sensitivity 30 μV for 30 dB quieting. Comes with two microphones. 4¼" × 18⅛" × 10⅜" D ..... $259.95

**TA600 8-Track Deck**
Record/playback stereo design. Has all con-

ventional controls including dual VU meters. Supplied with two dynamic mikes ... $119.95

## GRUNDIG

**S850 AM-FM/8-Track System**
Combines an AM-FM stereo receiver and an 8-track record/play tape system. Wow & flutter 0.2% rms (playback). (S + N)/N 45 dB (playback). Response 100-8000 Hz. Has two record-level meters. 20½" × 5⅛" × 20½" D .. $259.95
**S860.** Same except with a BSR 4-speed automatic turntable ..... $299.95

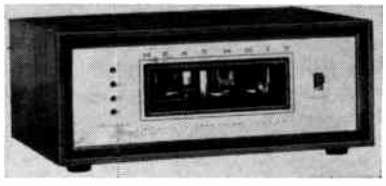
**RTV 2508 AM-FM/8-Track System**
Combines an AM-FM stereo receiver, an 8-track tape player, and a pair of separately housed speaker systems (10" × 16" × 6½") each with 6½" woofer & 2½" tweeter. 7 W/ch dynamic power at 5% HD ..... $169.95
**RTV 2508-P.** Same except with a BSR 4-speed automatic turntable & dust cover ... $199.95

**Studio 2600 8-Track Music Center**
Combines an AM-FM stereo receiver with two short-wave bands (3.5-8.5 & 9-22 MHz), a BSR C141 automatic turntable, and an 8-track stereo tape player. Comes with wood cabinet and dust cover ..... $329.95

**CR 815 8-Track Tape Deck**
Response 50-10,000 Hz; 2% HD; (S + N)/N 38 dB. Has line and mike inputs; line and headphone outputs. Includes record-level meter. 15⅛" × 4⅞" × 10⅜" D ..... $199.95

## HEATH

**GD-28 8-Track Stereo Deck**
Home playback deck for use in component



system. Response 50-10,000 Hz. Simulated walnut-finished cabinet measures 10⅜" × 4½" × 8¼" ..... $59.95

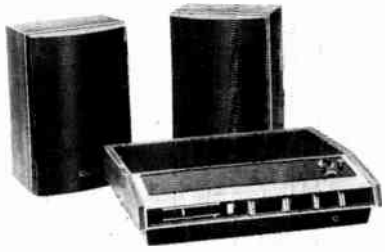
## HITACHI

**SP-2900 8-Track Recorder/Receiver**
AM-FM stereo receiver with a cartridge tape recorder and a pair of separately housed two-way speaker systems. 5 W/ch dynamic power at 5% THD. Features automatic stop/pause, fast-forward, tuning meter, and two VU meters. ..... $299.95

**TPQ-124 8-Track Player Deck**
Home player deck for use in audio systems. Has select/eject controls, program indicator

lights, and dust cover on loading slot. 11¼" × 10" × 4" ..... $79.95

**KSP-2810 8-Track Player/Receiver**
Cartridge player with AM/FM stereo receiver and matched speaker systems. Features slope-

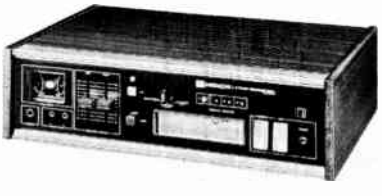


front enclosure, sliding tone and balance controls, a.f.c., tuning meter, stereo indicator, black-cut tuning dial. 18 W/ch dynamic power output ..... $219.95

**SDP-2820 8-Track/Phono System**
Combines a cartridge tape player, a BSR automatic record changer, and a pair of separately

housed speaker systems. Features 5 W/ch dynamic power at 5% THD. Supplied with dust cover ..... $269.95

**TRQ-134 8-Track Recorder Deck**
Stereo design featuring dual VU meters, slide-



type controls, fast-forward, and automatic stop. Comes with walnut cabinet ..... $149.95

## JVC

**ED-1102 8-Track Tape Deck**
Playback stereo design. Response 30-15,000 Hz; (S + N)/N −45 dB, wow & flutter 0.2% rms. Output 0.8 V. 3⅜" × 6¾" W × 9⅝" D .. $49.95

**ED-1261 8-Track Tape Deck**
Record/play stereo design. Response 30-14,000 Hz ±3 dB; (S + N)/N −50 dB; wow & flutter 0.2% rms. Record & erase bias 57 kHz. Has mike (0.8 mV) & line (80 mV) inputs. Line output 0 to 1 V. Has two VU meters, synchronous motor, pause button, and automatic start.

4⅝" × 16⅝" W × 10⅝" D ..... $149.95

## LAFAYETTE

**LSC-9000 Cartridge/Phono/Tuner**
Combines 4-speed Garrard 2025 automatic turntable with ceramic turnover cartridge and diamond stylus with 50 W/ch dynamic power amp, AM/FM stereo tuner, a pair of 3-way air-suspension speaker systems, and an 8-track cartridge player. Speaker cabinets measure 14⅞" × 11¼" × 6¾" D, each with 8" woofer and two 3½" tweeters. Unit has slide-type controls for balance, volume, bass & treble. Mike input. Control center measures 23½" × 9¼" × 15" D. Walnut vinyl cabinet includes a dust cover ..... $239.95

**RK-800A 8-Track Deck**
A home stereo playback deck designed to be

used with audio system. Response 30-12,000 Hz ..... $59.95

**SR-30 Cartridge Player/Receiver**
8-track cartridge player combined with an AM/FM stereo receiver and matching speaker systems. Has separate slide controls for tone and balance, a front-panel headphone jack, FM stereo light, plus a full complement of inputs and outputs. ..... $99.95

**RK-890A 8-Track Deck**
Stereo record/play design. Has stereo/mono mode switch, meter overload protection, sepa-

rate mike & aux. inputs and line-level outputs. Features sound-with-sound, dual VU meters. Sensitivity: mike 1 mV, aux. 100 mV. Response 30-12,000 Hz, wow & flutter 0.25%, output level 1 V max. With walnut metal case. 12" × 3¾" × 9⅛" D ..... $139.95

**LRK-855 8-Track/AM-FM Receiver**
Combines an AM/FM stereo receiver and 8-track record/playback unit with built-in 4-channel circuits. Has adapter circuits for deriving 4-channel sound from 2-channel sources. Basically is a 2-channel stereo recorder and playback unit. 7½ W/ch dynamic (IHF) power at 0.2% HD at 1 W output. Response 20-20,000 Hz ±1.5 dB. Input sensitivity: mag.

phono 4 mV, ceramic 130 mV, aux. 275 mV. FM sensitivity 3.5 μ V. 4½" × 19½" × 13¼" ..... ..... $199.95

## LLOYD'S

**Y854 8-Track Tape Player**
Stereo, mono, or automatic design. Has illumi-

nated program indicator. Supplied with walnut-grained enclosure ..... $49.95

**M751 8-Track/AM-FM Phono System**
Combines an AM/FM stereo receiver, an 8-track tape player, a BSR turntable, and a pair of sepa-

rately housed air-suspension duo-cone speaker systems. Walnut-grained finished vinyl-clad enclosures with dust cover ..... $199.95

**2D37 8-Track/Phono/Radio System**
Combines a 4-speed BSR turntable, an 8-track cartridge player, an AM-FM stereo receiver, and

a pair of separately housed speaker systems. 17 W/ch continuous power. Air-suspension speaker design with 8" dual-cone woofer and tweeter (23⅛" × 12" × 11⅝"). Has mike input. Control center 23⅛" × 12" × 11⅝" D. Comes with dust cover ..... $199.95

**Y639 8-Track Deck**
Features stereo play/record design. Has two record-level meters, linear slide-type controls.

Supplied with two microphones. 4½" × 15" × 10½" D ..... $99.95

## 3 8-Track tape machines

### MAGNAVOX

**8869 8-Track Player Deck**
Stereo design. Response 40-10,000 Hz ±4 dB; wow & flutter 0.22%; (S + N)/N 40 dB. Features automatic program changer & continuous play. 9¾" × 3¾" H × 6¾" D. Walnut cabinet. $54.95
**8830.** Same except with automatic eject, program selector switch, and repeat play. 7¼" × 3¾" × 10" D ..... $64.95

**8835 8-Track Recorder Deck**
Stereo design. Response 40-10,000 Hz ±4 dB; wow & flutter 0.2%; (S + N)/N 42 dB. Features

mike inputs, automatic program changer, continuous play, program select & eject, and automatic level controls. 16½" × 4½" × 11" D ..... $129.95
**8870.** Basically the same but with right & left channel level controls and meters. 15¼" × 4" × 10" D. Walnut cabinet ..... $159.95

### MOTOROLA

**FH225HW AM-FM/Cartridge Player**
Combines stereo cartridge player with AM-FM stereo receiver and two speaker systems. 30

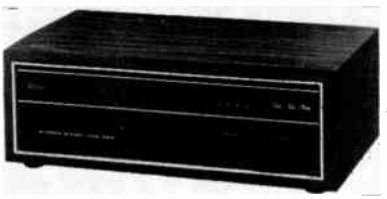
W/ch dynamic (EIA) output. Has stereo phone jack ..... $229.95

**GA15HW 8-Track Tape Deck**
Stereo design. Has conventional automatic

program advance; push-button channel selector; lighted program indicator ..... $59.95

### OLSON

**RA-308 8-Track Stereo Deck**
Playback only. Features automatic start and manual/automatic program changer. Program



indicator lights. Walnut cabinet. 11½" × 7¼" × 4¼". Audio cables included .... $49.99

### PENNEY, J.C.

**1759 8-Track/Phono/Receiver System**
Combines an AM-FM stereo receiver with 5 W/ch continuous power at 5% HD, an 8-track record/play tape machine, a BSR C-141 4-speed automatic turntable, an EPC-35TTCD phono cartridge, and a pair of separately housed speaker systems (16¾" × 11½" × 8½") each with 8" woofer & 2½" tweeter .. $339.95

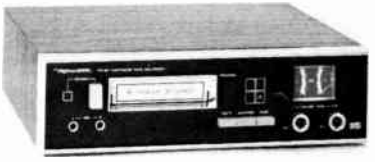
**1900 Phono/8-Track Player**
Combines an AM/FM stereo tuner, a BSR 4-speed minichanger, an 8-track tape player, and

two separately housed speaker systems, each with 6½" woofer & 2" tweeter. With dust cover ..... $179.95

### RADIO SHACK

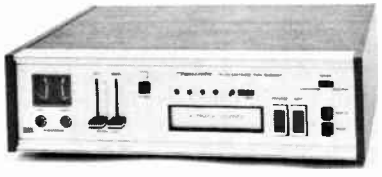
**14-913 8-Track Stereo Player**
Includes an 8-track tape player and two separately housed speaker systems (8" × 10½" × 8½" each). Has 2½ W/ch dynamic (EIA) power; 5% HD. Walnut cabinet. 15½" W × 10½" × 3¼" ..... $89.95

**TR-881 8-Track Recorder Deck**
Has VU meters for each channel and independent record-level controls. Features pause con-



trol and "Auto-Stop" switch that stops tape after four programs during record. Has mike input. Response 50-12,000 Hz; wow & flutter 0.3% rms. Oiled walnut wood case with brushed aluminum panel. 17¼" × 5" × 9⅜" .... $99.95

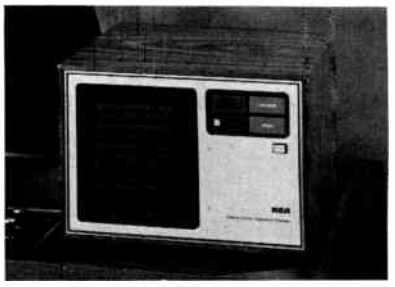
**TR-800 8-Track Recorder Deck**
Has dual VU meters with "Glide Path" level controls, pause control, "Auto-Stop" switch, and mike inputs. Response 50-15,000 Hz; wow



& flutter 0.2% rms. Walnut wood cabinet with brushed aluminum front panel. 15¹¹⁄₁₆" × 10³⁄₁₆" × 4¼" ..... $139.95

### RCA

**MYC555 8-Track Changer Deck**
8-track stereo tape changer which plays up to



five 8-track stereo cartridges in sequence automatically through any console or compact stereo system equipped with tape jacks. Can provide over six hours of uninterrupted music. Automatic and manual cartridge and track selection. Automatic shut-off after last cartridge. Walnut-grained vinyl cabinet on reinforced wood fiber. 8⅞" × 12½" W × 10⅝" D ..... $169.95

**VYC950 8-Track Tape Changer/AM-FM Receiver**
Three-piece stereo sound center with 8-track tape changer which provides more than six

hours of uninterrupted music and AM-FM stereo receiver. Tape changer magazine will hold up to five cartridges which can be played in sequence automatically or selected manually. Two closed-back speaker enclosures (15½" H × 9" W × 6¾" D), each housing 6½" woofer and a tweeter. Cabinets of walnut-grained vinyl and reinforced wood fiber. Control center 8⅞" H × 15⅞" W × 10⅝" D ..... $329.95

**VYC520 Compact with 8-Track Player**
Same basic features and dimensions as VYC720 (see Cassette section) but with 8-track cartridge tape player rather than cassette player/recorder ..... $229.95

**YZD-588 8-Track Player**
Features automatic and manual track selec-

tion. White and rosewood finish. Supplied with two 4" speaker systems ..... $97.95 to $99.95

**VS-6026W Phono/Receiver/8-Track System**
Combines 4-speed record changer with ceramic cartridge and diamond stylus; a 25 W/ch dynamic power amp with 5% THD at 8 ohms (response 40-20,000 Hz); an 8-track tape player; an AM-FM stereo tuner section; and a pair of two-way air-suspension speaker systems (10" H × 20" W × 7½" D) each with 8" woofer & 3½" tweeter. Control center 10¼" H × 23⅛" W × 14⅝" D. Supplied with dust cover and tape storage space. Oiled walnut. . $399.95 to $419.95

### SONY

**HP-238 8-Track/Phono/Radio System**
Combines an 8-track stereo tape recorder, wow & flutter 0.25%, fast-forward & rewind; a BSR 4-speed automatic turntable with automatic shutoff, crystal cartridge, and hinged dust cover; an AM-FM stereo receiver, 18 W/ch dy-

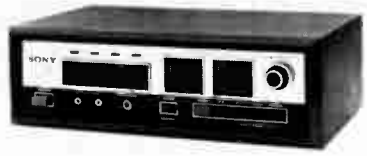
namic power into 8 ohms and at 5% HD. Response 40-40,000 Hz ±3 dB at 1 W. Has main/remote speaker switch and is supplied with two Sony 2-way SS-210A speaker systems (each with 6½" woofer & 2" tweeter). Walnut-grained wood cabinets. 9⅞" × 23⅛" × 17¼" D ..... $349.95

**HST-118A 8-Track Player/Receiver**
Same as Model HST-119 (see "Cassette" section) except has an 8-track tape player instead of a cassette recorder ..... $179.95

**HP-148A 8-Track/Phono/Receiver**
Same as Model HP-149A (see "Cassette" section) except has an 8-track tape player instead of a cassette recorder ..... $229.95

## SONY/SUPERSCOPE

**TC-228 8-Track Recorder Deck**
Stereo design. Response 30-13,000 Hz; (S + N)/N 45 dB. Bias frequency 95 kHz. Wow & flutter



0.17%. Has two VU meters, one d.c.-type motor. Aux. (70 mV sensitivity) & mike (—70 dB sensitivity) inputs & line output (0.5 V sensitivity). Features automatic total mechanism shut-off. Walnut case. 14⅜" × 4¾" × 8¾" D ... $169.95

## SYLVANIA

**MST2736W Phono/8-Track/Receiver**
Combines a Garrard automatic turntable with Pickering magnetic cartridge, viscous-damped cue/pause control, and anti-skating device; an

AM-FM stereo receiver; an 8-track stereo tape player; and a pair of sealed air-suspension speaker systems (18" × 11¼" × 9" D) each with 8" woofer and two 3" tweeters. Has built-in Phase Q4 matrix to synthesize regular two-channel stereo program material. 20 W/ch dynamic power at 1% HD (12½ W/ch continuous). Power bandwidth 25-20,000 Hz; response 25-20,000 Hz ±1½ dB. FM sensitivity 2.5 μV for 30 dB quieting; capture ratio 5.5 dB. Walnut cabinets with dust cover. Control center 9¼" × 23½" × 15¾" D ..... $319.95

**ET2750W 8-Track Tape Deck**
Playback-only design with automatic start/stop.

Output 0.5 V/ch. Response 40-12,000 Hz. Wow & flutter 0.3% rms. 7⅝" × 8" D × 4⅛" H. $59.95

## TELEX

**48H 8-Track Changer**

Selects at random 16 hours of continuous, non-repetitive sound. Switches and selects 12 stereo 8-track cartridges. 5 W/ch continuous into 8 ohms. Third harmonic distortion less than 2% at 4 W. Supplied with dust cover. 18¼" × 9" H × 16¼" D ..... $299.95
Optional matching speakers Sp 3-H Pair $69.95
**Model 48D.** Deck only with 1 V preamp output. Response 40-12,000 Hz, (S + N)/N 42 dB, flutter 0.2% max. ..... $249.95

## V-M

**569 Phono/8-Track System**
Combines a V-M 4-speed "Stere-O-Matic" record changer with 10" turntable and flipover sapphire/diamond ceramic cartridge, an 8-track stereo cartridge player, and a pair of separately housed speaker systems, each with 6" × 9" oval speaker. Amp. 2 W/ch continuous power at 5% HD. Response 60-15,000 Hz ±3 dB. Overall size 10" H × 21" W × 14¾" D (closed)

### NOTICE TO OUR READERS

***We consider it a valuable service to our readers to continue, as we have in previous editions of the TAPE RECORDING & BUYING GUIDE, to print the prices submitted by the manufacturers for items described as available at press time. With few exceptions, prices submitted by manufacturers should be considered "net."***

***We are aware that prices vary across the country in different trading areas. It is obvious that we are not in a position to quote local prices for the various trading areas in the United States on each of the items listed. Accordingly, we are quoting the price furnished to us by the manufacturer or distributor, for each of the products, although it may be possible to purchase some items in your trading area (depending on where you are) at a price lower than that listed in this Guide.***

***We would also like to point out that almost all manufacturers' and distributors' prices are subject to change without notice.***

# 3 8-Track tape machines

..... $159.95

**517 8-Track/Phono/Radio System**
Combines an automatic turntable with dust cover, an 8-track stereo tape player, an AM-FM

stereo receiver, and a pair of separately housed speaker systems. 15 W/ch (EIA) at 5% THD .....$299.95

## WEBCOR

**1521 8-Track Stereo Player**
Features 25 W/ch dynamic power at 5% THD (5 W/ch continuous power with both channels driven). Has conventional controls & comes with pair of SP-9 two-way bass-reflex speaker systems (each with 6½" woofer & 2¼" h.f. radiator, mechanical crossover). Walnut grain. 13¾" × 4¾" × 9½" ..... $89.95

**12-8608 8-Track/Phono/Receiver**
Combines a Garrard 4-speed automatic turntable with cueing lever, dust cover; an AM-FM stereo receiver; an 8-track cartridge player; and a pair of SP-44 air-suspension speaker systems (each with 8" woofer, 2¼" high-freq. radiator, 3" mid-range, and exponential horn with 1¼" driv-

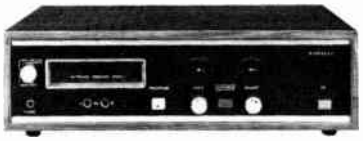
er). 25 W/ch dynamic power at 5% THD (5 W/ch continuous power with both channels driven). Has main/remote speaker switch and storage for five 8-track tapes. 24" × 16" × 9". Walnut-grain wood cabinet ..... $259.95
**12-8615.** Same as 12-8608 except with pair of SP-36 3-way speaker systems (each with 6½" woofer, 2¼" high-freq. radiator, and exponential horn with 3" driver for mid-range).. $229.95
**12-5025.** Same as 12-8615 except without the Garrard changer ..... $179.95
**12-8508.** Same as 12-8608 except different styling. Has black-out dial ..... $239.95
**12-8505.** Same as 12-8508 except with SP-36 3-way speaker systems ..... $199.95

## WESTBURY

**806 8-Track/AM-FM Player**
Portable design. Operates from 117-volt a.c., self-contained batteries, or 12-volt car or boat

battery. Combines player with AM/FM stereo receiver and two 8-ohm speaker systems. Features push-button function control, automatic stereo switching with stereo indicator light, and slide controls for stereo balance and tone. Comes with car/boat power cord, 8 "D" cells, and a.c. power cord. Response 40-12,000 Hz. 13½" × 9½" × 6½" D ..... $89.95

**4100 8-Track Record/Play Deck**
Records or plays 8-track stereo cartridges. Features a selector switch which permits



choice of repeat, continuous, automatic stop (1, 2, 3 & 4), and automatic stop (1 through 4) functions. Has individual volume controls for left and right channels, level meters, fast-forward, and a stereo headphone jack. Playback response 50-10,000 Hz +4 dB, overall response 60-8000 Hz +6 dB, wow & flutter 0.3% rms, (S + N)/N 40 dB. Output 0.775 V. Microphone and auxiliary inputs. 15⅝ W" × 10" D × 4½" H ..... $99.95

**6100 8-Track Player/Receiver**
Combines 8-track stereo player with AM/FM stereo receiver. Response 80-10,000 Hz ±3 dB, wow & flutter 0.35%, (S + N)/N 35 dB. 2½ W/ch dynamic (EIA) power at 5% HD. Has two separate speaker systems (12" H × 9" W × 5" D) each with 6½" woofer and 2½" tweeter. Has automatic FM stereo switching, record-changer input jacks, a.c. outlet. Control center 16" W × 9½" D × 4½" H ..... $99.95

**7100 8-Track Player/Receiver**
Combines an 8-track stereo tape playback unit

with an AM/FM stereo receiver. Has tuning controls, selector switch, slide-type volume, bass & treble controls, phono input jack. Includes stereo beacon lamp and channel indicator. 19¾" W × 9¾" D × 4¾" H. Two matched speaker systems each with 6½" × 2" tweeter with 6" exponential horn housed in walnut wood cabinets (14" H × 9" W × 4" D) .. $129.95

**8100 8-Track Player/Receiver**
Combines an 8-track stereo player with an AM/FM stereo receiver, 10 W/ch continuous

power, 50 W/ch dynamic at 5% HD. Features graduated treble and bass controls and phono/tape input jacks. Has tuning meter, separate loudness control, a.f.c. switch. Comes with two separately housed speaker systems (18" H × 12" W × 8¼" D) each with air-suspension speaker with exponential horn. Control center 18" H × 4" W × 8" ..... $199.95

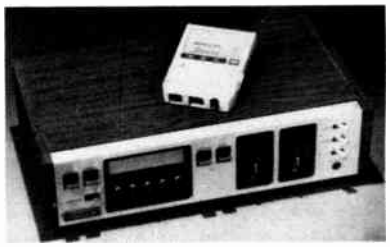
**9000 8-Track Player/Receiver**
Combines an 8-track stereo player with an AM/FM stereo receiver. 20 W/ch continuous power at 1% distortion (100 W/ch dynamic at 5% HD). Features automatic stereo switching, speaker damping controls, contour controls, tuning meters, bass & treble controls. Has tape monitor switch, a.f.c. switch. Two separate air-suspension speaker systems with exponential horns and crossover network (17½" H × 11½" W × 7½" D). Control center 20⅛" W × 13¼" D × 5½" H ..... $279.95

## WOLLENSAK

**8055 8-Track Recorder Deck**
Features record/play of 8-track stereo cartridges; automatic "on-off"; automatic eject

after playing one or all tracks; automatic record level; time counter; pause control; fast-forward; dual VU meters. Frequency response 30-15,000 Hz. Wow & flutter 0.25%. (S + N)/N 50 dB. Line output 1 V at 0 VU. Sensitivity: mike 25 mV; aux. 80 mV. 17⅜" × 4⅞" × 10½". Walnut cabinet ..... $169.95

**8050-A 8-Track Stereo Tape Deck**
Record/play deck for use in component systems. Has special cueing method which as-



sures that tape is always at the beginning when unit is placed in record mode, automatic eject to prevent accidental erasure of previously recorded material, pause lock, fast-forward, dual illuminated VU meters, switchable automatic-level control, stereo headphone jack. Response 30-15,000 Hz, (S + N)/N better than 50 dB ..... $159.95

# SECTION 4 4-channel components

## AKAI

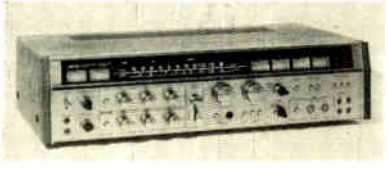
### CR-80D-SS 4-Ch. 8-Track Recorder Deck

Features 2- or 4-channel play/record. Response 30-16,000 Hz ±3 dB. Wow & flutter 0.25% rms;

(S + N)/N 47 dB. Has four mike (0.5 mV) & line (50 mV) inputs; four record-level meters; universal power supply ..... $249.95

### AS-980 Four-Channel Receiver

42½ W/ch dynamic power (170 W total); 30 W/ch continuous power. Features CD4 with



front-panel separation controls, SQ logic and regular matrix so that any type of 4-channel sound can be reproduced. Unit is equipped with bass & treble controls, loudness control, low and high filter, AM-FM tuner, damper switches (to 10 dB or 20 dB), facilities for connecting three sets of speakers. Has two phono inputs: one set for CD4 and one for normal 2-channel use; two tape inputs for dubbing from one tape recorder to another. Remote balance control and volume control optional . $699.95

### 1730D-SS 4-Channel Tape Deck

Features surround stereo. Four-track, 4 & 2 channel play and record with two erase heads

(2-channel & full track) for compatibility with 2-channel stereo. Features automatic shutoff, pause control, universal voltage selector, and two speeds (7½, 3¾ ips). Response 30-22,000 Hz ±3 dB, wow & flutter 0.12% rms, dist. 1.5%, all at 7½ ips. Has mike (0.4 mV) and line (40 mV) inputs plus line (1.23 V) output. 16½" × 18" × 9½" ..... $349.95

### GX-280D-SS 4-Channel Tape Deck

Play/record design for 2 and 4 channels. Fea-

tures 4 heads, 3 motors, automatic reverse, and sound-on-sound facilities ..... $649.95

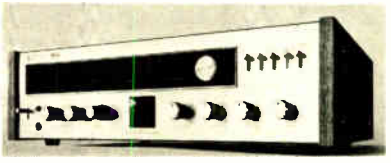
### 1800D-SS 4-Channel Tape Deck

Combines a reel-to-reel 2 or 4-channel, 4-track stereo recorder and an 8-track 2- or 4-channel cartridge machine. Has four record level meters and all necessary 4-channel controls. Reel-to-

reel tape speeds 1⅞, 3¾ & 7½ ips; wow & flutter 0.12% rms at 7½ ips. Response 30-22,000 Hz ±3 dB at 7½ ips. Has four mike (0.8 mV) & line (80 mV) inputs. Universal power supply. 16⅞" × 17⅞" × 9⅝" D ..... $499.95

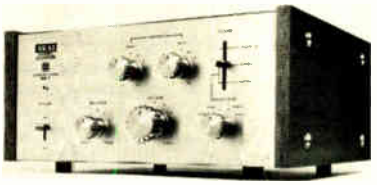
### AS-8100S 4-Channel AM-FM Receiver

Designed for either 2- or 4-channel operation. 30 W/ch dynamic power into 4 ohms; 18 W/ch continuous power at 8 ohms (22 W/ch at 4 ohms). For 2-channel power is 36 W/ch continuous at both 4 & 8 ohms. Power bandwidth 20-30,000 Hz at 8 ohms. HD 0.1% at 8 ohms. Re-



sponse (aux.) 20-100,000 Hz ±1.5 dB at 1 W. FM sensitivity 2 μV for 30 dB quieting; capture ratio 1.5 dB. Input: mag. phono 3 mV; aux. 150 mV; tape monitor (DIN/Pin) 150 mV. Has joystick-type 4-way balance control & universal power supply. Features built-in 4-channel matrix decoder. 19¼" × 7" × 14½" D .... $399.95

### SS-1 4-Channel Decoder/Adapter

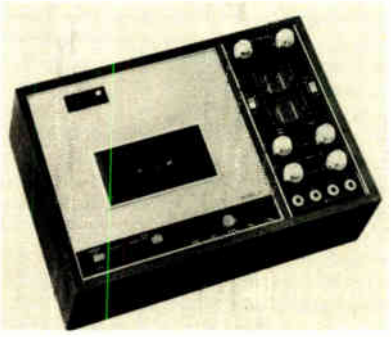


Designed to play back any form of matrixed or discrete 4-channel program material. . $99.95

## ASTROCOM/MARLUX

### 307 4-Channel Cassette Deck

Deck features play and record. Response 30-12,000 Hz, wow & flutter 0.14%, (S + N)/N



46 dB. Has hysteresis motor, four VU meters, counter, eject button, automatic reverse and shutoff, pause control, bias switch, mike & line inputs. Remote control optional extra ..... under $500.00

### 711 4-Channel Deck

Two-speed (7½-3¾ or 15-7½ ips), 4-head, 4-channel, 3-motor deck. Will handle up to 10½" reels. Response 20-20,000 Hz at 7½ ips, wow & flutter 0.07% at 7½ ips, (S + N)/N 60 dB, 0.9% THD at 1 kHz & 0 VU. Has 4 low-impedance mike and 4 high-impedance line inputs; 4 low-impedance outputs with master gain control. Features synchronous recording on all 4 channels and has built-in mixing facility ..... under $2000.00

# 4 4-channel components

## BSR-METROTEC

### SDW-Q 4-Channel Decoder

Universal design for both "SQ" and EV-4 quadraphonic records. Will also synthesize 4-channel effects from 2-channel stereo sources. Has master volume and front/rear balance controls; matrix mode selector; tape monitor circuit ..... $69.95

### SD4A-Q 4-Channel Decoder/Amp

Combines a universal decoder for both "SQ" and EV-4 quadraphonic discs with a 2-channel power amp. To be used with your present 2-channel stereo system for 4-channel operation. Power output 15 W/ch (dynamic power) into 8 ohms (10 W/ch continuous power). HD 0.8%. Power bandwidth 15-50,000 Hz; response 10-50,000 Hz ±2 dB. Sensitivity 150 mV. Will synthesize 4-channel effect from 2-channel stereo sources ..... $149.95

## CHANNEL MASTER

### 6294 4-Channel 8-Track Car Player

Features 2- or 4-channel reproduction; 4-way balance; slide-type controls; manual track selector; repeat switch; built-in automatic tape head cleaner. 6 W/ch dynamic power at 5% THD. Supplied with burglar alarm switch in mounting bracket. 2½" × 5⅜" × 7½" D. .$99.95


## CLARICON

### 21-400 Quadraphonic System

Combines an 8-track, 2- and 4-channel tape player; an AM-FM stereo receiver with four channels of amplification; and four separately housed speaker systems (each a two-way air-suspension type with 8" woofer, tweeter, & horn dispersion). Speaker cabinets 15" × 10" × 7". Features 30 W/ch dynamic power and 2.5 μV FM sensitivity. Inputs for mag. and ceramic phono cartridges. Will also decode matrixed 4-channel phono discs. Control center 20" × 12" × 5". Walnut finish ..... $299.95

## CLARK, DAVID

### 4 CH-A Headset

Combination design. Can be used as a regular 4-channel headset or with a decoder can be used to synthesize 4-channel response from any 2-channel program source. Has high-level output at 30 Hz and uniform frequency response up to 16,000 Hz ..... $80.00
With DC-2A decoder ..... $95.00

## CONCORD

### CD-8-4 4-Channel, 8-Track Tape Deck

Designed as either 2- or 4-channel cartridge tape player. Wow & flutter 0.15%. Response 100-9000 Hz; (S + N)/N 44 dB; 1.5% THD at 1000 Hz. Output adjust 500 mV. 4" H × 8¾" W × 10½" D. Walnut cabinet ..... $99.95

### CSQ-2-4 SQ Decoder

Designed specifically to reproduce SQ matrixed program material. Will also synthesize regular 2-channel stereo records. Gain 1.3 dB. Response 20-20,000 Hz. Input imp. 1 megohm. Dist. 1% THD max. Must be connected at output of a preamp. 3¼" H × 9¾" W × 7" D. Walnut cabinet ..... $79.95

## CROWN INTERNATIONAL

### CX844 Tape Recorder

Three-speed (15, 7½, 3¾ ips), 4-channel, 4-track, 3-motor design. Will handle up to 10½" reels. Has 3 heads. Response 20-25,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. Features braking, pause control, four VU meters, optional remote record, and automatic photocell shut-off. ..... $2880.00

### SX744 Tape Recorder

Two-speed (7½ & 3¾ ips), 4-track, 4-channel, 3-motor design. Will handle up to 10½" reels. Has 3 heads. Response 20-25,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. Features braking, pause control, four VU meters, and automatic shut-off. ..... $1895.00

## DOKORDER

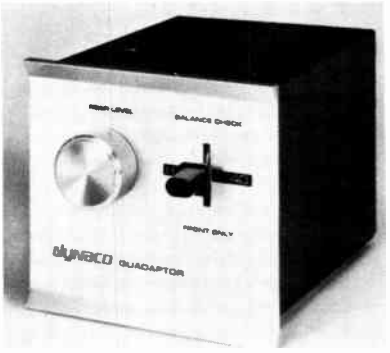
### MR-800Q 4-Channel AM-FM Receiver

Compatible with matrixed, discrete 4-channel or 2-channel stereo. Has E-V "Phase II" matrix decoder. 30 W/ch (120 W total) continuous power into 8 ohms & at 0.5% THD. Output of amps can be bridged for 60 W/ch 2-channel output. Has aux, phono, and tape inputs. FM sensitivity 1.8 μV for 30 dB quieting. Ceramic filter in i.f. stages. Power bandwidth 30-45,000 Hz. 19⅞" × 6⅞" × 13⅝" D ..... $479.95

## DYNACO

### Quadaptor

The simplest type decoder for recovering 4-channel information from 2 channels. Does not require two additional power amplifier channels. Unit connects between speakers and power-amp outputs. Is a passive device. 4½" × 4½" × 6¾" D. Kit ..... $19.95
Assembled ..... $29.95




## ELECTROPHONIC

### 447C 2-or 4-Ch 8-Track Player

Combines an AM-FM stereo receiver with a 2- or 4-channel discrete 8-track tape player. 25 W/ch (100 W total) dynamic power into 8 ohms at 5% HD. Supplied with four speaker systems (10½" W × 7½" D × 17⅝" H) each with a duo-cone speaker & horn diffuser. Walnut. 20¾" × 4⅝" × 11¾" D ..... $329.95

### 466D 4-Channel System

Combines an AM-FM stereo receiver and a 2- or 4-channel 8-track tape player for playing back 4-channel discrete tapes or "SQ" matrix program material. 50 W/ch (200 W total) dynamic power into 8 ohms at 5% HD. Supplied with

four separately housed speaker systems (11" × 19" × 8⅛" D) each with duo-cone speaker and horn diffuser. Walnut finish. 20⅜" × 4⅜" × 12¼" D ..... $359.95

### 449G 4-Channel System

Combines an AM-FM stereo receiver, a 2- or 4-channel 8-track tape player for playing back 2-

or 4-channel discrete 8-track tapes or "SQ" matrix program material. Has separate volume controls for each channel. Supplied with four separately housed, pedestal-mounted speaker systems (9½" × 11½" × 5⅜" D) each with a 6½" duo-cone speaker. Walnut grain finish. 20¾" × 4⅝" × 11¾" D ..... $249.95

## ELECTROSTATIC

### ESS Satellite-4 4-Ch. Speaker System

Has a 12" woofer, four 6" mid-ranges, and four 2¼" cone tweeters; crossovers at 100 & 3000 Hz. Power required 10 W continuous capacity 50 W continuous. Response 30-20,000 Hz ±3.5 dB. Designed specifically for 4-channel operation, i.e., four small mid/high-frequency speakers are supplied plus a separate 100 W continuous bass amplifier, crossover with equalization, and woofer commode. 11" × 8" × 4" D. $499.00

## ELECTRO-VOICE

### EVX-44 Universal 4-Channel Decoder

Automatically provides correct decoding of all types of matrixed 4-channel program material.

Provides optional front-to-rear separation enhancement. Connects into hi-fi system between preamp & power amp or through tape jacks. Has inputs for 2- and 4-channel tape sources. (S + N)/N 70 dB below ¼ V. Gain is unity. Maximum input 4 V rms. Response 20-20,000 Hz ±1 dB. 2¾" × 8" × 7" D ..... $99.95

## FISHER

### 304 4-Channel AM-FM Receiver

Can be used for either 2- or 4-channel stereo. 25 W/ch dynamic power at 8 ohms (39 W/ch

into 4 ohms); 15 W/ch continuous power into 8 ohms (20 W/ch into 4 ohms). 0.5% THD from 20-20,000 Hz at rated power. Power bandwidth 12-30,000 Hz; response (aux.) 20-20,000 Hz ±2 dB. Usable FM sensitivity 1.8 μV for 30 dB quieting; capture ratio 1.2 dB. Power output when connected as a 2-channel amp is 38 W/ch continuous into 8 ohms with all channels operating and from 20-20,000 Hz at 0.5% THD. Has SQ decoder & dual monitor facilities. 21½" × 6⅞" × 16⅞" D ..... $329.95

### 404 4-Channel AM-FM Receiver

Same as Model 304 except power ratings: 38 W/ch dynamic into 8 ohms (50 W/ch into 4 ohms); 22 W/ch continuous into 8 ohms (28 W/ch into 4 ohms) at 0.5% THD from 20-20,000 Hz. For 2-channel stereo power is 44 W/ch continuous. Has joy-stick type master balance control, mid-range control & extra center-of-channel tuning meter ..... $429.95

### 504 4-Channel AM-FM Receiver

Same as Model 404 except power ratings: 50 W/ch dynamic into 8 ohms (80 W/ch into 4 ohms); 32 W/ch continuous into 8 ohms (40 W/ch into 4 ohms) at 0.5% THD and from 20-20,000 Hz. For 2-channel stereo power is 90 W/ch continuous. Has joy-stick type master balance control and additional tone controls ..... $529.95

### 40 4-Channel System

Combines an AM/FM stereo receiver, a 4-speed automatic turntable with magnetic cartridge, and a 4- and 2-channel 8-track tape cartridge

player. Includes matrixing circuit to provide 4-channel reproduction from conventional 2-channel programs. 25 W/ch (100 W total) dynamic (EIA) power at 5% HD. FM sensitivity 2.5 μV. 25" × 8¾" × 17½" D ..... $499.95
PC4 Dust cover ..... $19.95

### CP-100 4-Channel, 8-Track Deck

4- or 2-channel, 8-track playback. Response

50-12,000 Hz. 4⅝" × 10¼" × 10⅛" D .....
..... $169.95

### TX-420 4-Channel Converter

Designed to be used with present stereo systems to provide 4-channel reproduction. Has 4-channel preamps and 2-channel stereo power amp. Includes a 4- or 2-channel 8-track cartridge player and decoding (matrixing) system for producing 4-channel material from 2-chan-

nel conventional or encoded sources. 18 W/ch (2 channels) dynamic power into 8 ohms (15 W/ch continuous) at 0.5% HD. Power bandwidth 30-20,000 Hz. Sensitivity: tuner & aux. inputs 200 mV. 16⅝" × 4¾" × 11¾" D .....
..... $299.95

### 801 4-Channel Receiver

Similar to the Model 601 with an AM/FM stereo tuner and four power amps. 50 W/ch dynamic (IHF) power at 1000 Hz and 4 ohms (44 W/ch continuous power). Power bandwidth 20-25,000 Hz at 4 ohms and 0.5% HD. Sensitivity: mag. phono 2.7 mV, aux. #1 & #2 200 mV, tape monitor 300 mV. Features a matrixing circuit to provide 4-channel sound from conventional 2-channel sources. FM usable sensitivity 1.7 μV (IHF). 17" × 5¼" × 16½" D ..... $749.95

### 601 4-Channel Receiver

AM/FM stereo tuner with four separate power amps. 37½ W/ch dynamic power at 1000 Hz & 8 ohms (36 W/ch continuous power). Power

bandwidth 25-22,000 Hz at 0.5% HD. Sensitivity: mag. phono 2.7 mV, aux. #1 & #2 200 mV, tape monitor 300 mV. Features a matrixing circuit to produce 4-channel sound from conventional 2-channel program material. FM usable sensitivity 1.8 μV (IHF). 17" × 5¼" × 16½" D ..... $599.95

### QP-44 2/4 Channel Stereo Headphones

Response 20-18,000 Hz. Switchable 2-channel/4-channel operation. Sensitivity: 10 mV for average listening. Max. power 0.2 W. 8 ohms. 10-ft coiled cord. 20 ounces ..... $69.95

## GENERAL ELECTRIC

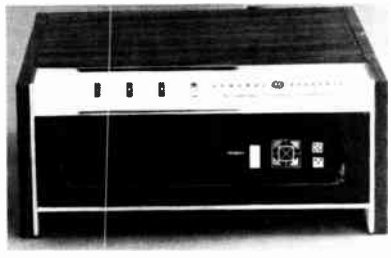
### QA40 4-Channel Decoder/Amp

Combines a 2-channel amplifier with a matrixed decoder. Will play discrete, matrixed, or synthe-

sized 4-channel program material. Has to be used with another 2-channel amplifier. .$99.95

### TA400 4-Channel 8-Track Deck

Will play 2- or 4-channel discrete tapes. Fea-



tures automatic or manual program sequencing ..... $89.95

### SC4200 4-Channel 8-Track System

Similar to the Model SC4000 except includes an AM-FM stereo receiver ..... $299.95

# 4 4-channel components

## HARMAN-KARDON

### 50+ 4-Channel AM-FM Receiver

Has four separate power amplifiers that can be ganged for 2-channel stereo. 12½ W/ch continuous power into 8 ohms with all four channels driven (18 W/ch for 2-channel stereo). THD 0.5% from 20-20,000 Hz. FM sensitivity 2.7 μV for 30 dB quieting. Has SQ matrix decoder. ..... $249.95
Optional cabinet ..... $21.95

### 75+ 4-Channel AM-FM Receiver

Has four separate power amplifiers that can be ganged for 2-channel stereo. 18 W/ch continu-

ous power at 8 ohms with all four channels driven (45 W/ch for 2-channel stereo). HD 0.5% from 20-20,000 Hz. FM sensitivity 2 μV for 30 dB quieting. Has SQ matrix decoder, main/remote speaker switch, and twin power supplies ..... $399.95
Optional cabinet ..... $35.00

### 100+ 4-Channel AM-FM Receiver

Has four separate power amplifiers that can be ganged for 2-channel stereo. 24 W/ch continuous into 8 ohms with all channels driven (57½ W/ch for 2-channel stereo). HD 0.5% from 20-20,000 Hz. FM sensitivity 1.9 μV for 30 dB quieting. Has SQ matrix decoder, main/remote speaker switch, two tuning meters, and twin power supplies ..... $499.95
Optional cabinet ..... $35.00

### 150+ 4-Channel AM-FM Receiver

Has four separate power amplifiers that can be ganged for 2-channel stereo. 30 W/ch continu-

ous into 8 ohms with all channels driven (70 W/ch for 2-channel stereo). HD 0.5% from 20-20,000 Hz. FM sensitivity 1.8 μV for 30 dB quieting. Has SQ matrix decoder, main/remote speaker switch, FM quieting, tuning meter. Design features twin power supplies for improved regulation ..... $599.95
Optional cabinet ..... $35.00

### 8+ 4-Channel, 8-Track Deck

Designed for both 2- and 4-channel playback. Features automatic switching for stereo or quadriphonic. Track selector lights, powered ejection of cartridge. Response 30-12,000 Hz. Has heavy-duty type a.c. motor. Supplied with cabinet ..... $169.95

## HEATH

### AA-2010 Four-Channel Amplifier

Will operate in mono, stereo, discrete 4-channel, or matrixed 4-channel with its built-in "universal" decoder. 50 W/ch (4 channels) dynamic power into 8 ohms (65 W/ch into 4 ohms, 30 W/ch into 16 ohms). Can be used to power two separate speaker systems or two 4-channel systems. Back-lighted front panel contains four calibrated VU meters with a meter-range switch covering three ranges: 0 VU at 35 W, 3.5 W, or 350 mW. Meters are used to balance output.

Kit ..... $359.95
Walnut cabinet ..... $24.95

### AD-2022 "Universal" Decoder

Provides 4-channel matrixed signals from any encoded material. Will also enhance current

stereo records, tapes, and FM-stereo broadcasts with a simulated 4-channel effect. Designed to be inserted between your stereo system's separate preamp and amplifier or by using the amplifier's or receiver's tape monitor inputs. 110-120 V, 50-60 Hz.
Kit ..... $39.95

## HITACHI

### TPQ-144 8-Track 4-Channel Deck

Designed for either 2- or 4-channel playback.

Has four preamplifiers & walnut cabinet. ..... $129.95

### CS-4000 4-Channel 8-Track Player

Automotive design featuring separate volume and tone controls, channel selector, 4-channel

indicator, 4-way balance controls. Has built-in 4-channel synthesizer to convert regular two-channel tapes into 4-channel. 7 W/ch dynamic power at 5% THD. Safety lock and key. 6⅝" × 2¾" × 7⅛" D ..... $139.95

### CS-1440 8-Track Auto Player

Conventional design but has speaker matrix to synthesize regular 2-channel tapes into 4-channel or will play 2-channel across the front or rear speakers. Has safety lock and key ..... $69.95

## JVC

### 4VN-770 4-Channel Integrated Amp

16 W/ch dynamic power at 8 ohms (25 W/ch at 4 ohms); 12½ W/ch continuous power at 8 ohms with all four channels driven and at 0.5% THD. 100 W/ch dynamic power at 4 ohms with 2-channel power bridging (BTL). Power bandwidth 10-30,000 Hz. Input sensitivity: mag. phono 2.5 mV; aux. & tape monitor 75 mV. Fea-

tures jacks for 4-channel headphones, built-in 4-channel decoder and synthesizer & optional remote control ..... $269.95

### 4VN-990 4-Channel Integrated Amp

66 W/ch dynamic power at 8 ohms (70 W/ch at 4 ohms); 35 W/ch continuous power at 8 ohms

(38 W/ch at 4 ohms) with all four channels driven & at 0.5% THD. 155 W/ch dynamic power at 8 ohms with 2-channel power bridging (BTL). Power bandwidth 10-30,000 Hz. Input sensitivity: mag. phono #1 & #2 2.5 mV; aux. & tape monitor 150 mV. Features 5-position tone control network for front and rear channel centering on 40/250/1000/5000/15,000 Hz. Can reproduce all four-channel discrete program material. Has built-in 4-channel decoder and synthesizer for reproducing 4 channels from regular 2-channel program material. Jack for optional remote control. 16⅝" × 5⅜" × 15⅜" ..... $469.95

### VN-5101 4-Channel Add-On Amp

Basically a 2-channel amplifier with 4-channel inputs to be used with your present stereo system. 34 W/ch dynamic power into 8 ohms (50 W/ch at 4 ohms); 22 W/ch continuous power into 8 ohms (24 W/ch into 4 ohms) with both channels driven and at 0.5% THD. Power bandwidth 30-30,000 Hz. Features 5-position tone-control network centering on 40/250/1000/5000/15,000 Hz. Has built-in synthesizer to produce 4-channels from regular 2-channel program material. Has jack for optional remote control. 10⅜" × 5⅞" × 14" D ..... $239.95

### 4RD-1405 4-Channel Tape Deck

Will play/record 2- and 4-channel reel-to-reel tape. Two speeds (3¾ & 7½ ips). Response 30-

18,000 Hz ±3 dB at 7½ ips with low-noise tape. (S + N)/N −52 dB; wow & flutter 0.1% at 7½ ips. 57 kHz bias & erase. Has two heads (record/play & erase), mike (0.5 mV) & line (80 mV) inputs, and line output (0-1.2 V). Features low-noise or standard tape switch. 7⅝" × 16" × 13½" D ..... $299.95

### 4MD-20X 4-Channel Cartridge

CD-4 design to be used with the RCA/JVC 4-channel disc and Shibata stylus. Response 20-

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# 4 4-channel components

60,000 Hz. Output 2 mV. Crosstalk 30 dB. Tracking force 1.5-2g ..... $69.95

### 4RD-1401 4-Channel Tape Deck

Will play/record 2- and 4-channel reel-to-reel tapes. Two speeds (3¾ & 7½ ips). Response

30-20,000 Hz ±3 dB at 7½ ips with low-noise tape. (S+N)/N −53 dB; wow & flutter 0.1% rms at 7½ ips. 95 kHz bias & erase. Three heads (record, play & erase). Has mike (0.3 mV) & line (80 mV) inputs & line output (0-1 V). Features low-noise or standard tape switch. 16⅛" × 17⅝" H × 7⅜" D ..... $449.95

### 4ME-4800 4-Channel 8-Track System

Playback design supplied with four separately housed (17⅞" × 9⅞" × 5½" D) two-way speaker

systems, each with 6½" woofer & 2" cone tweeter. 6.2 W/ch dynamic power at 8 ohms; 3.7 W/ch continuous power at 8 ohms with all four channels driven HD 3%. Response 40-20,000 Hz. Wow & flutter 0.25% rms. Has mag. phono (5 mV), ceramic phono (200 mV), and aux. (100 mV) inputs. Features joystick-type balance control ..... $269.95

### 4ED-1203 4-Channel 8-Track Deck

Will play back 2- and 4-channel cartridge tapes. Response 30-12,000 Hz ±3 dB. (S+N)/N −50 dB from peak level; wow & flutter 0.25% rms. Has line output 0.8 V. 10¼" × 4⅜" × 9⅞" D ...

..... $99.95

### 4ED-1205 4-Channel 8-Track Deck

Will play back 2- and 4-channel and record 2-channel cartridge tapes. Response 40-12,000

Hz ±3 dB. (S+N)/N −50 dB from peak level; wow & flutter 0.2% rms. Has line output (0-1 V) and mike (0.8 mV) & aux. (80 mV) inputs. Features fast-forward, four input-level controls, tape counter, automatic repeat and stop. 16⅝" × 4⅝" × 11" D ..... $199.95

### 4MM-4600 4-Channel AM-FM System

Combines an AM-FM 2- or 4-channel receiver with four separately housed speaker systems

(17½" × 10" × 5¾" D) each with 6½" & 2" speakers. 8 W/ch dynamic power into 8 ohms; 7 W/ch continuous power into 8 ohms with all four channels driven. FM sensitivity 2.2 μV for 30 dB quieting. Input sensitivity: ceramic phono 150 mV; tape 300 mV. Has joystick-type balance control. Can be used to play 4-channel discrete program material and has built-in synthesizer to produce 4 channels from standard 2-channel program material. 19" × 5⅝" × 15¾" D ..... $249.95

### 4VR-5404 4-Channel AM-FM Receiver

10 W/ch continuous power at 8 ohms; power bandwidth 20-30,000 Hz. Capture ratio 2 dB; FM sensitivity 2.2 μV. Can be used for discrete 4-channel reproduction and built-in matrix decoder for E-V, QS, RM, and SQ. 4 ch/2-ch tape monitoring, built-in joystick master balance control (PPC). 5⅜" × 19" × 13⅜" .$229.95

**4VR-5406.** Basically same as 4VR-5404 in design and styling except has built-in CD-4 discrete 4-channel record demodulator. Features automatic 4-ch/2-ch switching 5⅜" × 19" × 13⅜" D ..... $279.95

### 4VR-5414 4-Channel AM-FM Receiver

28 W/ch dynamic power at 8 ohms (30 W/ch at 4 ohms); 15 W/ch continuous power at 8 ohms

(20 W/ch at 4 ohms) with all four channels driven and at 0.5% THD. 65 W/ch dynamic power at 8 ohms with 2-channel power bridging (BTL). Power bandwidth 20-30,000 Hz. FM sensitivity 2 μV for 30 dB quieting; capture ratio 2 dB. Input sensitivity: mag. phono 3 mV; aux. 150 mV; tape monitor 150 mV. Can be used for discrete 4-channel reproduction and has built-in synthesizer for converting regular 2-channel program material into 4 channel. Also has 5-position tone control network for centering the two front speakers on 40/250/1000/5000/15,000 Hz. Has input for 4-channel optional remote control unit. 19⅜" × 5⅞" × 14⅜" D ..... $389.95

### 4VR-5445 4-Channel AM-FM Receiver

Basically same as Model 4VR-5414 in design & styling except has higher power and 5-position tone control network for both front & rear speakers. 34 W/ch dynamic power at 8 ohms (50 W/ch at 4 ohms); 21 W/ch continuous power into 8 ohms (23 W/ch into 4 ohms) with all four channels driven and at 0.5% THD. 68 W/ch dynamic power at 8 ohms with 2-channel power bridging (BTL). Power bandwidth 20-30,000 Hz. 22⅞" × 5⅞" × 14" ..... $529.95

### 5944 4-Channel Headphones

2- or 4-channel design. Response 20-20,000

Hz. HD 0.5% at 1 mV. Has a built-in phase changeover switch ..... $49.95

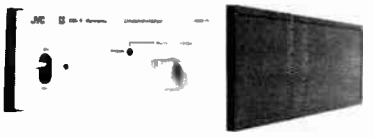
### 4VC-5244 4-Channel Record Changer

CD-4 design with built-in 4-channel demodulator. Has 4-pole outer rotor motor. Response 20-

16,000 Hz. Output 300 mV at 5000 ohms. Semi-adjustable separation control. 7⅞" × 15¾" × 17¼" D ..... $199.95

### 4DD-5 4-Channel Demodulator

Designed to be used with the CD-4 four-channel system. Can be added to any existing 2-channel



turntable & 4-channel reproducing system. Input 1.5 mV at 100,000 ohms impedance. Output 300 mV at 5000 ohms impedance. Response 20-16,000 Hz. Separation semi-adjustable. 3⅛" × 6⅞" × 11½" ..... $99.95

## KENWOOD

### KR-6140A 4-Channel Receiver

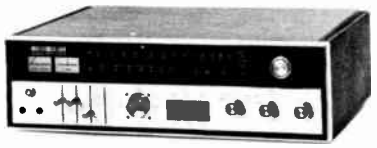
Features SQ, regular matrix decoder systems,

discrete (tape), and conventional 2-channel capability. 50 W/ch dynamic power into 8 ohms (80 W/ch into 4 ohms); 30 W/ch (120 W total) continuous power into 8 ohms with all channels driven (50 W/ch into 4 ohms) at 0.5% HD. Power bandwidth 20-30,000 Hz; response 15-40,000 Hz (aux.). FM sensitivity 1.9 μV for 30 dB quieting; capture ratio 2.5 dB. Input: phono 2.5 mV; aux. #1 & #2 150 mV; tape play A & B 150 mV. Features dual 4-channel tape dubbing capabilities, mike mixing, FM interstation muting. Has remote volume control for each of four channels. Universal power supply. 17⅜" × 6⅞" × 14⅝" ..... About $600.00

## KLH

### Fifty-Four 4-Channel AM-FM Receiver

25 W/ch (96 W total) continuous power into 4 or



8 ohms with all four channels driven (60 W/ch into 8 ohms in 2-channel stereo mode). Power bandwidth 16-30,000 Hz into 8 ohms; response 20-20,000 Hz at 1 W. FM usable sensitivity 1.8 μV for 30 dB quieting; capture ratio 2 dB. Input sensitivity: mag. phono 2.5 mV; aux. & tape monitor 250 mV. Has two ceramic filters in i.f. 17⅞" × 5½" × 14" D. Walnut grained cabinet ..... $525.00

## KOSS

### 4-Channel Quadrafones

All three versions are designed to be used for either 2- or 4-channel operation. Each earpiece has dual 1½" dynamic drivers. These are connected in parallel for regular 2-channel stereo use. 3.2 to 600 ohm operation. Dist. 0.5% at 109 dB SPL. Capacity 5 V continuous with provision for 14 dB transient peaks. Has balance control on each earpiece. 22 ounces.

**K/6LCQ.** Response 20-17,000 Hz. Has foam-

filled vinyl ear cushions for ambient noise isolation averaging 18 dB ..... $39.95

**KO/747Q.** Response 20-19,000 Hz. Has fluid-filled ear cushions for 40 dB ambient noise isolation ..... $55.00

**PRO/5Q.** Response 20-20,000 Hz. Has fluid-filled ear cushions for 40 dB ambient noise isolation ..... $70.00

### K2+2 4-Channel Headphones

Dynamic type. Features four separate drive elements (2 in each phone) for 4-channel reproduction, arranged in conventional 4-channel format. Has switch for conventional stereo operation. Frequency response 10-20,000 Hz. Sensitivity −87 dB ±3 dB SPL from each cup with 1 V continuous signal at 1000 Hz. Impedance 300 ohms each driver. For use with 3.2 to 600 ohm source impedances. Power input 5 V continuous maximum per phone. 10-ft. coiled

cord. 26 ounces. Fluid-filled ear cushions. Comes with carrying case ..... $85.00

## LAFAYETTE

### LA-524 4-Channel Decoder/Amplifier

Designed to convert regular 2-channel stereo systems into discrete and SQ matrix 4-channel stereo systems. Features built-in SQ decoding circuit for playback of Columbia and other SQ-decoded discs; firm's 4-channel matrixing cir-

cuit for regular 2-channel stereo program sources. Requires separate 2-channel amp & speakers. Features master front- and rear-volume control. Has fused speaker outputs, 30 W/ch dynamic power ..... $79.95

### RK-48A 4-Channel Tape Deck

Can be used as a 2- or 4-channel stereo, 8-track playback tape deck. Features a "Continu-

ous Repeat" track selector button. Has 1 V output. Hum & noise −49 dB. 4½" × 9½" × 10½" D ..... $97.95

### F-4400 4-Channel Headphones

Four separate 2¼" speakers, each in its own acoustically isolated chamber, deliver 4-chan-

nel sound from 4-channel amplifiers and receivers. Exclusive, patented baffle plate increases front-to-rear separation. Has 4-channel/2-channel switch. Built-in circuitry derives 4 channels from 2-channel sources. Frequency response 20-20,000 Hz. Impedance 4-16 ohms. Foam-filled vinyl leatherette earpieces and adjustable headband. With 6-ft cable connectors ..... $39.95

### SQR-40 4-Ch, 8-Track/Receiver System

Receiver features sensitive AM-FM stereo tuner, 4-channel "SQ-M" decoder, "Composer" derived 4-channel from 2-channel sources, discrete 4- & 2-channel 8-track tape player, and four separate amplifiers. Comes with four wide-range walnut speaker systems (8½" W × 14½" H × 5½" D). 21½" W × 11⅛" D × 4⅝" H. ..... $179.95

### SQR-20 4-Channel Receiver System

Receiver features sensitive AM-FM stereo tuner, 4-channel "SQ" matrix decoder, "Composer" derived 4-channel from 2-channel sources, discrete 4- & 2-channel when connected to a 4-channel tape source, and four separate amplifiers. Comes with four wide-range walnut speaker systems (8½" W × 14½" H × 5½" D). 16½" W × 10⅛" D × 4½" H. ..... $169.95

### 4-Channel Adapter for Cars

Derives 4-channel sound from present 2-channel car stereo tape system or FM radio. Front

panel contains rear-level speaker control, 2- or 4-channel mode switch, and front (L & R) speaker-level controls. If present system has four speakers, only adapter is required; if two speakers, two more speakers must be added. For 12-V negative ground systems. Includes two 3-ft., two 6-ft., and two 15-ft. connecting cables. 5½" W × 1¾" H × 2½" D. #99-85128 ..... $9.95
99-62994. Pair of 3" × 5" matching rear deck speaker systems ..... $7.10

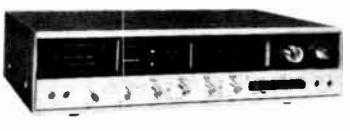
### LA-2525 4-Channel Amplifier

A full 4-channel amplifier with 7½ W/ch dynamic (IHF) power. Response 20-20,000 Hz

±1.5 dB. Includes matrixing circuit used to convert any 2-channel source material into 4-channel sound. Sensitivity: mag. phono 3.5 mV, ceramic phono 125 mV, tuner 500 mV, aux. 275 mV ..... $69.95

### LR-440 4-Channel System

Upgraded version of LA-2525 and with AM/FM stereo receiver added. FM sensitivity 1.65 μV (IHF), (S + N)/N 70 dB, capture ratio 1.5 dB. Response 20-20,000 Hz ±1.5 dB at rated output. Input sensitivity: mag. phono 3.5 mV, ceramic phono 140 mV, tape play 500 mV, aux. #1 &



#2 250 mV. Also includes "SQ Decoder" circuits for Columbia SQ 4-channel records. Has FM detector output jack for future FM 4-channel adapters. In simulated walnut metal case. 18½" × 13¾" × 4¾" ..... $339.95

### SQ-M 4-Channel Decoder

For reproducing 4-channel sound. Includes the company's "Composer Circuit" (similar to Dynaco system) to convert conventional 2-channel stereo sound sources into 4-channel repro-

# 4 4-channel components

duction. Also includes CBS matrixing circuits for playback of CBS 4-channel SQ Quadraphonic records. Has simulated walnut-finished case. 6" × 2⅞" × 7¼" D ..... $44.95

### LA-975 Integrated Amplifier

Features a 2-channel amplifier but does have an "SQ" logic decoder built-in for 4-channel sound (additional 2-channel amplifier required). 33 W/ch continuous power at 4 ohms. Power bandwidth 20-35,000 Hz; response 20-20,000 Hz ±1 dB. HD 0.07% at 1 W output. (S + N)/N −75 dB (high-level input); −60 dB (low-level input). Sensitivity: mag. phono 4.5 mV; ceramic phono 135 mV; tuner, tape monitor, and source 500 mV; aux. 250 mV. Has multiple-speaker switching. Overall size 13" W × 4⁹⁄₁₆" H × 10¼" D ..... $169.95

### LR-4000 AM-FM 4-Channel Receiver

Features "SQ" wave-matching full logic circuitry; "Composer" derived 4-channel for regu-

lar 2-channel program sources. 47½ W/ch continuous at 8 ohms & 1% THD. 75 W/ch dynamic power into 4 ohms. Power bandwidth 13-35,000 Hz; response 20-20,000 Hz ±1.0 dB at 1 W output. Input sensitivity: mag. phono 4 mV; ceramic phono 140 mV; tape play 500 mV. (S + N)/N −70 dB (high-level input); −60 dB (low-level input). FM usable sensitivity 1.65 μV for 30 dB quieting; capture ratio 1.5 dB. Has tape monitoring facilities (up to 4 channels); main/remote speaker switching for all four channels; 4-channel headphone jacks. Walnut cabinet. 21" W × 13" D × 5¼" H ..... $499.95

### LR-220 AM-FM 4-Channel Receiver

Features "SQ-M" decoding circuitry; "Composer" derived 4-channel for regular 2-channel program sources. 17.2 W/ch dynamic power at 4 ohms & 1% THD; 8.8 W/ch continuous power (35.2 W total). 0.125% THD at 4 ohms. Input sensitivity: mag, phono 4 mV; ceramic phono 150 mV; high-level 275 mV. (S + N)/N −70 dB (high level input); −55 dB (low-level input). FM sensitivity 2.5 μV for 30 dB quieting. Has 4-channel stereo headphone jacks; main/remote speaker switching for all four channels. Walnut cabinet. 15⅞" W × 11¼" D × 4⁷⁄₁₆" H .. $219.95

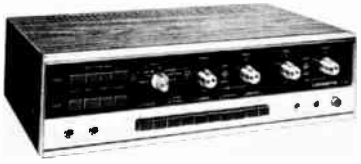
### SQ-L 4-Channel SQ Decoder

"SQ" logic decoder and 4-channel adapter. Permits playing 4-channel "SQ" records, 4-channel FM "SQ" broadcasts, and is compatible with all other 4-channel matrixed program

sources. Has 4-channel tape input and output jacks; two input sensitivity controls; master gain control for all four channels of amplification. 3" × 8¾" H × 8⅞" D ..... $79.95

### LA-64 4-Channel SQ Amplifier

Has built-in SQ logic/automatic gain control decoder. 23½ W/ch dynamic power at 8 ohms;



32½ W/ch continuous power at 4 ohms & at 0.8% THD. Power bandwidth 15-25,000 Hz. Input sensitivity: aux. 250 mV; mag. phono 3.5 mV; ceramic phono 125 mV; tuner & tape play 500 mV. Overall size 13½" × 4" × 9½" D ..... $199.95

### QD-4 4-Channel Adapter

Synthesizes 4-channel sound from regular 2-channel stereo records, tapes. Does not require

an additional stereo amplifier. Has 4-position function switch, rear level control, phono jacks. 5¾" W × 4⁹⁄₁₆" D × 2⅞" H ..... $19.95

## MARANTZ

### 2440 4-Channel Adapter/Power Amp

Is a two-channel stereo power amplifier to be used with your present stereo system for 4-

channel operation. Has four lighted level meters and circuits to synthesize regular stereo records. Will play any 4-channel discrete program material and has input for optional SQ decoder module. 20 W/ch continuous power into 4 or 8 ohms at 0.3% THD with both channels driven (10 W/ch into 16 ohms). Response 15-80,000 Hz ±2 dB; power bandwidth 10-50,000 Hz. Has input for optional RC-4 remote-control unit; 4-channel headphone outputs; tape monitor. 16⅞" × 5" × 14" D. Gold anodized front panel ..... $299.95

### 4060 4-Channel Integrated Amplifier

Complete four-channel control amp. Has circuits to synthesize 4-channel sound from 2-

channel stereo records, all necessary balancing controls, input jack for optional SQ decoder, and remote-control. 15 W/ch continuous power at 4 & 8 ohms and at 0.9% THD with all channels operating (7½ W/ch into 16 ohms). Response 20-20,000 Hz ±1 dB. Input sensitivity: 1.8 mV; aux. 180 mV. Features main/remote speaker switch; 4-channel headphone jacks. 14¼" × 4¾" × 12" D. Gold anodized front panel. ..... $299.95

### 4100 4-Channel Integrated Amplifier

Has complete 2- or 4-channel capability. 25 W/ch continuous power into 8 ohms and at 0.3% THD with all four channels driven (60 W/ch for 2-channel operation). Power bandwidth 15-50,000 Hz; response 15-80,000 Hz ±2 dB. Input sensitivity: mag. phono 1.8 mV; aux. 180 mV. Has inputs for 4-channel discrete programs, and circuits for synthesizing 4-channel sound from 2-channel stereo records or tapes. Has input jacks for optional SQ decoder & re-

mote-control; four lighted level meters; tape monitor for two tape decks. 15⅜" × 5¾" × 14½" D. Blackout meter panel & gold anodized front panel. ..... $499.95

### 4415 4-Channel Amp/Receiver

Provides essentially the same features and performance as the Model 4060 with the addition

of an AM-FM stereo tuner section. Sensitivity 2.8 μV for 30 dB quieting; capture ratio 2.5 dB. 16⅞" × 5" × 14¼" D ..... $399.95

### 4430 4-Channel Amp/Receiver

Provides essentially the same features and performance as the Model 4100 with the addition

of an AM-FM stereo tuner section. FM sensitivity 1.7 μV for 30 dB quieting; capture ratio 1.6 dB. Has both signal-strength and center-of-channel meters. 16⅞" × 5" × 14¼" D . $599.95

## MOTOROLA

### FH275HW 8-Track, 4-Channel Player

Will operate on 4-channel or conventional 2-channel stereo. 15 W/ch dynamic (EIA) power

at 5% THD. Supplied with four speaker systems, each with an 8" woofer & 3½" tweeter

(cabinets 10" × 13¼" × 8⅜" D). System response 20-20,000 Hz. Has novel electronic balancing grid for use in balancing 4 channels for any particular listening position in the room. Walnut cabinets. 22⅞" × 5⅛" H × 12⅛" D ..... $399.95

**FH411JW 4-Channel Receiver**

Will reproduce 4-channel discrete sound sources and synthesize any 2-channel program

material. 5 W/ch dynamic power at 5% THD. FM sensitivity 10 μV for 30 dB quieting. 22¾" W × 5½" × 11¾". Walnut finish ..... $199.95

**FH410HW.** Same as FH411JW except with four separately housed speaker systems (13¼" × 10" × 7¾" D) each with 5¾" speaker ..... $275.00

**FH480JW.** Same as FH410HW except with 4-channel 8-track cartridge tape player built-in. 5⅜" H × 29⅜" W × 11¾" D ..... $359.95

**GA48HW 4-Channel Cartridge Deck**

Playback only. 4- or 2-channel 8-track tape unit. Vinyl walnut-grained cabinet .... $99.95

## MURA

**QP-280 "Quadset" Headset**

Has 4-channel/stereo switch; 10-ft coiled cord with dual plugs marked for easy identification. Response 20-20,000 Hz. Power rating 0.2 W; impedance 8-16 ohms. Custom leather-type padding on earcups and headband ... $24.95

**QP-300 Deluxe "Quadset"**

Features two woofers and two tweeters in each earcup for a total of eight dynamic speakers. Electronic crossover network. Impedance 8-16 ohms. Frequency response 20-20,000 Hz ±5 dB. Maximum allowable input 500 mW. Comes with 6-ft cable, plugs marked for easy identification, and zipper carrying case ..... $69.95

## OLSON

**HF-180 4-Channel Synthesizer**

Passive device does not require a.c. power. Suitable for reproducing out-of-phase program material from any 2-channel stereo tape, disc, or stereo FM. 6¼" × 2½" H × 5¼" D ... $24.98

## PENNEY, J.C.

**1704 4-Channel 8-Track/Radio**

Combines an AM-FM stereo tuner with matrix adapter, an 8-track tape player with four numbered (1-4) separately housed speaker systems, each with a 6" round speaker, with 3 W/ch continuous sine-wave output at 5% HD. Walnut wood cabinets ..... $259.95

## PILOT

**310 4-Channel Integrated Amplifier**

Can be used for 2- or 4-channels. 30 W/ch (120 W total) continuous power at 8 ohms with all channels driven & at 0.5% THD. Power bandwidth 10-40,000 Hz; response 20-25,000 Hz ±1 dB. Input sensitivity: mag. phono 2.5 to 4.5 mV; aux. 300 mV; mike 1 mV; tape output 250 mV.

Features main/remote 2- and 4-channel speaker switch, mike mixing, built-in "Pilotone" for balancing four channels; four output level meters. Has 5-position mode switch for 4-channel discrete, CBS "SQ" decoder, Matrix-4 decoder, 2-channel stereo (double power), and mono operation. 18½" × 6½" × 17½" D .... $349.90

**365 4-Channel AM-FM Receiver**

15 W/ch (60 W total) continuous power at 8 ohms with all four channels driven & at 0.5%

THD. Power bandwidth 20-25,000 Hz; response 20-20,000 Hz ±1 dB. Input sensitivity: mag. phono 2.5 to 4.5 mV; aux. 300 mV; tape output 250 mV. FM sensitivity 2.5 μV for 30 dB (S + N)/N; capture ratio 2.5 dB. Has same 5-position switch as the Model 366 4-channel receiver and center-channel tuning meter. Walnut veneer wood cabinet. 18½" × 6½" × 17½" D . $379.90

**366 4-Channel AM-FM Receiver**

30 W/ch (120 W total) continuous power at 8 ohms with all four channels driven & at 0.5%

THD. Power bandwidth 10-40,000 Hz; response 20-25,000 Hz ±1 dB. Input sensitivity: mag. phono 2.5 to 4.5 mV; aux. 300 mV; mike 1 mV; tape output 250 mV. FM sensitvity 1.8 μV for 30 dB (S + N)/N; capture ratio 1.8 dB. Features main/remote 4-channel speaker switch, mike mixing, tape monitor, "Pilotone" for balancing speakers. Has 5-position mode switch for discrete, CBS "SQ", Matrix-4 decoder, stereo (double power), and mono operation. With walnut veneer cabinet. 18½" × 6½" × 17½" D. ..... $499.90

## PIONEER

**QT-2100 4-Channel Tape Deck**

8-track, 2- or 4-channel stereo playback de-

sign. Response 30-12,000 Hz, (S + N)/N 48 dB, wow & flutter 0.2%. Output 0.775 V at 50,000 ohms. 17" × 5¾" × 13" D ..... $249.95

**QM-800A 4-Channel Power Amp**

Features 42½ W/ch (170 W total) dynamic power at 8 ohms (60 W/ch into 4 ohms); 30

W/ch continuous power into 8 ohms with all four channels driven & at 0.5% HD (36 W/ch into 4 ohms). Power bandwidth 5-50,000 Hz at 8 ohms & 0.5% HD. (S + N)/N 90 dB. Response 8-60,000 Hz ±0.5 dB. Input sensitivity: 500 mV at 50 kohms, 1 V at 80 kohms, and 2 V at 105 kohms. Has four level meters, universal power supply, speaker switch. Amp could be used as four separate channels, or as a 2-channel, 2-way multiamp system with an electronic crossover network ..... $329.95

**QT-6600 4-Channel Tape Deck**

Reel-to-reel design for record/playback 4- or 2-

channel stereo. One motor drive with automatic reverse. Two speeds (7½, 3¾ ips), wow & flutter 0.12% at 7½ ips. Response 50-15,000 Hz ±2 dB 7½ ips, (S + N)/N 55 dB. Has mike (0.3 mV) and line (30 mV) inputs. Output 0.775 V at 50,000 ohms. 17" W × 18⅜" H × 8⅜" ..... $599.95

**QC-800A 4-Channel Preamp**

Has built-in SQ decoder and regular matrix decoder for synthesizing 4-channel reproduc-

tion from 2-channel discs or tapes. Design gives choice of three different 4-channel effects in addition to 4-channel discrete. Input sensitivity: phono #1 & #2 2.5 mV; tuner, aux. #1 & #2, tape monitor #1 & #2 150 mV. Recording output #1 & #2 150 mV. Has low and high filters, (S + N)/N (phono) 80 dB. Output voltage 2.5 V (4 V max.). Features tape-to-tape duplication and universal power supply. 17" × 5½" × 13¼" D ..... $269.95

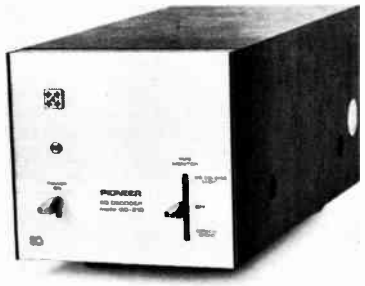
**QA-800A 4-Channel Integrated Amp**

Features 36 W/ch (144 W total) dynamic power into 8 ohms (51 W/ch into 4 ohms); 20 W/ch continuous sine wave into 8 ohms with all four channels operating & at 0.5% HD (24 W/ch into 4 ohms). Power bandwidth 15-50,000 Hz at 8 ohms & 0.5% HD. Response 8-70,000 Hz ±1 dB. Input sensitivity: mag. phono #1 & #2 2.5 mV; tuner, aux. #1 & #2, tape monitor #1 & #2 200 mV. Tape output #1 & #2 200 mV. Has SQ and regular matrix decoder built-in and will provide for four-channel discrete tapes or discs. Universal power supply. 17" × 5½" × 13¼" D ..... $369.95

**QD-210 SQ Decoder**

Translates all SQ-encoded sound into four-

# 4 4-channel components



channel stereo. Input sensitivity 200 mV; 0.3% HD. Response 20-20,000 Hz ±2 dB ( front side). Connects between preamp & power amp. Has tape and monitoring output jacks. Universal power supply. 5⅜" W × 5¾" H × 13¼" D. $99.95

### QL-600A 4-Channel Amp Adapter

Designed as a 2-channel integrated amp to be used with your present stereo system to develop four-channel reproduction. Includes decoding circuits for SQ and other matrixing sources and will synthesize regular stereo records. Has level meters & controls for all four

channels. Connects between tape recorder terminals and tape monitor of your present stereo system. 18 W/ch dynamic power into 8 ohms; 10 W/ch continuous power into 8 ohms with both channels driven and at 0.5% HD (12 W/ch into 4 ohms). Power bandwidth 20-30,000 Hz at 8 ohms & 0.5% HD. Response 20-20,000 Hz ±1 dB. Provides terminals for 4-channel discrete and 2-channel stereo. Has universal power supply. 17" × 5½" × 13¼" D ... $229.95

### QX-4000 4-Channel AM-FM Receiver

Capable of decoding all important types of matrixed program sources including SQ. 20 W/ch (80 W total) dynamic power into 8 ohms (27 W/ch into 4 ohms); 10 W/ch continuous power into 8 ohms with all four channels operating and at 1% HD (11 W/ch into 4 ohms). Power bandwidth 15-20,000 Hz at 8 ohms & 1% HD. Response 10-100,000 Hz ±3 dB. FM usable sensitivity 2.2 μV for 30 dB quieting; capture ratio 3 dB. Input sensitivity: mag. phono 2.3 mV; aux., tape monitor 200 mV. Tape rec. output 200 mV (DIN connector 35 mV). Has linear-type FM dial scale, inter-station FM muting, signal-strength meter, and universal power supply. 17¾" × 5¾" × 13¾" D ..... $349.95

### QX-8000A 4-Channel AM-FM Receiver

Capable of decoding all important types of matrixed program sources as well as SQ 2- and

4-channel tapes or discs...32½ W/ch (130 W total) dynamic power into 8 ohms (45 W/ch into 4 ohms); 22 W/ch continuous power into 8 ohms and at 1% HD with all four channels operating (27 W/ch into 4 ohms). Power bandwidth 15-100,000 Hz at 8 ohms & 1% HD. Response 5-100,000 Hz ±3 dB. FM usable sensitivity 2.2 μV for 30 dB quieting; capture ratio 3 dB. Input sensitivity: mag. phono #1 & #2 2 mV; mike 8 mV; aux. #1 & #2, tape monitor #1 & #2 170 mV. Tape rec. output 170 mV. Has mike input, FM inter-station muting, two tuning meters (signal-strength and center-of-channel tuning), and universal power supply. 20" × 6¾" × 15⅝" D ..... $549.95

## RADIO SHACK

### TR-284B Quadraphonic Player

8-track play only for 2- or 4-channel reproduction. Supplied with four separately housed speaker systems (7⅞" × 5½" × 9⅞" each). Walnut cabinets. 15" × 5" × 11¾" ..... $159.95

### Auto Q8 4-Channel Car Player

Will play 4- or 2-channel 8 track tapes. Mounts under dash. 12-volt d.c. negative-ground operation. Supplied with mounting bracket but less speakers. 7" × 9" × 4" ..... $99.95

### QA-680 4-Channel Integrated Amp

Has built-in universal matrix decoder. 17½ W/ch dynamic power (70 W total) at 8 ohms

(12½ W/ch continuous). Power bandwidth 20-25,000 Hz. Sensitivity: mag. phono 5 mV. Has jacks for 4-channel headphones and front & rear speaker switches. Walnut wood case with aluminum front panel. 4" × 14⅛" × 11¾". ..... $199.95

### Q-800 4-Channel 8-Track Deck

Will play/record 2- or 4-channel programs. Has "Auto-Stop." Tape head automatically senses

and adjusts to either 2- or 4-channel tapes. Walnut-grain wood cabinet with aluminum front panel ..... $89.95

### QTA-750 4-Channel AM-FM Receiver

Features built-in 4-channel amp and matrix decoder. 20 W/ch dynamic power at 8 ohms (15

W/ch continuous). Response 20-20,000 Hz ±1 dB; power bandwidth 20-25,000 Hz. HD 8% at full power. FM sensitivity 3.3 μV for 30 dB quieting. Has tape inputs, outputs, and monitor. Separate aux. input for discrete 4-channel Q-8 cartridges or reel-to-reel tapes. Has 4-channel headphone jack. Semi-blackout dial. Walnut wood cabinet with gold front panel. 13" × 19" × 5¾" ..... $259.95

### Nova-44 4-Channel Headphones

Quadraphonic/stereophonic dynamic design. Each earcup has separate speakers for two

channels. Dual plugs provided for stereo or 4-channel use. Ported earcups. Frequency range 20-20,000 Hz; 8 ohms. 15-ft coiled cord ..... $39.95

### 494 4-Channel Tape Deck

Three-speed (7½, 3¾ & 1⅞ ips), four-track, three-head design. Has four discrete channels,

four VU meters, and level controls. Response 50-18,000 Hz; wow & flutter 0.13% rms at 7½ ips. Records discrete 4-channel and standard 2-channel stereo. Walnut wood cabinet with brushed aluminum front panel. 16" × 14⅜" × 6⅝" ..... $299.95

## RCA

### YZD444 4-Channel 8-Track Player

4-channel, 8-track stereo player with separate bass, treble, and stereo balance controls; depth control for front-to-back balance. Automatic operation, automatic 2- and 4-channel sensing, and automatic or manual track selection. Jacks for external amplifier and speaker system. Four separate speaker systems (18" H × 11" W × 7" D) each with 8" woofer & tweeter. Housed in walnut veneer hardwood cabinets. Control center 4¾" H × 15¾" W × 11" D. $279.95-$299.95

### 12R800 4-Channel Car Player

Can be used for 4- or 2-channel 8-track cartridge playback. 4 W/ch dynamic power at 5%

THD. Response 40-10,000 Hz ±3 dB. Wow & flutter 0.4% rms. For use with 12-V negative-ground power sources. Size with bracket

2⅝" × 10⅛" × 7½" D ..... $119.95

## ROBINS

### Quad-Synthesizer

Adapter to permit simulated 4-channel effect from existing 2-channel stereo material. De-

signed to be used with standard stereo equipment. Two additional speakers required.
Basic version ..... $6.95
With volume and balance controls added. $9.95

## ROTEL

### RX-154A 4-Channel AM-FM Receiver

Can be used as a 2- or 4-channel receiver. 10 W/ch continuous power at 4 ohms for 4 ch. operation (20 W/ch for two channels) and 0.5%

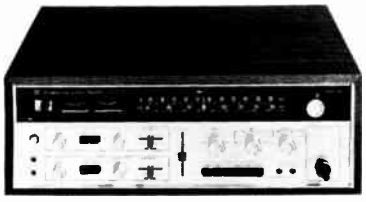
THD. Power bandwidth 30-30,000 Hz. FM sensitivity 4 μV for 30 dB quieting; capture ratio 8 dB. Will play 4-channel discrete sources, 4-channel SQ matrixed discs or tapes, and will synthesize regular 2-channel stereo sources. Has 4-channel headphone jack. 17¼" × 5" × 12½" D. Walnut cabinet ..... $239.95

## SANSUI

The company has a series of four different AM-FM 2- and 4-channel receivers, including decoder, synthesizer, amplifier, control centers. Each can decode all compatibly matrixed 4-channel recordings and broadcasts, synthesize 2 rear channels of ambient signals from conventional 2-channel recording to 4 channels. Will also play discrete 4-channel tapes.

### QRX-6500 4-Channel Receiver

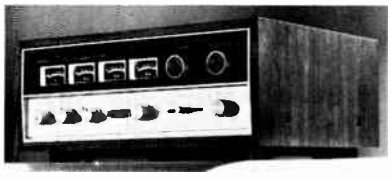
37 W/ch continuous power output at 8 ohms with 0.5% THD. Response 20-30,000 Hz ±1 dB



(50 W/ch at 4 ohms); 70 W/ch dynamic (IHF) power at 4 ohms. FM sensitivity 1.8 μV for 30 dB quieting. Has multi-system 4-channel speaker selectors and vario matrix ... $699.95

### QS-500 4-Channel Converter

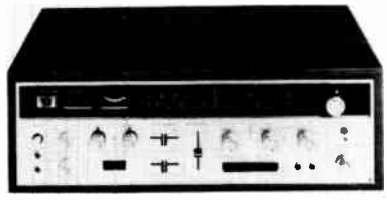
Basic principle of decoding/synthesizing 2-channel program material or reproducing 4-channel discrete programs is the same as previous 4-channel receiver design. Difference is that only 2 channels of power amplification are



included. Designed to be used with present stereo systems for 4-channel reproduction. Has four VU meters for channel balancing, 2- and 4-channel tape monitoring, and provision for rotating channel outputs. 33 W/ch continuous (IHF) power at 8 ohms (40 W/ch at 4 ohms) at 0.5% THD. 60 W/ch dynamic (IHF) power at 4 ohms. Power bandwidth 20-40,000 Hz ..... $289.95

### QRX-4500 4-Channel Receiver

27 W/ch continuous power output at 8 ohms (38 W/ch at 4 ohms) with 0.5% THD. 60 W/ch



dynamic (IHF) power at 4 ohms. Power bandwidth 20-30,000 Hz. FM sensitivity 2 μV for 30 dB quieting. Decodes via vario matrix. Controls are similar to QRX-6500 ..... $599.95

### QR-1500 4-Channel Receiver

15 W/ch continuous power output at 8 ohms (20 W/ch at 4 ohms) with 0.8% THD. 25 W/ch

dynamic (IHF) power at 4 ohms. Power bandwidth 20-30,000 Hz. FM sensitivity 3 μV for 30 dB quieting ..... $299.95

### QR-500 4-Channel Receiver

Economy version. 8 W/ch dynamic (IHF) power

at 8 ohms (15 W/ch at 4 ohms). Power bandwidth 30-30,000 Hz. FM sensitivity 5 μV for 30 dB quieting ..... $199.95

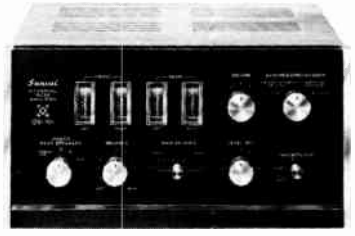
### MQ-2000 4-Channel Compact

Combines a Perpetuum-Ebner 2032 automatic turntable with Shure M75-6 magnetic car-

tridge, and an AM-FM 2- or 4-channel stereo receiver with integrated amplifier. 14 W/ch continuous (IHF) power at 8 ohms (15 W/ch at 4 ohms) at 1% THD. 18 W/ch dynamic (IHF) power at 4 ohms. Power bandwidth 30-30,000 Hz. FM sensitivity 5 μV for 30 dB quieting ..... $349.95

### QS-100 4-Channel Converter

Same as QS-500 except 15 W/ch continuous



power at 8 ohms (18 W/ch at 4 ohms) at 0.8% THD. 25 W/ch dynamic power at 4 ohms. Power bandwidth 25-40,000 Hz ..... $169.95

### QS-1 Decoder/Synthesizer

Offers full facilities for 2- or 4-channel opera-

tion and system control, including four VU meters but without any power amplifiers ..... $119.95

## SANYO

### DCX-3000K 4-Channel Receiver

Designed for both discrete and matrix 4-channel operation. Has SQ logic & Sanyo matrix decoders. Can be used as a 2- or 4-channel amplifier. AM-FM stereo receiver sensitivity 2.8 μV for 30 dB quieting. HD 0.8%. (S+N)/N 60 dB. 5 W/ch (20 W total) continuous power into 8 ohms and at 1% HD (7½ W/ch dynamic power into 8 ohms). Response 20-40,000 Hz; power bandwidth 30-15,000 Hz. Input sensitivity: mag. phono 2.5 mV; aux. 100 mV; tape 300 mV. Has remote speaker facility. Overall size 17¼" × 12½" × 5". Is supplied with walnut cabinet ..... $249.95

### DCX-3300K 4-Channel Receiver

Has all the features for 4-channel discrete and three matrix decoder circuits (SQ logic and variations). AM-FM stereo receiver with FM sensitivity 2.2 μV. Selectivity 40 dB. 10 W/ch (40 W total) continuous power into 8 ohms & at 0.8% HD. Response 20-40,000 Hz; power bandwidth 20-34,000 Hz. Input sensitivity: mag. phono 3 mV; aux. 100 mV; tape 300 mV. Features four output-level meters; 2- or 4-channel operation; mike input. 17¼" × 12½" × 5". Walnut cabinet ..... $379.95

### DCA-1700X 4-Channel Decoder/Amp

Features a 2-channel amplifier with SQ 4-channel matrix decoder (has two 4-channel effects). 20 W/ch (40 W total) continuous power into 8 ohms & at 0.8% HD. Response 10-100,000 Hz ±2 dB. Input sensitivity: phono #1 & #2 2.5 mV; aux. #1 & #2 & tuner 100 mV. 11½" × 10" × 4¼" ..... $199.95

### DCA-1600X 4-Channel Decoder/Amp

Features a 2-channel amplifier & three different matrix circuits including the SQ logic decoder. 10 W/ch (20 W total) continuous

# 4 4-channel components

power (20 W/ch dynamic power) into 8 ohms & at 0.8% HD. Response 10-100,000 Hz ±2 dB. Input sensitivity: aux. #1 & #2 150 mV. 11½" × 10" × 4¼" ..... $139.95

### RD-8200 8-Track 2/4 Ch. Player Deck

Will play both 2- or 4-channel 8-track programs. Features fast-forward, automatic sensing sys-

tem for 2- & 4-channel cartridges. Response 50-12,000 Hz. (S + N)/N 45 dB. Wow & flutter 0.2%. 13" × 12⅜" × 4¾" ..... $139.95

### DXR-5111 4-Channel Music System

Combines an AM-FM 4-channel receiver and four separately housed (9" × 6" × 14") speaker systems, each with 6½" speaker. 7½ W/ch (20 W total) dynamic power at 5% HD. Has SQ decoder and will accept 4-channel discrete tapes. 17" × 4" × 10½" D ..... $189.95
**DXR-5111P.** Same except with separately housed 4-speed automatic turntable . . $239.95

### DXL-5485 4-Ch. AM-FM/8-Track System

Combines an AM-FM 4-channel receiver, a 2/4 channel 8-track tape deck, and four separately

housed speaker systems (9" × 14" × 7" D) each with 6½" speaker. Response of tape deck 50-12,000 Hz. Wow & flutter 0.25% max. (S + N)/N 50 dB. 10 W/ch (40 W total) dynamic power at 5% HD. Has SQ matrix decoder. 18½" × 5" × 10½" ..... $249.95
**DXL-5485P.** Same except with separately housed 4-speed automatic turntable . . $279.95

### GXT-4830 4-Ch. AM-FM/8-Track/Phono System

Combines an AM-FM 4-channel receiver; an 8-track tape deck with response 50-12,000 Hz, (S + N)/N 50 dB, wow & flutter 0.25% max; an automatic record changer with ceramic cartridge & 8" turntable; plus four separately housed speaker systems. Two front speakers 10" × 15½" × 7"; two rear speakers 7¾" × 10" × 7" D, each with 6½" speaker. Power output 10 W/ch (40 W total) dynamic power at 5% HD. Has SQ matrix decoder. Comes with dust cover. 19½" × 9½" × 14½" D ..... $279.95

### GXT-4620 4-Ch. AM-FM/Cassette/ Phono System

Sames as GXT-4830 except has cassette recorder deck in place of 8-track cartridge deck. Supplied with dust cover & one microphone ..... $289.95

### GXT-4650 4-Channel Music System

Features an AM-FM 4-channel receiver; a stereo cassette recorder; a built-in automatic record changer (10" turntable); and four separately housed speaker systems. Two front speakers

10½" × 16¼" × 7¼"; two rear speakers 8" × 10½" × 7¼", each with 6½" speaker. Cassette response 50-12,000 Hz, (S + N)/N 45 dB, wow & flutter 0.20% max. 12½ W/ch (50 W total) dynamic power at 5% HD. Has SQ matrix decoder. 21½" × 9½" × 14½" D ..... $329.95

### DXL-5490 4-Ch. 8-Track System

Combines an AM-FM 4-channel receiver; an 8-track tape deck with 2-channel record and 2- or

4-channel playback; and four separately housed speaker systems. Two front speakers 12" × 17½" × 7¼"; two rear speakers 8¼" × 12" × 7¼" D. Front speakers are 2-way designs, each with 6½" & 2½" speakers; rear speakers have 6½" units. Tape deck response 50-12,000 Hz. (S + N)/N 50 dB; wow & flutter 0.25%. 16¼ W/ch (65 W total) dynamic power at 5% HD. Has SQ matrix decoder and separate record/playback amp. 20" × 6" × 12½" . $329.95

### GXT-4880 4-Ch. 8-Track System

Similar to Model DXL-5490 except has automatic record changer with 10" turntable & ce-

ramic cartridge. Speaker systems are two front (10½" × 16¼" × 7¼") and two rear (8" × 10½" × 7¼") each with 6½" speaker. Does not have separate record/play amp. 12½ W/ch (50 W total) dynamic power at 5% HD. Supplied with dust cover & one microphone. 21½" × 9½" × 14½" ..... $379.95

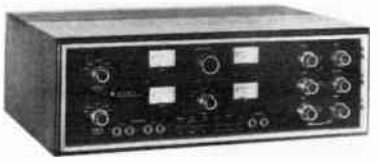
### DXT-5340 4-Channel System

Combines an AM-FM 4-channel receiver; a cassette tape recorder; a 2- or 4-channel 8-track tape deck; a built-in automatic record changer with 10" turntable; and four separately housed speaker systems (12" × 17½" × 7¼") each with 6½" & 2½" speakers. 8-track tape deck has 50-12,000 Hz response; (S + N)/N 50 dB; wow & flutter 0.25. Cassette recorder response 50-12,000 Hz; (S + N)/N 45 dB; wow & flutter 0.2. 16¼ W/ch (65 W total) dynamic power at 5% HD. Has SQ matrix decoder. Supplied with dust cover & two microphones. 21" × 10" × 14" ..... $439.95

## SCOTT, H.H.

### 499 4-Channel Stereo Amp

Frequency response 15-30,000 Hz ±1 dB. Continuous power output per channel with all chan-



nels driven; 35 W at 8 ohms, HD 0.5% at rated output, hum & noise (phono) —65 dB. Input sensitivity: high level (extra) 0.50 V, phono high 3.0 mV, phono low 6.0 mV, tape 1.0 mV, mike 10 mV. Designed to drive four speakers from a true 4-channel source such as a four-channel tape recorder but can be used to drive a pair of speakers from tape recorder or record player while the second pair of channels drives a pair of extension speakers. Features four independent VU meters, tape monitoring facilities, loudness compensation, high and low filtering, four front-panel microphone jacks, and independent tone and volume controls for each of the four channels. 18½" W × 11⅞" D × 6¼" H ..... $459.90

## SONY

### SQP-400 4-Ch. Receiver/Phono

Combines an AM-FM stereo receiver with an FM sensitivity of 2.2 μV for 30 dB quieting; 10 W/ch (40 W total) dynamic power at 8 ohms & 5% HD; a BSR 4-speed phono changer with crystal cartridge, a hinged dust cover, cue control; and four Sony SS-170 two-way speaker systems. Will play back SQ matrixed discs & 4-channel discrete tape programs. 9" × 20⅞" × 15¼" D ..... $359.95

### SQD-2020 4-Channel Decoder

Designed as a control center for 4-channel discrete tapes and has built-in SQ full-logic (gain-riding) matrix decoder. Features four VU monitor level/balance meters. (S + N)/N 80 dB. HD 0.1%. Sensitivity: input & 4-ch. 1, 2 250 mV; Rec/PB 2 & 4-ch. tapes 750 mV. Output: front 500 mV, back 550 mV & 2 V. SQ separation LF/RF, LF/LB, RF/RB 20 dB; CF/CB 15 dB. 5⅞" × 15¾" × 12⅞" ..... $229.50

### SQR-6650 4-Channel Receiver

AM-FM stereo design with four separate power amplifiers that can be ganged for two-channel operation. Has two matrix decoding circuits—one for SQ and one for all other designs. 8 W/ch continuous power at 8 ohms (25 W/ch for 2-channel operation). Has four VU meters for bal-

ancing. FM sensitivity 2.2 μV for 30 dB quieting. —70 dB selectivity ..... $329.50

## SONY/SUPERSCOPE

### TC-824CS 4-Channel, 8-Track Player

Combines an 8-track, 2/4 channel cartridge tape player with four channels of amplification

& four separately housed speaker systems. 5 W/ch continuous power at 5% THD. Rosewood

cabinets ..... $299.95

**TC-277-4 Quadradial Tape Deck**
Reel-to-reel, 3-speed (7½, 3¾, 1⅞ ips), 4-channel, in-line design. Response 50-16,000

Hz ±3 dB at 7½ ips, (S+N)/N 52 dB; wow & flutter 0.12% at 7½ ips. Has two heads (4-channel erase & record/play), four inputs, and four line outputs (1/ch). Input sensitivity 0.06 V. 15¾" × 7¾" × 15½" H..... ..... $349.95

**TC-854-4S 4-Channel Tape Deck**
Three-motor, 3-speed (3¾, 7½ & 15 ips) design with 10½" reel capacity. Will record/play 2 or 4

channel. Features vari-speed pitch control and Sony's "Synchro Trak" for precise synchronization of each track. Response 30-18,000 Hz ±2 dB at 7½ ips (S+N)/N 56 dB with standard tape (59 dB with SLH-180 tape). Wow & flutter 0.04% at 7½ ips. Has four VU meters, sound-on-sound capabilities, record equalization switch for standard or low-noise, high-output tape. 17⅜" × 22" × 10" D. ..... $1795.00

**TC-84 4-Channel Cartridge Player**
Features 2 or 4 channel playback for cars. Response 50-12,000 Hz; wow & flutter 0.25% (S+N)/N 45 dB. Designed for 12 V d.c. negative-ground operation. Has four individual level controls, one motor. 11½" × 3" × 8⅞" D. Supplied with mounting hardware ..... $169.95

## SPECTROSONIC

**SQ-4 4-Channel "Quadapter"**
Combines a 2-channel power amplifier and an SQ matrix decoder. 20 W/ch continuous power at 8 ohms, 30-20,000 Hz & 0.5% HD with both channels driven (30 W/ch dynamic power). HD 0.25% at rated output & at 1000 Hz. Power bandwidth 12-37,000 Hz. Input sensitivity: SQ 1 V, phase shift 1 V, discrete 250 mW. Has controls for 4-channel discrete tape. ..... ..... $119.50

## SUPEREX

**QT-4 "Quad-Tette" Headphones**
Has four identical reproducers (two to an ear-

cup) with frequency response of 25-17,000 Hz. 15-ft. cord. Ivory/Cordovan ..... $50.00

**QT-4B "Quad-Tette" Headphones**
Has four identical reproducers (two to an earpiece) with frequency response of 20-18,000 Hz. 15-ft. cord and 2-4 ch. sw..... $65.00

## SYLVANIA

**DMQ2784W 4-Ch. 8-Track Converter**
Will play 2- or 4-channel 8-track tapes. Has two power amplifiers and is designed to be used with your present 2-channel stereo system for 4-channel output. 12½ W/ch continuous power into 8 ohms and at 1% THD. Frequency range 25-35,000 Hz; power bandwidth 30-35,000 Hz.

Wow & flutter (cartridge tape player) 0.3%. Has tape monitor switch, inputs for matrixed four-channel program sources, and tape outputs ..... $229.95

**PQ4 4-Channel Adapter**
Used to simulate 4-channel reproduction. Will pick up out-of-phase response from conventional 2-channel stereo discs or tapes. Four speakers are required plus one regular two-channel stereo amplifier. ..... $9.95

## TEAC

**AN-300 4-Ch. Dolby Noise Attenuator**
Has four separate Dolby-B type noise-reducing systems within a single housing. Features four

VU meters. With channels operated in pairs the unit affords simultaneous decoded stereo monitoring or full 4-channel Dolby encoding. Has a standard 400-Hz recording calibration tone on all four channels and a 420-Hz pulse circuit for easy identification of the calibration tone. Increased (S+N)/N of 10 dB at 10,000 Hz (5 dB at 1000 Hz). Sensitivity: tape and line 0.1 V. Outputs: record and monitor 0.3 V. Has multiplex filter. Response 20-20,000 Hz ±1.5 dB. 6¾" H × 16⅛" W × 10⅛" ..... $439.50

**AX-300 4-Channel Mike/Line Mixer**
Has a preamplifier and features inputs for six low-impedance microphones (four circuits mike/line switchable and two circuits mike only). Has a six in and four out format. (S+N)/N is −62 dB (−72 dB line); mike (600 ohms unbalanced) input 0.1 V max.; line input 0.3 V (7 V

# 4 4-channel components

max.). 6⅛" × 16⅛" W × 10⅜" D..... $299.50

**3340 4-Channel Tape Deck**
Two-speed (7½ & 15 ips), 4-track, 3-head design for 4- or 2-channel stereo or mono record &

playback. Response 30-18,000 Hz ±3 dB at 7½ ips. Wow & flutter 0.06% at 7½ ips. (S + N)/N −60 dB. HD 1% at 1000 Hz & normal level. Has inputs for mike (0.25 mV) and line (0.1 V) and line output (0.3 V). Features "Simul-Sync" for each head, permitting synchronization of any of the remaining three tracks. For 7" & 10½" reels; eight inputs can be recorded simultaneously (4 mike & 4 line) each individually controlled. Ideal for sound effects and mixes. Has dual bias level for conventional and high-performance tapes and four VU meters. 20½" × 17⅜" × 8¾" D. ..... $849.00

**2340 4-Channel Tape Deck**
Two-speed (3¾ & 7½ ips), 4-track, 3-head design for 4- or 2-channel stereo or mono record & playback. Response 40-18,000 Hz ±3 dB at 7½ ips. (S + N)/N −55 dB. HD 1% at 1000 Hz & nor-

mal level. Has inputs for mike (0.25 mV) and line (0.1 V) and line output (0.3 V). Features "Simul-Sync" for each head permitting synchronization of any of the remaining three tracks; 3-motor transport; dual bias-level switch for conventional & high performance tapes; mike/line mixing; separate record & playback amp; four VU meters. 18¾" × 17⅜" × 8¾" D..... $759.50

## TECHNICS BY PANASONIC

**SE-405H CD-4 Discrete 4-Ch. Demodulator**
Low-distortion, high-separation demodulator for playback of CD-4 discrete 4-channel recordings. Includes 4-channel semiconductor cartridge for mounting in any standard tonearm

and will also play 2-channel and all other discs. Phono cartridge response d.c. to 50,000 Hz. Demodulator audio response 20-16,000 Hz. Built-in equalizer/preamps. Inputs: phono #1 (semiconductor cartridge) 3 mV; phono #2 (magnetic cartridges) 1.5 mV. Input impedances: phono #1 4700 ohms, phono #2 100,000 ohms. Output 300 mV. Has 3-position mode selector including 4-Chan. Auto for demodulating CD-4 records or automatically switching to 2-channel stereo, depending on record being played; 4-Chan. Aux.; Conventional Stereo. Indicator automatically lights to indicate playing and demodulation of CD-4 record. Separation adjustment. 3¾" H × 8 1/16" W × 13" D ..... $135.00

**RS-740US 4-Channel Tape Deck**
Two speeds (7½, 3¾ ips). Response 30-20,000 Hz ±3 dB at 7½ ips, wow & flutter less than 0.1%. Has four independent VU meters, spe-

cial front and rear separation controls, tape-bias adjustment switch, front or rear headphone monitoring and pause control, mike & line inputs, digital counter, and automatic shut-off, 3 heads ..... $449.95

**SH-3433 4-Channel Audio Scope**
3-inch screen to view all 4-channel signal levels & phase relationships. Connects either at

speaker terminals or outputs of any preamp. ..... $249.95

**SA-6400X 4-Channel Receiver**
25 W/ch (100 W total) dynamic power into 8 ohms (37½ W/ch into 4 ohms); 19 W/ch continuous power into 8 ohms (26 W/ch into 4 ohms) & at 0.5% THD. Power bandwidth 9-40,000 Hz; response (aux.) 20-50,000 Hz ±1½ dB. FM sensitivity 1.8 μV for 30 dB quieting; capture ratio 1.5 dB. Input sensitivity: mag. phono & mike 3 mV; aux & tape monitor #1, #2, #3 200 mV. Features 75 & 300 ohm antenna inputs; main/remote speaker switch; remote control joystick-type balance control; built-in decoder. Will play all discrete and matrixed 4-channel program material. Has mike input with mixer. 17⅞" × 6¼" × 16⅛" D..... $429.95

**SA-6800X.** Same except for power rating of 50

W/ch dynamic into 8 ohms (75 W/ch at 4 ohms); 42 W/ch continuous at 8 ohms (53 W/ch at 4 ohms). Has extra center-of-channel tuning meter and mike input with mixer and position control to rotate mike source into any channel. ..... $599.95

**RS-858US 4-Channel 8-Track Deck**
Will record/play all 2- or 4-channel cartridge programs. Has four separate input level con-

trols, four VU meters, mike & line inputs. Response 30-15,000 Hz; wow & flutter 0.2%. 8¼" × 21⅛" × 11¼" ..... $259.95

**SA-8000X 4/2-Ch. AM-FM Receiver**
Features built-in CD-4 demodulator for playback of discrete phono discs plus a variable AFD matrix decoder/synthesizer that can be

matched to any matrix system. BTL (balanced transformerless) amplifier design enables 2- or 4-channel stereo operation. Has four VU meters, 6-element ceramic i.f. filters in FM. FM sensitivity 1.9 μV for 30 dB quieting. IHF dynamic power 40 W/ch (160 W total) into 4 ohms (160 W at 8 ohms in 2-channel (BTL) mode). With all channels driven continuous power is 18 W/ch (72 W total) at 4 ohms; 16 W/ch (64 W total) at 8 ohms. In 2-channel (BTL) operation, continuous power with both channels driven is 38 W/ch at 8 ohms. THD 0.5% at rated power. Power bandwidth 5-40,000 Hz. (S + N)/N 72 dB (phono), 94 dB (aux.)..... $499.95

**SA-6000X 4/2-Ch. AM-FM Receiver**
Features variable AFD matrix decoder/synthesizer that can decode any matrix system, plus inputs to accommodate any 4-chan-

nel discrete or 2-channel source. BTL (balanced transformerless) design enables 2- or 4-channel stereo operation. 6-element ceramic filters and monolithic IC's in FM i.f. strip. IHF

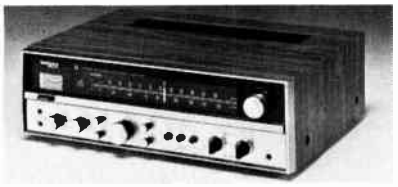
dynamic power is 30 W/ch (120 W total) into 4 ohms. Continuous power with all channels driven is 16 W/ch (64 W total) at 4 ohms; 14 W/ch (56 W total) at 8 ohms. Continuous 2-channel (BTL) power is 48 W/ch at 8 ohms; 32 W/ch at 8 ohms with all channels driven (64 W total). THD 0.5% at rated power. Power bandwidth 7-35,000 Hz. (S + N)/N 72 dB (phono); 94 dB (aux.). FM sensitivity (IHF) 1.9 $\mu$V for 30 dB quieting ..... $349.95

**SA-5600X 4/2-Ch. AM-FM Receiver**

Accommodates all discrete 4-channel sources and includes 2-position matrix decoder for matching all matrix sources in use and for optimum synthesizing/enhancing. BTL (balanced transformerless) power amplifier permits use of full power in either 4- or 2-channel modes. 6-element ceramic filters and monolithic IC's in i.f. section. IHF dynamic power 27 W/ch (108 W total) at 4 ohms. With all channels driven 14 W/ch (56 W total) at 4 ohms; 11 W/ch (44 W total) at 8 ohms. 2-channel (BTL) mode continuous power 40 W/ch at 8 ohms; 30 W/ch (60 W total) at 8 ohms with both channels driven. THD 60 dB (phono); 75 dB (aux.). FM sensitivity (IHF) 1.9 $\mu$V for 30 dB quieting ..... $309.95

**SA-5400X 4/2-Ch. AM-FM Receiver**

Designed for any 4- or 2-channel application with complete discrete and matrix capability. Two-position switch for decoding any matrix source or optimum sythesizing/enhancing. Two tape monitors. The i.f. stages have ceramic filtering and monolithic IC's. FM sensitivity 1.9 $\mu$V for 30 dB quieting IHF dynamic power 17 W/ch (68 W total) at 4 ohms in 4-channel mode. Continuous 4-channel power with all channels driven 9 W/ch at 4 ohms (36 W total); 8 W/ch at 8 ohms (32 W total). Continuous 2-channel (TL) power 25 W/ch with both channels driven; 18 W/ch (36 W total) at 8 ohms. THD 0.8% at rated power. Power bandwidth 7-28,000 Hz. (S + N)/N 75 dB (aux.); 60 dB (phono) ..... $259.95



## TELEDYNE

**RA-632 4-Channel Receiver**

AM/FM-stereo design; 60 W/ch dynamic power (240 W total) with one channel operating. Has universal type decoder for matrix or synthesized program material. Features a joystick-type control; main & remote speaker switch. Walnut finish cabinet ..... $229.50

**RA-660.** Similar to RA-632 in design and styling except has 20 W/ch dynamic power (80 W total) ..... $189.50

**PH-220 4-Channel Headphones**

Features dual stereo plug system consisting of front and rear stereo connectors for 4-channel or one plug may be used for conventional 2-channel stereo listening. Two separate full-range driver elements in each earcup. Padded earcushions and fully adjustable cushioned headband ..... $44.98

## TELEDYNE PACKARD BELL

**D05201 "Rhapsody" 2- & 4-ch. Music System**

Combines an AM-FM stereo receiver, an 8-track 2- or 4-channel tape recorder. Has synthesized 4-channel circuits to develop 4-channel response from standard 2-channel music sources. 6½ W/ch dynamic power (25 W total) at 5% THD. Is supplied with four separately housed speaker systems (front) 9⅛" × 14¼" × 5⅝" D (each with 6½" duo-cone and 3½" tweeter): (rear) 8¾" × 11½" × 4¾" D (each with 6½" duo-cone speaker). With two microphones. Control center 18½" × 4¾" × 12½" D ..... $289.95

**R10201 Allegro 4-Channel System**

Combines an AM-FM stereo receiver with four separate power amplifiers and four individually housed speaker systems. 12½ W/ch (4 channels) dynamic (EIA) power at 1% THD. Two speaker systems (11⅞" × 17⅜" × 7⅜" D) have 8" air-suspension woofers & 2" tweeters; two speakers systems (8¾" × 11½" × 4¾" D) have 6" full-range dual-cone high-compliance speakers. Features both 2- and 4-channel operation. FM sensitivity 10 $\mu$V for 30 dB quieting. Has walnut side panels & top sections. 17⅜" × 4⅝" × 14⅛" D. ..... $219.95

**C10203 Etude 4-Channel Player**

Same as Model R10201 Allegro but with Garrard 2025TD automatic turntable with ceramic cartridge. 21⅞" × 8⅞" × 15½" D .... $259.95

**B10202 Ballad 4-Channel System**

Same as Model R10201 Allegro except with an 8-track stereo tape player & headphones. 21⅞" × 4⅝" × 14⅛" D ..... $249.95

**K10204 Sonata 4-Channel System**

Same as B10202 Ballad but with Garrard 2025TC automatic turntable with ceramic cartridge. 22" × 9¼" × 15½" D. ..... $299.95

**Q05401 Rondo 4-Channel System**

Combines an 8-track tape player, an AM-FM stereo receiver, a 4-channel matrix system, and

# 4 4-channel components

four speaker systems (4⅛" × 14¼" × 5⅜" D), each with 6" dual-cone woofer & 2" dual-cone tweeter. Has 4-channel amplifier, 12½ W/ch (4

channels) dynamic (EIA) power at 5% THD. Will play 2- or 4-channel programs. 19¾" × 4¼ × 12½" D. ..... $299.95

### R10401 Largo 4-Channel Receiver

AM-FM 4-channel receiver for discrete or encoded program material. 25 W/ch dynamic

power at 1% THD. Has E-V "Phase II" decoder. FM sensitivity 2.5 μV for 30 dB quieting. 22" × 6¾" × 14⅜" D. ..... $299.95

**R10402.** Same but with four individual speaker systems (11⅞" × 17⅜" × 7⅜" D), each with 8" & 2" air-suspension-type dual-cone speakers. ..... $450.00

### R20201 Fantasia 4-Channel Receiver

AM-FM 4-channel receiver for discrete or encoded program material. 25 W/ch dynamic power at 1% THD. FM sensitivity 12 μV for 30 dB quieting. Has mag. or ceramic phono inputs. 18¼" × 5¼" × 12¼" D. ..... $199.95

**R20202 Fantasia II.** Same as R20201 except with four separate speaker systems, each with 8" & 2" air-suspension dual-cone speakers. Cabinet size 14" × 20" × 7½" D. ..... $349.95

### R30401 Oratorio 4-Channel Receiver

An AM-FM 4-channel receiver (with four separate amps), 45 W/ch dynamic power at 1% THD. FM sensitivity 2 μV for 30 dB quieting. Has E-V "Phase II" decoder & means of combining four output channels into two channels with 60 W/ch continuous power. Has tilt-out control panel. 19⅞" × 6⅞" × 13⅝" D. ..... $499.95

**R30402.** Same as R30401 except with four Model S-6041 speaker systems, each with 12" woofer, a 5" mid-range, and a 3½" domed tweeter. 17⅜" × 24" × 12" D. ..... $1000.00

## TELEX

### 2 + 2 Tape Deck

Four- or two-channel reel-to-reel design. Can provide discrete 4-channel playback only. Has

3 motors, 3 speeds (7½, 3¾, 1⅞ ips), automatic shutoff/tape-break switch. Response 40-18,000 Hz ±3 dB, (S + N)/N 48 dB, wow & flutter 0.2% at 7½ ips. 16½" W × 11" × 6¼" ..... $249.95

## TOSHIBA

### SA-304 4-Channel AM-FM Receiver

10 W/ch continuous power (40 W total) into 8 ohms at 0.8% HD and each channel driven separately (20 W/ch for 2-channel operation). Response 20-40,000 Hz ±2 dB. Power bandwidth 20-30,000 Hz at 0.8% HD. Sensitivity: mag. phono 3 mV; aux. 150 mV. FM sensitivity 2.5 μV for 30 dB quieting. Capture ratio 2.5 dB. Has built-in RM (Regular Matrix) and SQ 4-channel matrix decoder. Has input provisions for CD-4 discrete decoder. Has universal line inputs. 15¾" × 4½" × 11⅜" ..... $299.95

### SB-404S 4-Channel Integrated Amplifier

15 W/ch continuous power (60 W total) into 8 ohms and at 0.5% HD with each channel driven separately (26 W/ch for 2-channel stereo). 17 W/ch dynamic power (68 W total). HD 0.4% at rated output (0.1% at 2 W/ch). Response 10-55,000 Hz ±1.5 dB; power bandwidth 10-30,000 Hz at 0.8% HD. Sensitivity: mag. phono 1 & 2 3 mV; condenser phono 30 mV; tuner 150 mV; aux. 1 & 2 150 mV; tape 500 mV. Has RM (Regular Matrix) and SQ decoders. Has universal line inputs. Overall size 15¾" × 4½" × 11" ..... $269.95

### PT-844 2- and 4-Channel Tape Deck

Reel-to-reel type. Three speeds (1⅞, 3¾ & 7½ ips), 3 heads. Response 30-20,000 Hz ±3 dB with low-noise tape. (S + N)/N 50 dB. Wow & flutter 0.09% at 7½ ips. Has regular & low-noise tape switch. 15¾" × 17½" H × 8¾" D ..... $499.95

### SA-504 4-Channel AM-FM Receiver

30 W/ch (120 W total) continuous power into 8 ohms & at 0.4% THD and with each channel driven separately (53 W/ch for 2-channel stereo). Response 20-40,000 Hz ±1 dB; power bandwidth 10-80,000 Hz. FM sensitivity 1.8 μV for 30 dB (S + N)/N; capture ratio 1.5 dB. Input

sensitivity: mag. phono 2.5 mV; condenser phono 30 mV; aux. & tape 160 mV. Has built-in QM & SQ 4-channel matrix decoder, FM muting, signal-strength & center-of-channel tuning meters, and tape monitor. Can be used for 4-channel discrete playback. 20" × 4⅞" × 14". ..... $499.95

## V-M

### 1547 4-Channel Tape Player Deck

Plays either 2- or 4-channel 8-track tape cartridges. Response 50-10,000 Hz. Has built-in

preamp. ..... $79.95

### 1548 4-Channel Receiver

Combines an AM-FM stereo receiver, an 8-track 2- or 4-channel tape player with 4 channels of power amplification. 6 W/ch dynamic (EIA) power at 5% THD; 4 W/ch continuous power. Receiver sensitivity 15 μV for 30 dB (S + N)/N. Wow & flutter (tape player) 0.3%. Supplied with walnut cabinet. Overall size 21⅝" × 5⅜" × 11⅞" D ..... $199.95

**Model 1538.** Same technical performance as 1548 except does not include the AM-FM receiver or 8-track player. 3⅞" × 14½" × 9¾" D ..... $99.95

## WESTBURY

### 4510 2- and 4-Channel 8-Track Player

Plays both 2- and 4-channel tapes automatically. Features 5 W/ch continuous power and is

supplied with four separately housed speaker systems. Walnut cabinets ..... $189.95
System without speakers ..... $119.95

## WOLLENSAK

### 6154 4-Channel Deck

Three-speed (7½, 3¾, 1⅞ ips), 4-channel playback, 4-track stereo record/playback, 3-head, 2-motor deck. Will handle up to 7" reels. Response 35-20,000 Hz ±2 dB, wow & flutter 0.12% at 7½ ips, (S + N)/N 54 dB. Has braking, VU meters, automatic shutoff, pause control, echo effects, sound-on-sound, sound-with-sound, and phono input ..... $299.95

### 8054 4-Channel Player

Plays 8-track, 2- and 4-channel quadrasonic cartridges. Has a channel-selector key, auto-

matic programming facilities for 2- or 4-channel, fast-forward. Response 30-15,000 Hz, wow & flutter 0.25%, (S + N)/N 52 dB ... $119.95

### 8060 8-Track, 4-Channel Tape Deck

Record-play deck. Can record and play stereo and matrixed four-channel but play-only dis-

crete four-channel material. Has digital counter for accurately timing recordings, cueing, automatic eject, pause lock, fast-forward, and stereo headphone jack ..... $199.95

# SECTION 5 Accessories
## Headphones, Microphones, Blank Tape, Miscellaneous

### AKAI

**ASE-22 Dynamic Headphones**
Moving-coil type. Response 20-20,000 Hz. Sensitivity 1.0 mW, distortion 1% at 1.0 mW. 8

ohms impedance. ½ W maximum input per phone. Has individual earphone volume controls. 6-ft. coiled cord. Weight 20 ounces ..... $34.95

### AKG

**K-100 Dynamic Headphones**
Response 20-20,000 Hz. Efficiency: 1 mW for 112 dB SPL. Impedance: 600 ohms each driver for multi-impedance matching 4 to 1000 ohms. 13 ounces ..... $29.00

**K-150 Dynamic Headphones**
Ultra-lightweight. Response 20-20,000 Hz. Efficiency: 1 mW for 112 dB SPL; with under 1% distortion at 125 dB SPL. Impedance: 600 ohms each driver for multi-impedance matching 4 to 1000 ohms. 9 ounces ..... $39.00

**K-180 Dynamic Headphones**
Has adjustable drivers for subjectively controllable sound. Response characteristics vary due to change in volume. Response 16-20,000 Hz. Efficiency: 1 mW for 112 dB SPL. Distortion less than 1% at 125 dB SPL. Impedance: 600

ohms each driver for multi-impedance matching 4 to 1000 ohms. 21 ounces ..... $69.00

### ASTROCOM/MARLUX

**Stereo Headphones**
Dynamic type. Response 30-18,000 Hz, 8 ohms impedance. Sensitivity 1 mW, maximum input 500 mW. Distortion 1%. Features replaceable headpad, ear cushions, and cord. 6-ft. coiled cord. 15 ounces ..... $39.95

### BEYER

**DT-48 Dynamic Headphones**
Moving-coil type. Originally designed as an audiometry instrument for measuring human

hearing in lab research. Range 16-20,000 Hz ±2 dB. Response virtually flat. Comes with 10-ft cord ..... $105.00
**DT-48-K.** Same as DT-48 except with plug-in coiled cable ..... $110.00

**DT900 Dynamic Headphones**
Moving coil type. Response 30-18,000 Hz. 5-

2000 ohms impedance. 200 mW maximum input per phone. 6-ft. cord ..... $29.95

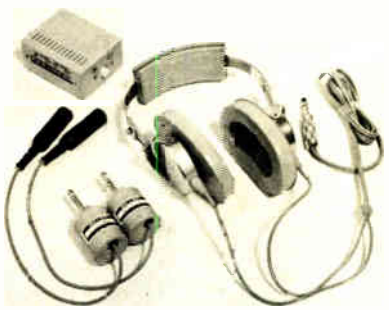
**DT96A Dynamic Headphones**
Moving coil type. Response 30-17,000 Hz. Sensitivity 1.0 mW at 400 Hz produces 110 dB (re $2 \times 10^{-4}$ μbar). 50-200 ohms impedance. 100 mW maximum input per phone. 5-ft. cord. 8 ounces ..... $37.50

**DT100 Dynamic Headphones**
Moving coil type. Response 30-18,000 Hz. Sensitivity 1 mW at 400 Hz produces 110 dB (re $2 \times 10^{-4}$ μbar). 5-100-400-2000 ohms impedance. 1 W maximum input per phone ..... $57.50

**DT480 Dynamic Headphones**
Moving coil type. Response 20-18,000 Hz. Sensitivity 1 mW at 400 Hz produces 115 dB (re $2 \times 10^{-4}$ μbar). 25-200 ohms impedance. 1 W maximum input per phone. ..... $75.00

### BEYER/GOTHAM

**DT-48S Stereo Headphones**
Dynamic design extending from 20-18,000 Hz ±2 dB. Dist. 0.3% below 100 Hz & 0.1% above.



Peak power demand 200 mW or 1 V max. per phone. Input 10 mV. Impedance: 5 ohms each for stereo (10 ohms total for mono) ... $98.00
DT-48SN. 50-ohm mono design ..... $98.00
DT-48SP. Stereo design with separate plugs on each phone ..... $98.00
TR-48. Plug-in transformer for 600-ohm input ..... $19.60
TR-48. Pair for stereo use ..... $34.00
UG-8. Speaker/phone switcher box .... $8.90

### CLARICON

**85-287A Headphones**
Dynamic design with individual volume controls. Response 19-20,000 Hz. Stereo/mono switch ..... $14.95

**85-289 Headphones**
Dynamic design with individual volume controls. For 4, 8, or 16 ohm outputs. Response 18-22,000 Hz. 10-ft coiled cord ..... $24.95

### CLARK, DAVID

**100A Headphones**
Dynamic type with frequency response 20-10,000 Hz ±3 dB. Sensitivity 1.0 mW at 1000 Hz produces 100 dB (reference 0.0002 μbar). Distortion less than 0.2% at 100 phon. 17 ohms impedance and 1.0 W maximum input per phone. 8-ft. coiled cord. 16 ounces. Also available in impedances of 300, 600, and 1200

# 5 Headphones

ohms ..... $50.00

### 200 Headphones
Permanent-magnet type with frequency response 20-17,000 Hz. Sensitivity 1.0 mW at 1000 Hz produces 105 dB (reference 0.0002 μbar). 8 ohms impedance. 1.0 W input. 17 ounces ..... $29.00

### 250 Headphones
Similar to 200, but with individual earphone volume control ..... $34.00

### 300 Headphones
Permanent-magnet type with frequency response 20-17,000 Hz. Sensitivity 1.0 mW at

1000 Hz produces 105 dB (reference 0.0002 μbar). 8 ohms impedance. 1.0 W maximum input per phone. 10-ft. coiled cord ... $21.00

## FISHER

### HP-70 Dynamic Headphones
Response 30-18,000 Hz. Sensitivity 2.5 mW for

average listening. Max. power 0.5 W. 16 ohms. 10-ft. coiled cord. 12 ounces ..... $29.95

### HP-100 Dynamic Headphones
Response 18-22,000 Hz. Sensitivity 2 mW for average listening. Max. power 0.7 W. 50 ohms. 10 ounces .8-ft. coiled cord ..... $49.95

## HITACHI

### HD-66 Dynamic Headphones
Response 20-18,000 Hz. Distortion less than 1.0% at 1 mW. 8 ohms impedance. 0.5 W maximum input per phone. 12 ounces .... $29.95

## KENWOOD

### KH-71 Stereo Headphones
Open-back dynamic design. Has 3" speakers. Response 20-20,000 Hz. Max. input 0.5 W, 8 ohms. With 12-ft. coiled cord ..... $49.95

**KH-51.** Economy version of the Model KH-71 ..... $29.95

## KLH

### Eighty Dynamic Headphones
Response 20-20,000 Hz ±4 dB; sensitivity 1 mW at 1000 Hz produces 112 dB (80 μbar). Distortion 0.5% at 112 dB SPL. 600 ohms impedance, 1.66 mW maximum input per phone. Has special headband webbing which conforms exactly to shape of wearer's head. Phones may be driven from 0-600 ohm source. Has 10-ft. cord. Weight 11¼ ounces. Black and gray ..... $49.95

## KOSS

### ESP-9 Electrostatic Headphones
Frequency response 15-15,000 Hz ±2 dB. Sensitivity 80 dB SPL (reference 0.0002

dyne/cm²). Distortion less than 0.2% at 110 dB SPL. 4 to 16 ohms impedance. 6-ft. coiled cord. 19 ounces. Black, fluid-filled earcups for ambient noise isolation. Designed for critical studio monitoring ..... $150.00

### ESP-6 Electrostatic Headphones
Frequency response 30-19,000 Hz ±5 dB. Sensitivity 80 dB SPL (reference 0.0002 dyne/cm²). Distortion less than 0.2% at 110 dB SPL. 4 to 16 ohms impedance. 10-ft. coiled cord. 27 ounces. Black, fluid-filled earcups for ambient noise isolation. Self-contained polarizer ..... $95.00

### PRO-4AA Dynamic Headphones
Frequency response 10-20,000 Hz. Distortion is negligible at 95 dB SPL. 4 to 16 ohms im-

pedance. 10-ft. coiled cord. 19 ounces. Fluid-filled earcups for ambient noise isolation ..... $60.00

### PRO-600AA Dynamic Headphones
Same as PRO-4AA except nominally 600 ohms voice-coil impedance for matching audio transmission lines. 600 ohms characteristic impedance. Available on special order ..... $65.00

### KO-727B Dynamic Headphones
Frequency response 10-16,000 Hz. Distortion unmeasurable at 95 dB SPL. 4 to 16 ohms impedance. 10-ft. coiled cord. 19 ounces. Dark green finish ..... $34.95

### KO-747 Stereo/Mono Headphones
Compatible with both stereo and mono music sources. Features a volume control on each

earcup for fine adjustments in level and balance. Incorporates the firm's new driver element. Has extendible, stainless-steel headband with self-adjusting, pivoting yoke to permit the phones to fit any head size. Frequency response 30-20,000 Hz. Two-tone brown. Fluid-filled washable ear cushions .... $45.00

### KRD-711 "Red Devil" Headphones
Dynamic type. Frequency response 10-17,000 Hz. THD less than ½% at 110 dB SPL. 3.2 to 600 ohms impedance. 5 V maximum input per phone. 10-ft. coiled cord. 12 ounces. Red solid plastic ..... $29.95
**K-711** Same as above, but in jet black . $29.95

### K-6LC Dynamic Headphones
Frequency response 10-16,000 Hz. Distortion unmeasurable at 95 dB SPL. 4 to 16 ohms impedance. 10-ft. coiled cord. Individual earphone volume controls. Brown/beige .. $29.95
**Model K-6.** Same except without volume controls ..... $22.50

### SP-3XC Headphones
Frequency response 10-14,000 Hz. 4 to 16 ohms impedance. 10-ft. coiled cord. Brown ..... $15.95

### T-3 Speaker/Headphone Transfer Switch
Provides a speaker "on-off" switch and stereophone jack. Connects to speaker terminals of amplifier or receiver. Adds low-impedance jack to system for wide-range performance of stereophones ..... $7.95

### T-1 Monitoring Adapter
For use with dynamic phones in monitoring tapes from high-impedance sources such as tape recorders with preamps only. Adapter contains matching transformers to match 600 to 10,000 ohm outputs down to 4 ohms. Equipped with two output jacks for stereophones and two pin-type jacks for inputs ..... $7.95.

### HV-1 Dynamic Headphones
Has 2" dia. driver & will operate from 3.2 to 600 ohm outputs. Response 20-20,000 Hz; capacity 5 V continuous with provision for 14 dB-SPL transient peaks. 9.3 ounces. 10-ft coiled cord ..... $39.95

**T-5A Remote Control Station**
Similar to T-10A. Has jacks for two sets of stereophones. Left- and right-channel volume controls and speaker "on-off" switch. Has walnut-like base combined with black trim. .... $9.95

**T-4A Connector Box**
Accepts up to five sets of stereophones. 14-ft. cord with 3-conductor phone plug fits standard headphone jack. Private listening for five persons at one time. Unit measures 6" diameter and has walnut-like base combined with black trim and aluminum plug-in panel ..... $12.95

**T-10A Chairside Listening Station**
Offers remote control for two sets of stereophones. Features separate volume controls for each stereophone and a speaker "on-off" switch. Wires directly to amplifier or receiver. Unit measures 6" diameter and has a walnut-like base combined with black trim and aluminum control panel ..... $19.95

## LAFAYETTE

**F-2001 Electrostatic Headphones**
Stereo design. Frequency response 5-35,000 Hz. Maximum power handling capacity 10 W. Delivers 3 octaves of sound beyond conventional phones. Comes with self energizer with speaker/phone switch and inputs for attaching two phones. Has adjustable cushioned vinyl headband and 5" × 4½" earphone cushions. Impedance 4-16 ohms. Weight 16 ounces. Includes color-coded speaker cables ... $49.95

**F-500 4-Speaker Stereo Headphones**
Each earcup contains a 2-speaker, 2-way sound system featuring a dynamic 3⅝" woofer and a 3" super Mylar cone-type tweeter with a 400-Hz LC crossover network. Response 16-22,000 Hz. Extra wide foam-filled ear cushions. Rugged shockproof construction. Adjustable cushioned vinyl headband. Impedance 8-16 ohms. Comes with 6-ft coiled cord ..... $44.95

**F-1000 Two-Way Stereo Headphones**
Individual left- and right-channel volume controls. Response 20-20,000 Hz. Each earcup contains a 2½" two-way woofer/tweeter transducer. Lightweight form-fitting design. Impedance 8 ohms. Comes with 6-ft coiled cord ..... $39.95

## LLOYD'S

**Y707 Headphones**
Stereo design. 8 ohms. 10½-ft cord ... $9.95

**Y669 Headphones**
Stereo design with slide-type volume control on each earpiece. 8 ohms. 15-ft coiled cord $14.95

## MURA

**SP-99 Stereo Headset**
Lightweight headset designed to be worn either over the head or under the chin. Impedance 4-16 ohms. Frequency response 30-16,000 Hz. 2 W max. output. Comes with 6-ft cord .. $11.50

**SP-100 Stereo Headset**
Lightweight headset. Frequency response 30-15,000 Hz. Comes with 8-ft cord ..... $11.50

**SP-202 Stereo Headset**
Features volume controls for each earpiece and stereo/mono switch. Response 30-15,000 Hz. Imp. 8 ohms. Comes with 10-ft coiled cord ..... $14.95

**SP-402 Stereo Headset**
Features fully padded headband and oversized ear cushions. Individual volume controls and stereo/mono switch included. Response 30-18,000 Hz. 8 ohms imp. 10-ft coiled cord ..... $19.95

**SP-600 Stereo Headset**
Open-air design to accommodate surrounding sounds while listening. Mylar speakers for improved response. Response 20-20,000 Hz. 1 mW power required. 8 ohms impedance. Comes with 10-ft coiled cord ..... $29.95

**SP-103A Stereo Headset**
Features tone and volume controls on each earcup. Response 20-20,000 Hz. Has stereo/mono switch, 8 ohms impedance. 10-ft coiled cord ..... $37.95

**SP-205 Stereo Headset**
Features slide-type volume and tone controls; Mylar speakers; stereo/mono switch. Impedance 8 ohms. Response 30-20,000 Hz ±5 dB. Includes 16-ft coiled cord and zippered storage case ..... $49.95

**SP-206 Stereo Headset**
Features Mylar speakers and vented housing with bass-reflex-type enclosure. Has individual volume and tone controls. Response 20-20,000 Hz ±4 dB. Impedance 8 ohms. Stereo/mono switch. Comes with 25-ft coiled cord and zippered storage case ..... $59.95

## OLSON

**PH-192 Dynamic Headphones**
Stereo design with volume controls. 7-ft cord. Response 20-20,000 Hz. Impedance 8 ohms ..... $39.98

**PRO-213 Headphones**
Features calibrated volume and tone controls on each earpiece. Response 20-20,000 Hz. Vinyl-covered foam-padded ear cushions & headband. 10-ft coiled cord with ¼" plug. 8 ohms ..... $42.98

**PH-173 Stereo Headphones**
Response 25-18,000 Hz. Impedance 4-16 ohms. Includes 20-ft cable with ¼" three-circuit phone plug ..... $32.98

## PICKERING

**OA-1 Headphones**
Lightweight, open-air design. 8 ohms. Max. input 300 mW. Sensitivity: 100 dB at 600 Hz. Response 30-19,000 Hz. Is equipped with 7-ft cord ..... $19.95

## PIONEER

**SE-305 Headphones**
Dynamic stereo type; 8 ohms each channel. Response 20-20,000 Hz. Sensitivity 108 dB/0.3 V; maximum input 500 mW each channel. 16-ft, 5-in coiled cord ..... $34.95

**SE-505 Headphones**
Two-way stereo dynamic design with a woofer & tweeter in each phone: 8 ohms each channel.

# 5 Headphones

Response 20-20,000 Hz. Sensitivity 108 dB/0.3 V; Features both tone & volume controls on each phone. maximum input 500 mW each phone. With 16-ft, 5-in coiled cord .... $59.95

### SE-20A Headphones

Dynamic type. Response 20-18,000 Hz, 4-16 ohms impedance. 0.5 W max. input per phone.

8-ft. coiled cord with a 3-conductor stereo plug. 13 ounces ..... $24.95

### SE-30A Headphones

Dynamic design, 4-16 ohms. Response 20-20,000 Hz. Sensitivity 115 dB/0.3 V (400 Hz, artificial ear). Max. input 2 V per phone. 2¾" driver unit. Supplied with 16-ft. coiled cord with 3-conductor phone plug. 13.4 ounces ..... $34.95

### SE-L20 Headphones

Dynamic type. Response 20-20,000 Hz, 4-16 ohms impedance. 0.3 W max. input per phone. Features specially designed high-molecular-film diaphragm 1½" speaker in each earpiece. ..... $29.95

### SE-L40 Headphones

Features open-back design. 4 to 16 ohms. Maximum input 0.5 V. Response 20-20,000 Hz; sensitivity 96 dB/0.1 V. Has 1½" dynamic speaker. 9¾-ft cable. Comes with carrying case ..... $39.95

### SE-100J Electrostatic Headphones

Features an electret element and therefore does not require a d.c. power supply. The electret element is a push-pull static-type two-way system. Response 20-35,000 Hz. Is supplied with the company's JB-100 adapter which connects to output terminals (4-16 ohms). Will adjust output signal strength. Adapter size 5⅜" W × 3⅛" H × 8⅜" D. Comes with 8.2-ft cable. ..... $129.95

## RADIO SHACK

### Nova-15 Headphones

Dynamic type. Ported open-back earcups. Response 20-20,000 Hz. 10-ft cord. 4 to 16 ohms impedance ..... $19.95

### Pro-1 Headphones

Dynamic type. Response 10-24,000 Hz; 8 ohms impedance; 10-ft. coiled cord; fluid-filled ear cushions. Has individual earphone volume controls ..... $49.95

### Custom Pro Headphones

Dynamic type. Response 20-20,000 Hz. Impedance 4 to 16 ohms; bass port ..... $23.95

### Nova Pro Headphones

Stereo dynamic design with volume controls on each earcup. Response 20-20,000 Hz; 8 ohms impedance. 10-ft. coiled cord ..... $29.95

## SANSUI

### SS-2 Dynamic Headphones

Moving-coil type. Response 20-18,000 Hz, distortion 1% at 1 mW. 8 ohms impedance. 500 mW max. input per phone. 6-ft. cord. 12.6 ounces. Black and white ..... $16.95

### SS-10 Dynamic Headphones

Moving-coil type. Response 20-20,000 Hz. 8 ohms impedance. 500 mW max. input per phone. 10-ft. coiled cord. Has individual headphone volume controls and "Y" connector on additional 6.5-ft. cord for simultaneous use of extra headset. 22 ounces. Cream ..... $32.95

## SCINTREX

### Mark IV Stereophones

Features flat response 15-20,000 Hz; response 20-15,000 Hz ±3 dB. Sensitivity (100 dB SPL)

10 mW. Maximum input 2 W; max. output 120 dB. HD 0.6% at 1000 Hz at max. dB. Ambient noise isolation 40 dB at 1000 Hz. 4-8 ohms impedance. Cycolac ear cups and fluid-filled ear cushions. Features patented dual-driver cavity assembly. Comes with 10-ft coiled cord with special strain-relief feature. Black with chrome-plated headband. 18 oz ..... $45.00

### 98 Stereophones

Features patented dual-cavity design and contoured response for accented bass and treble to match hearing characteristics. 4-300 ohms impedance. Sensitivity 6 mW; max. input 1 W; max. output 110 dB. Response 15-20,000 Hz. HD 1% at 1000 Hz at max. dB. Ambient noise isolation 40 dB at 1000 Hz. Cycolac ear cups and liquid-filled ear cushions. Chrome-plated headband. Comes with 10-ft coiled cord with strain-relief feature. 16 oz ..... $33.00

### PRO-500 Stereophones

Response 15-20,000 Hz; 20-18,000 Hz ±3.5 dB. HD 0.9% at 1000 Hz at max. dB. Sensitivity (100 dB SPL) 4 mW; max. input 1 W; max. output 110 dB. 4-16 ohms impedance. Ambient noise isolation 40 dB at 1000 Hz. Equipped with patented dual-driver cavity assembly. Liquid-filled ear cushions. 10-ft coiled cord with strain-relief feature. 18 oz ..... $60.00

### 10/10 Stereophones

Response 15-20,000 Hz; 30-14,000 Hz ±3 dB. 4-8 ohms impedance. Sensitivity (100 dB SPL)

10 mW. Maximum input 2 W; max. output 120 dB. HD 0.6% at 1000 Hz at max. dB. Ambient noise isolation 40 dB at 1000 Hz. Has Cycolac ear cups and liquid-filled ear cushions. Equipped with dual-driver cavity assembly. Blue/chrome. 10-ft coiled cord with strain-relief feature. 18 oz. ..... $39.95

### 88 Stereophones

Lightweight (9 oz) circumaural design which will withstand rugged use. Impedance 4-16 ohms. Sensitivity (100 dB SPL) 8 mW. Maximum input 1 W; max. output 110 dB. Response 15-20,000 Hz. HD 0.9% at 1000 Hz at max. dB. Ambient noise isolation 10 dB at 1000 Hz. Cycolac ear cups with liquid-filled ear cushions. Has automatic frequency compensation. Black with Polypropylene headband. 10-ft coiled cord with strain-relief feature ..... $19.95

## SENNHEISER

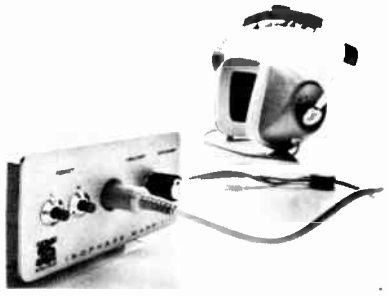
### HD414 Headphone

Dynamic stereo design. 2000 ohms/ch. Response 20-20,000 Hz. Sensitivity 17.7 μbar/V. Normal power 1 mW/ch (1.41V) for sound pressure of 102 dB. HD 1% at 22 V & 1000 Hz. Can be connected to any preamp output. 5 ounces without cord. 10-ft. cable ..... $39.95

## STANTON

### Isophase Electrostatic Headphones

Electrostatic design. Response 30-15,000 Hz ±3 dB. Sensitivity 2 V for 100 dB (SPL) sound pressure level at 1000 Hz. Distortion 1% at 115 SPL. Impedance 4-16 ohms. Has automatic cut-out circuit at 110 dB SPL. Supplied with Mark III electrostatic polarizer unit (also switches from headset to main speaker operation). Power requirements 120 V a.c., 4 W. For use with power amplifiers of 10 W or over. 11-



ft. cord. 15 ounces. 4¾" W × 7⅝" D × 2¾" H. Beige and cream. ..... $159.95
Second headset ..... $75.00
2-headset "Y" adapter ..... $9.95
10-ft. extension cord ..... $15.95

### Dynaphase Sixty Headphones

Dynamic design; two-way system—woofer & tweeter with individual LC crossover. Response 40-11,000 Hz ±3 dB. Sensitivity 95 dB for 1

mW at 1000 Hz (100 dB sound pressure level). Distortion 1% at 115 dB SPL. Impedance 12 ohms. Power input 0.5 W rms max. per phone. 10-ft. coiled cord. 28 ounces. Can use same accessories as the Dynaphase Forty. Blue and black ..... $59.95

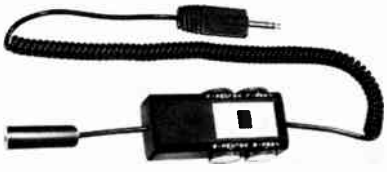
### Dynaphase Forty Headphones

Dynamic design. Response 60-10,000 Hz ±3 dB. Distortion 1% at 115 dB SPL. 12 ohms

impedance at 1000 Hz; Power input 0.5 W rms max. per phone. 10-ft cord. 21 ounces. Blue-black/chrome ..... $39.95
**Model 5748.** Same as Dynaphase Forty except 600 ohms imp ..... $47.95

### Dynaphase Seventy-Five Headphones

Dynamic design with remote control for volume & tone, 13-ft coiled cord. Response 40-11,000 Hz ±3 dB. Sensitivity 100 dB SPL (at 0.11-V at 1000 Hz). Max. input 0.5 W rms; dist. 1.0% with 115 dB SPL. Input 12 ohms imp. Features two-way design with separate woofer & tweeter with LC crossover network. 28 ounces ..... $74.95
**Model 5741.** Same as used on Dynaphase Seventy-Five. Separate volume & tone controls



for each channel, stereo/mono switch & 17-ft. extension coiled cord ..... $19.95
**Model 5742.** 25-ft. extension coiled cord $7.95

### Dynaphase Fifty Headphones

Same as Dynaphase Forty except has volume control on each earpiece ..... $49.95

## STAX

### SR3 Stereo Headset

Electrostatic design supplied with matching power-supply unit. Frequency range 25-30,000 Hz. Capacitance 120 pF including cord. Maximum sound level 115 dB. Use with any amplifier of 5 W or more. Has connections for two headsets, switch for loudspeaker or headphone, and an 8-ft cord ..... $125.00
Power supply alone ..... $45.00
Headset alone ..... $85.00
Extension cord ..... $14.95

### SRA-3S Headphone Amplifier

Features inputs for magnetic phono, Stax condenser cartridge (hi-level), and aux. Outputs for

two Stax headphones (or up to four, using two extension cords), tape recorder. Includes filter and stereo/mono switches. 5" W × 4" × 11" D ..... $165.00

## SUPEREX

### PEP-79 Electrostatic Headphones

Frequency response 10-22,000 Hz ±5 dB. Consists of PEP-71 stereophone (same as in PEP-

77D) and console that accommodates one set of stereophones. Designed to use level controls of main amplifier or receiver; no a.c. connection. Console wood-grain vinyl over steel ..... $85.00

### ST-F "Feather-Fone"

Weighs only 8 ounces (excluding 15-ft coiled cord) with a 25-17,500 Hz response. Maximum power 0.5 watt. Ivory/Cordovan ..... $24.95

### ST-C "Challenger"

Dynamic stereophones with 40-15,000 Hz re-

sponse. Double post and yoke headband. Cordovan ..... $19.95

### ST-N "Newport"

Contemporary design dynamic stereophones

with post and yoke headband. Response 30-15,000 Hz. Cordovan ..... $19.95

### PRO-B-VI Headphones

Has acoustic-suspension woofer and ceramic tweeter. Response 16-25,000 Hz. 4 to 16 ohms

impedance. 2 W maximum input per phone. 15-ft. coiled cord. Cordovan or transparent ..... $60.00

### ST-M Stereo Master Headphones

Has moving-coil dynamic woofer and ceramic tweeter. Response 20-20,000 Hz. 8 to 16 ohms impedance. 2 W maximum input per phone.

## 5 Headphones

Tweeter level control on each earphone. Has 7-ft. cord ..... $29.95

### ST-PRO-B Headphones

Moving-coil dynamic woofer and ceramic tweeter. Response 18-22,000 Hz. 4 to 16 ohms impedance. 2 W maximum input per phone. 7-ft. cord ..... $50.00

### PEP-77D Electrostatic Headphones

Frequency response 10-22,000 Hz ±5 dB. 4 to 16 ohms impedance. 5 W minimum input to

energizer. Uses "console" energizer (included). Provides two-phone accommodation and separate channel grounds. 15-ft. coiled cord. 12 ounce headphones ..... $120.00

### ST-V Headphones

Moving-coil dynamic type. Response 30-18,000 Hz. 4 to 16 ohms impedance. 2 W maxi-

mum input per phone. Individual earphone volume controls. 15-ft. coiled cord ..... $30.00

### EA500 Stereo-Headphone Amp

Compact, solid-state design. Response 20-20,000 Hz ±1 dB at maximum volume setting, tuner input, and with both channels driven. THD less than 0.5%. Maximum sine-wave out-

put: 500 mW into 8 ohms both channels driven. Hum level 75 dB below full output on mag. phono inputs. Unit has front-panel input (tuner-phono) selector, left & right volume controls, two parallel stereo headphone jacks, illuminated power switch, rear-panel mag. phono input, tuner input. 3" × 10¾" × 8⅓" D ..... $80.00

### TEAC

### HP-101 Dynamic Headphones

Stereo design. Frequency response 18-20,000 Hz. 8 ohms. Input sensitivity 1 mW, maximum power 500 mW. 6-ft. cable ..... $37.00
**HP-102.** Same as HP-101 except 10,000 ohms impedance ..... $37.00

### TELEDYNE

### PH-222 Stereo Headphones

"Open-back" design with each earcup having a ported back and "open-air" polyfoam cushions. Response 25-18,000 Hz. 6 ounces ... $24.98

### PH-219 Electrostatic Headphones

Stereo design with an electrostatic driver in each earcup. Response 25-19,500 Hz. Fluid-filled ear cushions. Comes complete with energizer, speaker/headphones switch, 10-ft coiled cord, and standard ¼" plug ..... $59.98

### TELEX

### Studio 1 Headphones

Dynamic design. Response 20-22,000 Hz. Sensitivity 105 dB SPL/mW. Distortion 1.0% at

122 dB SPL. 3 to 16 ohms impedance. 1.0 W maximum input per phone. Has tone & volume controls on each earphone. 15-ft. coiled cord. 24 ounces ..... $69.95
**Studio 2.** Same except without controls ..... $59.95

### 100 Stereo Headphones

Dynamic design for rough handling. Available in yellow, blue, and orange finishes. 8-ft cord. 8 ohms impedance ..... $15.95
**200.** Designed for additional comfort. Has volume control on each earpiece. 10-ft cord. Forest green ..... $24.95

### 300 Stereo Headphones

Dynamic design. Has 15-ft coiled cord. 8 ohms.

Gold with cinnamon brown trim ..... $34.95
**400.** Designed for additional convenience. Has volume control on each earpiece. Black with gray trim ..... $44.95

## 5 Microphones

### ADVENT

### MDC-1 Microphones

Matched pair of low-impedance microphones.

Cardioid pickup pattern. Frequency response 50-16,000 Hz. Balanced output. Has 20-ft cables and stands. Pair ..... $90.00

### AKG

### D-109 Dynamic Microphone

Sensitivity −56 dB ASA. Response 50-15,000 Hz ±3.5 dB. 200 ohms impedance. Omnidirectional pattern. Use for speech. Has lavalier, dust filter or windscreen, 30-ft. cable, and chrome finish. Connector not included . $49.00

### D-160E Dynamic Microphone

Sensitivity −55 dB ASA. Response 50-15,000 Hz ±3 dB. 200 ohms impedance. Omnidirectional pattern. Use for tape recording. Has slip-in stand attachment, dust filter or windscreen, with detachable windscreen. With windscreen presence rise, without windscreen linear response. Comes with 15-ft. cable, XLR connector, and chrome finish ..... $60.00

### D-190E Dynamic Microphone

Sensitivity −53 dB ASA. Response 40-15,000 Hz ±3 dB. 200 ohms impedance. Cardioid pat-

tern. Use for music. Has slip-in stand attachment, dust filter or windscreen, XLR connector. Comes with 15-ft. cable ..... $55.00
**Model D-190TS.** Same as D-190E except high impedance operation with "on-off" switch. Has 24-ft. cable and phone plug ..... $70.00

### D-200E Dynamic Microphone

Sensitivity −55 dB ASA. Response 30-15,000 Hz ±3 dB. 200 ohms impedance. Cardioid pat-

tern. Use for music and tape recording. Has slip-in stand attachment, dust filter or windscreen. Comes with 15-ft. cable, XLR connector, matte grey finish ..... $75.00
**Model D-200TS.** Same as D-200E except for high impedance operation with "on-off" switch, 24-ft. cable, and phone plug .. $90.00

### D-707E Dynamic Microphone

Sensitivity −52 dB ASA. Response 50-15,000 Hz ±3.5 dB. 200 ohms impedance. Cardioid pattern. Use for tape recording. Comes with slip-in stand attachment, pop or blast filter, chrome finish, 15-ft. cable, and XLR connector ..... $45.00
**Model D-707TS.** Same as D-707E but for high impedance operation with "on-off" switch, 24-ft. cable, phone jack ..... $60.00

### D-1000E Dynamic Microphone

Sensitivity −53 dB ASA. Response 40-16,000 Hz ±3 dB. 200 ohms impedance. Cardioid pattern. Use for rock vocals. Has slip-in stand attachment, pop or blast filter, chrome finish, 15-ft cable, and XLR connector ..... $65.00
**Model D-1000TS.** Same as D-1000E but for high impedance operation with "on-off" switch, 24-ft. cable, and phone plug .. $80.00

## BEYER

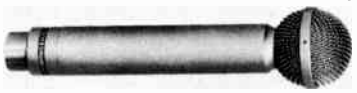
### M-500 Dynamic Ribbon Microphone

Super-cardioid; response 40-18,000 Hz ±2.5 dB. Sensitivity: −153 dBm (EIA); 200 ohms imp.

Has four-stage integral blast filter and Cannon XLR termination. Especially designed for rock vocals; low pop and breath noise even when singer's lips touch microphone ..... $105.00

### M-160 Double-Ribbon Microphone

Super-cardioid dynamic type. Response 40-18,000 Hz ±2.5 dB. Sensitivity: −152 dBm



(EIA); 200 ohms impedance. Low sensitivity at 120 degrees to axis. Suitable for stereo recording. Cannon XLR termination ..... $180.00

### M-260 Dynamic Ribbon Microphone

Super-cardioid design. Response 50-18,000 Hz ±2.5 dB. Sensitivity −153 dBm (EIA). High-energy ribbon. 200 ohms imp. Suitable for speech, music, or vocals 1¾" mesh head ×6" long. Cannon XLR termination ..... $90.00
**M-260SM.** Same as M-260 except with "on-off" and bass-cut switch ..... $105.00

### M-550LM Moving-Coil Microphone

Omnidirectional dynamic type. Response 70-18,000 Hz. For tape recording and general applications. Sensitivity: −152 dBm (EIA); will work with all impedances. Suitable for use indoors and outdoors. Comes with clamp, table stand, cable with jack plug. ..... $30.00
**M-550LMS.** Same as M-550LM except with "on-off" switch ..... $35.00

### M-810-N Moving-Coil Microphone

Dynamic cardioid design. Response 50-16,000 Hz. Sensitivity: −148 dBm. Suits all impedances. Designed for tape recording applications. Comes with windshield, clamp, and detachable 16-ft cable with jack, all housed in lined case ..... $45.00

### "Soundstar" X1N Dynamic Microphone

Dynamic cardioid design. Response 30-18,000 Hz ±2.3 dB. Sensitivity: −146 dBm (EIA); 200 ohms imp. Front-to-back attenuation greater than 20 dB. For tape recording, music, and vocals. Has built-in pop screen and hum compensation coil. Cannon XLR termination. . $65.00
**"Soundstar" X1HL.** Same as X1N except with high/low imp. switch ..... $75.00

### M-69 Moving-Coil Microphone

Dynamic cardioid design. Response 50-16,000 Hz ±3 dB. Sensitivity: −144 dBm (EIA); 200 ohms imp. For indoor/outdoor applications; unaffected by temperature or humidity. . $75.00
**M-69-SM.** Same as M-69 but with "on-off" and bass-cut switch ..... $90.00

### M-67 Moving-Coil Microphone

For tape recording, interviewing, and general outdoor/indoor work. Cardioid type. Response

40-18,000 Hz ±2.5 dB. Sensitivity: −148 dBm (EIA); 200 ohms imp. Special transducer mounting minimizes handling noise. Has built-in "on-off" bass-cut switch. 7¾" × 1½". Cannon XLR termination ..... $95.00

### M-101 Moving-Coil Microphone

Omnidirectional type. Response 40-20,000 Hz. Sensitivity: −150 dBm (EIA); 200 ohms imp.

Withstands pressures associated with modern music (modulated voltages up to 2 V).Low handling noise. 4½" × ⅞". Cannon XLR termination ..... $85.00

### M-201 Moving-Coil Microphone

Super-cardioid dynamic type. Response 40-18,000 Hz. Sensitivity: −149 dBm (EIA); 200

ohms imp. 6" × 15/16". Cannon XLR termination ..... $150.00

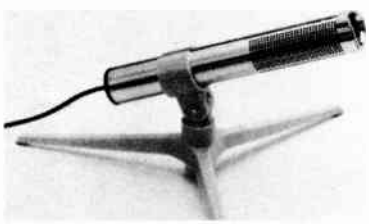
### M-88 Moving-Coil Microphone

Super-cardioid dynamic type. Response 30-20,000 Hz ±2.5 dB. Sensitivity: −144 dBm (EIA).Special transducer mounting eliminates body noise. Will withstand rough handling, humidity and temperature changes. For studio work, recording artists, and instrumentalists ..... $175.00

## ELECTRO-VOICE

### 621 Dynamic Microphone

Response 150-12,000 Hz ±2 dB. Specify high or low impedance when ordering. Cardioid pat-



tern. Supplied with slip-in stand attachment, desk stand, mike stand adapter. Use for music and tape recording. Comes in a matte satin finish. ..... $19.95

### 635A Dynamic Microphone

Sensitivity −149 dB EIA. Response 80-13,000 Hz ±3 dB. 150 ohms impedance. Omnidirectional pattern. Hand-held with slip-in stand attachment and lavalier neckcord assembly. Use for tape recording and broadcasting. Has a four-stage pop or blast filter, 18-ft. cable, Switchcraft A3F connector. Fawn beige matte finish ..... $56.70

### 670 Dynamic Microphone

Sensitivity −152 dB EIA. Response 60-14,000 Hz. User selects high or low impedance. Single-D cardioid. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has built-in "Acoustifoam" pop or blast filter, "on-off' switch, 15-ft. cable, and Switchcraft A3F connector. Frequency response varies with distance from microphone (maximum bass response is ¼" from source). Features an anodized brass finish ..... $45.90

### 670V Dynamic Microphone

Sensitivity −152 dB EIA. Response 60-14,000 Hz. User selects high or low impedance. Sin-

gle-D cardioid. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has built-in "Acoustifoam" pop or blast filter, "on-off" switch, 15-ft. connector, and Switchcraft A3F connector. Features a special thumb-actuated volume control for user convenience. Bass response varies with distance from sound source. Anodized finish ..... $50.10

### 674 Dynamic Microphone

Sensitivity −152 dB EIA. Response 60-15,000 Hz ±6 dB. User selects high or low impedance. Cardioid pattern. Use for speech, music, and tape recording. Comes with "on-off" switch, a ⅝"-27 thread for stand mounting, 15-ft. cable, built-in three-position bass tilt-off control, and E-V QC-4M "quick change" connector. Satin chrome finish ..... $61.35
**Model 674G.** Same as Model 674 but with gold finish ..... $64.20

### 676 Dynamic Microphone

Sensitivity −151 dB EIA. Response 60-15,000 Hz ±5 dB. User selects high or low impedance. Cardioid pattern. Has a slip-in stand attachment, 15-ft. cable, built-in three-position bass tilt-off control, and QC-4M connector. Windscreen available as an optional extra. Satin chrome or non-reflecting gray finish .. $61.35
**Model 676G.** Same as Model 676 except gold finish ..... $64.20

### 1710 Condenser Microphone

Sensitivity −142 dB EIA. Response 80-13,000 Hz. 150 ohms unbalanced; omnidirectional pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has a built-in "Acoustifoam" pop or blast filter, "on-off" switch, 18-ft. cable with permanent strain relief. Connector not included. Beige anodized with gray enamel trim ..... $39.75

### 1711 Condenser Microphone

Sensitivity −142 dB EIA. Response 60-15,000 Hz. 150 ohms balanced. Omnidirectional pat-

# 5 Microphones

tern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has built-in pop or blast filter, "on-off" switch, 18-ft. cable with Switchcraft A3F connector. Impervious to extremes of humidity or temperature. Beige anodized with gray enamel trim ..... $59.70

### 1750 Condenser Microphone

Sensitivity −137 dB EIA. Response 80-13,000 Hz. 150 ohms unbalanced. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has built-in pop or blast filter, "on-off" switch, 18-ft. cable with permanent strain relief. Beige anodized with gray enamel trim. Connector not included ..... $45.00

### 1751 Condenser Microphone

Sensitivity −137 dB EIA. Single-D cardioid. Response 60-15,000 Hz. 150 ohms balanced.

Hand-held with slip-in stand attachment. Use for tape recording, p.a., and sound reinforcement. Has built-in pop or blast filter, "on-off" switch, 18-ft. cable, and Switchcraft A3F connector. Beige anodized with gray enamel trim ..... $75.00

### RE10 Dynamic Microphone

Response 90-13,000 Hz. Super-cardioid polar pattern. 150 ohms impedance. Output −56 dB

(0 dB = 1 mW/10 dynes/cm²). Sensitivity −150 dB EIA. Has 18-ft. cable. 6¾" × 1⅜" with carrying case ..... $99.60

### RE55 Dynamic Microphone

Response 40-20,000 Hz. Omnidirectional pattern. 150 ohms impedance. Output −55 dB (0

dB = 1 mV/10 dynes/cm²). Sensitivity −149 dB EIA. 18-ft. cable. 10½" × 1⅞₂" with carrying case ..... $149.40

All of the above prices are "Net"

## HITACHI

### NDM-32 Dynamic Microphone

Sensitivity −78 dB. Response 70-12,000 Hz ±4 dB. Impedance 600 ohms. Omnidirectional with desk stand. Use for speech and recording applications. Supplied with plug connector and wind screen. 16-ft. cable. Black ..... $35.00

## LAFAYETTE

### Deluxe Ball Dynamic Microphone

General-purpose, omnidirectional, dual-impedance (50,000 & 250 ohms), selectable at cable end. Output at high impedance −59 dB. Frequency response 100-10,000 Hz. Has "on-off" switch. Includes ball screen, 6-ft detachable cable with mike plug at one end, black metal desk stand, and floor-stand adapter. Die-cast case finished in satin aluminum. Case is 6¼" long × 2⅛" max. dia. of ball ..... $15.75

### Condenser Microphone

Unidirectional cardioid pattern with high front-to-back rejection ratio and flat frequency response from 30-16,000 Hz. Impedance 600 ohms but can be used with inputs up to 20,000 ohms. FET circuitry. Powered by one "AA" penlite cell. Foam windscreen, 15-ft shielded cable, standard ¼" phone plug, metal tripod-type desk stand, floor-stand adapter, and battery are included ..... $24.95

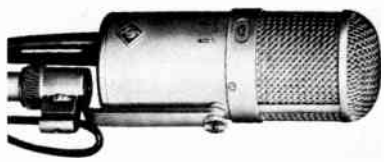
### Modern Dynamic Microphone

Lightweight omnidirectional dual impedance (50,000 & 250 ohms), selectable at cable. Response 100-10,000 Hz. Output −60 dB. "On-off" slide switch. Comes with floor-stand adapter, 20-ft detachable cable with mike plug, and wire mesh grille. Tapered metal case finished in satin-black and aluminum. 7" long × 1⅜" dia .. ..... $12.40

## NEUMANN

### FET-80 Condenser Microphones

A line of studio microphones that come in many configurations from omni, figure-8, cardioid,



multiple pattern to multiple pattern stereo. All can be either battery or phantom (separate power supplies) powered.

U-47FET ..... $390.00
Other FET-80 models ..... from $216.00

## OLSON

### MK-035B Omnidirectional Microphone

Dynamic type. Features "on-off" switch; 50,000 ohms imp.; 20-ft shielded cable with ¼"

plug. Output −60 dB at 1000 Hz. Response 100-10,000 Hz. Clamp-on mike holder with standard ⅝"-27 threading ..... $15.95

### MM-340B Cardioid Microphone

Features sliding volume control, breath filter, "on-off" switch; 20-ft cable with ¼" plug. 50,-

000 ohms imp. Output −54 dB. Response 100-15,000 Hz. 7¼" × 1¾" dia ..... $19.98

### MM-327B Dynamic Microphone

Cardioid design. Dual impedance (600 & 50,-

000 ohms) with selector switch. Response 55-14,000 Hz. Output −54 dB (high imp.), −72 dB (low imp.). Has built-in filter for anti-feedback & close-to-mouth use. With stand adapter and 20-ft. cord ..... $22.98

### MM-308B Cardioid Microphone

Cardioid design featuring anti-feedback circuit and built-in pop & windscreen. Response 60-14,000 Hz. High (50,000 ohms) & low (600 ohms) impedance. Comes with 20-ft cable with ¼" plug. Bright chrome finish. 7½" long × 1⅜" dia ..... $19.98

### MM-301B General-Purpose Microphone

Dynamic, ball-screen design. Cardioid pattern with dual impedance (50,000 & 600 ohms). Response 100-12,000 Hz. Comes with stand adapter and 20-ft cable with ¼" plug. Black and chrome finish. 6½" long × 1¾" dia .... $18.98

## RADIO SHACK

### Pro-100 Microphone Kit

Supplied as a pair with 13-piece accessory package including wind screens, table stands, floor stand adapters, lavalier cords, and cables. Response 10-10,000 Hz. Switchable 250 and 10,000 ohm impedance ..... $29.95

### Highball Dynamic Microphone

Cardioid design. Response 50-15,000 Hz. Features "on-off" switch and internal push-on impedance change 50/250 ohms or 50,000 ohms. Has pop filter and 15-ft. cable .. $39.95

### Highball 5 Dynamic Microphone

Cardioid design. Response 70-13,000 Hz. Has change plug for 600 to 20,000 ohm impedance. Includes stand adapter and 15-ft. cable ..... $28.95

### Electret-1045 Condenser Microphone

Cardioid design. Response 30-15,000 Hz. Can be switched from low imp. (600 ohms) to high

imp. (20,000 ohms). Has windscreen and desk stand. Powered by single penlight battery ..... $29.95

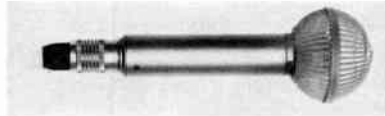
### Electret-1044 Condenser Microphone

Omnidirectional pattern. Response 30-15,000 Hz. Can be switched from 600 to 20,000 ohm impedance. Has foil diaphragm, windscreen, and mike stand. Powered by single penlight battery ..... $24.95

## SENNHEISER

### MD-211U Dynamic Microphone

Omnidirectional unit. Response 40-20,000 Hz. Sensitivity −58 dBm (0.13 mV/μbar) ±2.5 dB.



Has extremely wide, flat response unusual in a moving-coil microphone. 4¾" × 1" dia. Fitted with Cannon XLR connector ..... $159.00

### MD21N Dynamic Microphone

Omnidirectional, 200-ohm impedance design. Response 50-15,000 Hz ±3 dB. Sensitivity 0.2

mV/μbar at 1000 Hz. EIA rating −145.8 dB. Output level −53 dBm (1 mW/10 dynes/cm²). Fitted with small Tuchel connector. Has balanced output. 10 ounces. 4¾" × 1⅞" × 1⅞". ..... $90.00

### MD421U Dynamic Microphone

Cardioid, 200-ohm impedance design. Response 30-17,000 Hz ±5 dB. Sensitivity 0.2 mV/

μbar ±3 dB at 1 kHz. EIA rating −145.8 dB. Output level −53 dBm (1 mW/10 dynes/cm²). Has front-to-back ratio 18 dB, −2 dB and a variable bass attenuator. Fitted with XLR connector. 14 ounces. 7" × 1⅞" × 1 13/16" .... $134.00

### MD411HLM Dynamic Microphone

Super-cardioid. Features a built-in triple-impedance transformer to permit mike to be

connected directly to any tape recorder. High impedance is 25,000 ohms for tube units; 800 ohms medium impedance for transistor recorders; 200 ohms low impedance for recorders of either type fitted with low-impedance input transformers. Response 50-12,000 Hz. Side attenuation 20 dB at 120 degrees. Sensitivity 1.25 mV/μbar at 1 kHz: EIA rating −154 dB; output level −58.1 dBm (1 mW/10 dynes/cm²) all at high-imp. setting. Comes with table stand, floor stand adapter, and zippered case. 8 ounces ..... $54.00

### MD441 Dynamic Microphone

Super-cardioid design. Response 40-20,000 Hz; sensitivity 0.2 mV/μbar ±3 dB. Has brilli-

ance switch for nominal 5 dB boost at 5 kHz; 5-position bass attenator. Front-to-back ratio is 20 dB, −3 dB. Comes with quick-release mount that fits on floor stand or accessory table stand MZT-441. Windscreen for microphone is Model MZW441. 1.3" H × 1.4" W × 9.6" long . $205.00

## SHURE

### 300 Ribbon Microphone

Sensitivity −153 dB (EIA). Response 40-15,000 Hz. User selects high or low impedance. Bi-directional. Hinge mount to stand. Use for speech and music. Has 20-ft. cable and connector. Gray ..... $102.60

### 515SA "Unidyne B" Microphone

Dynamic type. Sensitivity −154 dB (EIA). Response 80-13,000 Hz. High impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, and music. Has "on-off" switch and 15-ft. cable. Chrome finish ..... $27.00
**Model 515SB.** Same as Model 515SA except low impedance ..... $27.00

### 545 "Unidyne III" Microphone

Dynamic type. Sensitivity −149 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. With slip-in stand attachment and hinge mount to stand. Designed specifically for speech, music, and tape recording. Supplied with 15-ft. cable and Amphenol-type MC4M connector. Chrome finish ..... $57.60
**Model 545S.** Similar to Model 545 but has cable connection through hinge and "on-off" switch in upright ..... $61.20
**Model 545SD.** Same as Model 545 but has "on-off" switch on microphone barrel ..... $61.20
**Model 545L.** Similar to Model 545 but has lavalier cord and clip ..... $48.00

### 546 "Unidyne III" Microphone

Dynamic type. Sensitivity −154 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hinge mount to stand. Use for speech, rock vocals, and music. Comes with 20-ft. cable and connector. Chrome finish. ..... $93.00

### 548SD "Unidyne IV" Microphone

Dynamic type. Sensitivity −141 dB (EIA). Response 40-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech and music. Has "on-off" switch, 15-ft. cable, and connector. Chrome finish ..... $72.00

### 55S Dynamic Microphone

Sensitivity −148 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hinge mount to stand. Use for speech and music. Supplied with Amphenol-type MC3M connector and 15-ft. cable. Chrome finish ..... $57.00
**Model 55SW.** Same as Model 55S except has built-in "on-off" switch ..... $58.80

### 565 "Unisphere 1" Microphone

Dynamic type. Sensitivity −148.5 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hinge mount to stand. Use for speech, rock vocals, and music. Has pop or blast filter, 15-ft. cable, and connector. Chrome finish ..... $64.80
**Model 565SD.** Same as Model 565 except has "on-off" switch ..... $67.80
**Model 566.** Similar to Model 565 except with shock mount ..... $99.00

### 578 Dynamic Microphone

Sensitivity −154 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Omnidirectional pattern. Hand-held. Use for speech and music. Has "on-off" switch, a 15-foot cable, and connector. Supplied with chrome finish ..... $54.00
**Model 578S** Similar to Model 578 except has swivel assembly ..... $60.00

### 580SA(B) Dynamic Microphone

Sensitivity −151 dB (EIA). Response 50-13,000 Hz. User specifies high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech and music. Comes with "on-off" switch, 15-ft. cable, and connec-

# 5 Microphones

tor. Chrome finish ..... $42.00

### 585SA(B) Dynamic Microphone

Sensitivity −151 dB (EIA). Response 50-13,000 Hz. User specifies high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, and music. Has pop or blast filter, "on-off" switch. Supplied with 15-ft. cable and connector. Chrome finish ..... $45.00
**Model 585SAV.** Similar to Model 585SA(B) but has volume control on microphone barrel ..... $49.80

### 588SA(B) Dynamic Microphone

Sensitivity −155 dB (EIA). Response 80-13,000 Hz. User specifies high or low impedance. Car-

dioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, and music. Has pop or blast filter, "on-off" switch. Comes with 15-ft. cable and connector. Chrome finish ..... $34.00

### 579SB Dynamic Microphone

Sensitivity −151 dB (EIA). Response 50-15,000 Hz. Low impedance, omnidirectional pattern. Has slip-in stand attachment, "on-off" switch, pop or blast filter. Use for speech, rock vocals, and music. Supplied with 20-ft. cable and connector. Chrome finish. ..... $45.00

## SONY/SUPERSCOPE

### ECM-16 Condenser Microphone

Sensitivity −57.8 dB (0 dB = 1 V/10 μbar). Response 50-13,000 Hz. Low impedance, omnidirectional pattern. Lavalier-type for speech and tape recording. Supplied with mini connector. Internal battery operation. 6-ft. cable. 9/16" dia. × 1 9/16" long. Silver .... $34.95

### ECM-18 Condenser Microphone

Sensitivity −56.8 dB (0 dB = 1 V/10 μbar). Response 50-12,000 Hz. Low impedance, cardioid pattern. Hand-held type for speech, music, and tape recording. Supplied with mini connector, dust filter or windscreen. 6.5-ft. cable. Internal battery operation. Silver gray and black ..... $24.95

### ECM-19B Condenser Microphone

Sensitivity −54 dB (0 dB = 1 V/10 μbar). Response 50-12,000 Hz. Cardioid pattern. Hand-

held type with "slip-in" stand attachment. Use for speech, music, and tape recording. Supplied with mini connector, dust filter or windscreen. Internal battery operation. 9-ft. cable. Silver and black ..... $34.95

### ECM-21 Condenser Microphone

Sensitivity −54 dB (0 dB = 1 V/10 μbar). Response 50-12,000 Hz. Low impedance, bal-

anced 50, 250, 600 ohms. Cardioid pattern. Hand-held with "slip-in" stand attachment. Use for music and tape recording. Comes with dust filter or windscreen and 19-ft. cable. Connector not included. Internal battery operation. Chrome ..... $54.95

### ECM-22P Condenser Microphone

Sensitivity −54.8 dB (0 dB = 1 V/10 μbar). Response 40-15,000 Hz; Low impedance, bal-

anced 250/600 ohms. Cardioid pattern. Hand-held with "slip-in" stand attachment. Use for speech, rock, vocals, music, and tape recording. Comes with dust filter or windscreen and 20-ft. cable. Connector not included. Internal battery/phantom powering ..... $99.95

### ECM-95S Condenser Microphone

Sensitivity −50 dB (0 dB = 1 V/10 μbar). Response 70-10,000 Hz. Low impedance. Cardioid pattern. Hand-held. Use for speech and tape recording. Supplied with 2-prong mini connector, stop/go switch, and 4.5-ft. cable. Internal battery operation. Silver ..... $22.95

### ECM-99 Condenser Microphone

Sensitivity −53 dB (0 dB = 1 V/10 μbar). Response 50-12,000 Hz. Low impedance. Cardioid (dual) pattern. Hand-held with "slip-in" stand attachment. Use for music and tape recording. Comes with dust filter or windscreen, 10-ft. cable, mini (2) connector, one-point stereo pickup. Internal battery operation. Nickel satin finish ..... $44.95

### F-98 Dynamic Microphone

Sensitivity −58 dB (0 dB = 1 V/10 μbar). Low impedance. Cardioid pattern. Hand-held. Use for speech and tape recording. Supplied with mini connector and 6.5-ft. cable ..... $10.95

## TEAC

### MC-201 Microphone

Electret. Response 50-15,000 Hz. Balanced

600 ohms. Has slip-in stand attachment, windscreen, and 10-ft. cable. ..... $77.00

## TELEDYNE

### EO-200 Omnidirectional Microphone

Electret condenser microphone. Response 30-16,000 Hz. Output −59 dB at 600 ohms. Can be used with most medium- and high-impedance inputs as well. Features an FET frequency converter, XL-type connector; powered by two AA penlite cells. Has non-glare finish, "on-off" switch, integral wind-breath filter, 20-ft shielded cable, and stand adapter. 6 ounces ..... $34.98

### EC-100 Unidirectional Microphone

Same specifications as EO-200 except unidirectional cardioid instead of omni .. $39.98

### EO-300 Omnidirectional Microphone

Lavalier-type electret condenser microphone. Has integral "built-on" tie clasp. 1/2" dia. × 1 1/8" long. Battery-operated power supply built into plug; operates from single mercury cell. Response 50-13,000 Hz; output level −59 dB at 600 ohms. May also be used with most medium- and high-impedance inputs. Non-glare finish. Includes PL-280-type connector and 20-ft shielded cable ..... $19.98

## TURNER

### TC10 Cardioid Microphone

Response 50-15,000 Hz; front-to-back ratio −22 dB; output level −55 dB (0 = 1mW/10 mi-

crobars). 150 ohms imp. Finished in anodized aluminum in desert gold. Each microphone is numbered, registered, and packed in metal carrying case with its own individual response curve ..... $225.00
**TC11.** Similar to Model TC10 with sea grey anodized finish. Response 50-14,000 Hz. Discrimination 20-25 dB. Low imp ..... $125.00
**TC11S.** Same as TC11 but features line-shorting "on-off" switch ..... $130.00
**TC12S.** Same as TC11S but high imp . $130.00
Note: TC series microphones will be available for shipment in September.

### 500 Microphone

Dynamic type. Sensitivity −151 dB (EIA), response 40-12,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment. For use in recording speech, rock vocals, and music. Pop or blast filter. Detachable 20-ft. cable. Supplied with XLR connector. Satin chrome finish ..... $100.00
**Model S-500.** Same except with rotary "on-off" switch ..... $105.00

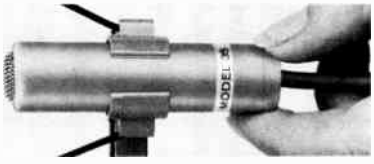
### 600 Microphone

Dynamic type. Sensitivity −151 dB (EIA), response 50-15,000 Hz. High impedance. Car-

dioid pattern. Hand-held with "slip-in" stand attachment. For speech, rock vocals, and music. Pop or blast filter, "on-off" switch. Detachable 20-ft. cable. Satin chrome finish . $70.00
**Model 602.** Same except low-impedance version ..... $70.00

### 35 Microphone

Dynamic type. Sensitivity −151 dB (EIA), response 40-12,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held for use in speech applications. 25-ft. cable. Non-reflecting desert gold finish ..... $70.00



### 700 Microphone

Dynamic type. Sensitivity −151 dB (EIA), response 40-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment. For speech, rock vocals, and music. Pop or blast filter, "on-off" switch. Detachable 20-ft. cable. Comes with Switchcraft A4F connector. Satin chrome finish ..... $95.00

### 2300 Microphone

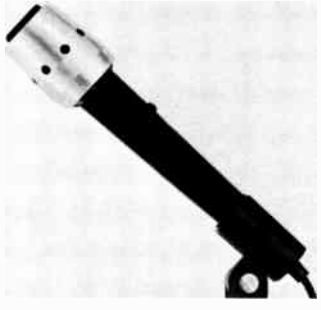
Dynamic type. Sensitivity −151 dB (EIA), response 50-15,000 Hz. High-impedance, omnidirectional. Hand-held with "slip-in" stand attachment. For speech, rock vocals, music, and tape recording. Has 20-ft cable, "on-off" switch, and phone plug. Satin chrome finish ..... $80.00
**Model 2302.** Same except low-impedance version ..... $80.00

### S-2850 Microphone

Dynamic type. Sensitivity −161 dB (EIA), response 70-12,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment, lavalier clip. Use for speech and tape recording. Does not include connector but does have "on-off" switch and 12-ft. cable. Black ..... $50.00

### 45 Cardioid Microphone

Dynamic design. Sensitivity −155 dB (EIA), response 100-13,000 Hz. High impedance. Use for speech, group singing, and music. Supplied with 20-ft. cable, phone plug, stand adapter, and "on-off" switch ..... $45.00
**Model 45A.** Same except low-impedance version ..... $45.00



### 2250 Cardioid Microphone

Dynamic design. Sensitivity −155 dB (EIA), response 70-13,000 Hz. High impedance. Use for speech, rock vocal groups, and music. Supplied with 20-ft. detachable cable, phone plug, stand adapter, and "on-off" switch. Comes with Cryovac carrying case ..... $65.00
**Model 2255.** Same except low-impedance version ..... $65.00

### SRR2811 Omnidirectional Microphone

Dynamic design. Sensitivity −159 dB (EIA), response 80-12,000 Hz. High impedance. Supplied with 12-ft. cable terminated in a variable-spaced, split 2-prong mini plug for cassette recorders. Has "on-off" switch. Black with desk stand ..... $20.00
**SRR2812.** Same except low impedance ..... $20.00

## UNIVERSITY

### 1655 Omnidirectional Microphone

Dynamic design; 200 ohms balanced. Response 50-15,000 Hz. Output −56 dBm (re: 10 dynes/cm²). Has built-in wind/pop filters; standard mounting swivel adapter. Supplied with 18 ft. cable. 6½" long × 1½" diam. tapering to ¾". 6¾ ounces ..... $49.50

### 5100 Dynamic Microphone

Sensitivity − 147 dB (EIA). Response 25-18,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held type with slip-in stand attachment; shock mounted. Has "on-off" switch, satin chrome finish, and 18-ft cable. Connector not included ..... $109.45

### 6000 Dynamic Microphone

Sensitivity − 151 dB (EIA). Response 50-15,000 Hz. Cardioid pattern. Low impedance. Use for speech, rock vocals, music, and tape recording. Has wind screen and sibilance filter. Satin chrome finish and flat black. 18-ft cable. Connector not included ..... $69.58

# 5 Blank Tape

## ADVENT

### Chromium-Dioxide Cassettes

Comes in screw-type housing with special

leader tape that cleans heads. In lots of six, comes with free optional storage album.

C-60 ..... $2.49
C-90 ..... $3.39
C-120 ..... $4.49

## AMPEX

### Reel-to-Reel Tape

General-purpose, 1.82-mil, acetate base, ¼".
311-13 600-ft, 5" reel ..... $2.43
311-15 1200-ft, 7" reel ..... $3.78
High-frequency, polyester base, ¼".
331-13 600-ft, 1.5-mil, 5" reel ..... $2.86
341-13 900-ft, 1.0-mil, 5" reel ..... $3.88
331-15 1200-ft, 1.5-mil, 7" reel ..... $4.59
341-15 1800-ft, 1.0-mil, 7" reel ..... $6.69
351-15 2400-ft, 0.5-mil, 7" reel .... $10.26
361-15 3600-ft, 0.5-mil, 7" reel .... $12.90
High-output, low-noise, polyester base, ¼".
345-15 1800-ft, 1.0-mil, 7" reel ..... $7.93
345-17 3600-ft, 1.0-mil, 10½" NAB . $19.07

### 8-Track Recording Cartridges

381-40 42 min ..... $2.35
381-64 64 min ..... $2.60
381-80 84 min ..... $3.05

### 350 Series Cassettes

Tensilized polyester.
350-C40 42 min., 0,7-mil ..... $0.92
350-C60 60 min., 0.7-mil ..... $1.02
350-C90 90 min., 0.510-mil ..... $1.62
350-C120 120 min., 0.370-mil ..... $2.01

### 360 High-Frequency Cassettes

Tensilized polyester.
360-C40 42 min., 0.740-mil ..... $1.06
360-C60 60 min., 0.740-mil ..... $1.39
360-C90 90 min., 0.510-mil ..... $1.93
360-C120 120 min., 0.370-mil ..... $2.47

### 362 Extended-Frequency Cassettes

Tensilized polyester.
362-C40 42 min., 0.740-mil ..... $2.32
362-C60 60 min., 0.740-mil ..... $3.04
362-C90 90 min., 0.510-mil ..... $4.07
362-C120 120 min., 0.370-mil ..... $4.64

### 364 20/20+ Cassettes

364-C40. 42 min ..... $2.60
364-C60. 60 min ..... $3.00
364-C90. 90 min ..... $4.50
364-C120. 120 min ..... $5.95

### 363 Chromium Dioxide Cassettes

363-C40, 42 min ..... $3.25
363-C60 60 min., 0.690-mil Mylar 50T. $4.25
363-C90 90 min., 0.470 mil Mylar 30T . $5.65

### Demagnetizer/Head Cleaner

220 For use with cassette machines .. $4.95
228 For use with 8-track cartridges .. $5.95

## BASF

### SP-52 Recording Tape

Polyvinyl chloride, tensilized, 1.5-mil. Recommended for standard play.
600 ft., 5" reel ..... $2.60
1200 ft., 7" reel ..... $3.90
1200 ft., 7" reel (3 pack) ..... $10.98

### LP-35 Recording Tape

Polyester base, tensilized 1-mil., long play.
900 ft., 5" reel ..... $3.41
1800 ft., 7" reel ..... $5.64
1800 ft., 7" reel (3 pack) ..... $16.27

### DP-26 Recording Tape

Polyester base, tensilized ¾-mil., double play.
1200 ft., 5" reel ..... $5.12
2400 ft., 7" reel ..... $8.14
2400 ft., 7" reel (3 pack) ..... $23.12

### TP-18 Recording Tape

Polyester base, tensilized, ½-mil., triple play.
1800 ft., 5" reel ..... $7.98
3600 ft., 7" reel ..... $12.26

### LP-35LH Long-Play Tape

1-mil polyester base. Low-noise, high-output.
900 ft., 5" reel ..... $4.10
1800 ft., 7" reel ..... $7.14

### DP-26LH Double-Play Tape

¾-mil polyester base. Low noise, high-output.
1200 ft., 5" reel ..... $5.86
2400 ft., 7" reel ..... $9.55

### TP-18LH Triple-Play Tape

½-mil polyester base. Low-noise, high-output.
1800 ft., 5" reel ..... $9.12
3600 ft., 7" reel ..... $13.67

### "Chromdioxid" SM Cassettes

Plastic swivel box (suitable for mailing).
2110-141, 30 min/side C-60 ..... $3.24
2120-191, 45 min/side C-90 ..... $4.74
2130-231, 60 min/side C-120 ..... $6.17

### LHSM Cassettes

Plastic swivel box (suitable for mailing).
C-60 ..... $2.55
C-90 ..... $3.79
C-120 ..... $4.71

### SKSM Cassettes

Plastic box
C-30 ..... $1.33
C-45 ..... $1.42
C-60 ..... $1.50
C-90 ..... $2.05
C-120 ..... $2.88

### "Sound Loop 8" Cartridges

45 minutes ..... $2.43
64 minutes ..... $2.60
84 minutes ..... $2.79

## CAPITOL

### Mod Line Cassettes

C-30, 15 min/side ..... $0.99
C-60, 30 min/side ..... $1.19
C-90, 45 min/side ..... $1.79
C-120, 60 min/side ..... $2.49
C-30, Three pack ..... $2.79
C-60, Three pack ..... $3.39
Cassette head cleaner ..... $0.99
Cassette saver ..... $2.29

### Mod Line 8-Track Cartridges

27-432-106, 32 min/150 ft ..... $1.69
27-440-106, 40 min/190 ft ..... $1.99
27-464-106, 64 min/300 ft ..... $2.29
27-480-106, 80 min/380 ft ..... $2.39
27-940-001, 4 pk of 40 min ..... $5.98
27-930-001, 4 pk of 80 min ..... $6.98
Cartridge head cleaner ..... $1.19

### Mod Line Open-Reel Tape

1.5-mil polyester
21-706-102, 600 ft., 5" reel ..... $1.89
21-712-102, 1200 ft., 7" reel ..... $2.49
1.0-mil polyester
21-609-102, 900 ft., 5" reel ..... $2.39
21-618-102, 1800 ft., 7" reel ..... $3.19
0.5-mil polyester, tensilized
21-312-102, 1200 ft., 5" reel ..... $2.69
21-318-102, 1800 ft., 5" reel ..... $3.69
21-324-102, 2400 ft., 7" reel ..... $3.99
21-336-102, 3600 ft., 7" reel ..... $5.99

### Capitol 2 (UHL) Ultra-High-Output, Low-Noise Tape

Standard-play type, 1.5-mil, polyester base.
678. 600 ft, 5" reel ..... $4.29
1278. 1200 ft, 7" reel ..... $6.69
Long-play type, 1.0-mil, polyester base.
968. 900 ft, 5" reel ..... $5.89
1868. 1800 ft, 7" reel ..... $8.49
All Capitol 2 UHL tapes have special leaders designed to be written upon and each end has a spliced-in switching foil.

### Capitol 2 High-Performance, All-Purpose Tape

Standard tape, 1.5-mil, acetate base.
652. 600 ft, 5" reel ..... $2.98
1252. 1200 ft, 7" reel ..... $4.79
Standard tape, 1.5-mil, polyester base
672. 600 ft, 5" reel ..... $2.98
1272. 1200 ft, 7" reel ..... $4.79
Standard tape, 1.0-mil, polyester base.
962. 900 ft, 5" reel ..... $3.59
1862. 1800 ft, 7" reel ..... $5.98
Double-play tape, 0.5-mil, tensilized polyester base.
1232T. 1200 ft, 5" reel ..... $5.29
2432T. 2400 ft, 7" reel ..... $8.99
Triple-play tape, 0.5-mil, tensilized polyester base.
1832T. 1800 ft, 5" reel ..... $6.98
3632T. 3600 ft, 7" reel ..... $10.89

### Capitol 2 Low-Noise Tape

1.5-mil, acetate base.
1259. 1200 ft, 7"reel ..... $4.29
1.5-mil, polyester base.
1279. 1200 ft, 7"reel ..... $4.79
1.0-mil, polyester base.
1869. 1800 ft, 7"reel ..... 6.89

### Capitol 2 Cassettes

High-output, low-noise cassettes with "Cushion-Aire" back coating.
C-40. 40 min ..... $2.49
C-60. 60 min ..... $2.98
C-90. 90 min ..... $4.39
C-120. 120 min ..... $5.95
Stak-Pak with two cassettes housed in storage chest.
C-40. 40 min ..... $4.98
C-60. 60 min ..... $5.98
C-90. 90 min ..... $8.79
C-120. 120 min ..... $11.89

### Capitol 2 Audiopak 8-Track Cartridges

8-150. 32 min ..... $2.79
8-190. 40 min ..... $2.98
8-300. 64 min ..... $3.29
8-380. 80 min ..... $3.49

## COLUMBIA

### Cassette Tapes

Each side color-coded for easy identification. High-output/low-noise gamma-ferric oxide. Response 20-20,000 Hz. Tensilized polyester base. Delrin rollers; constant-tension pressure pad for consistent tape-to-head contact; mounted in three-sided Mumetal shield to prevent pickup of hum and noise.
2CL-40. 40 min ..... $2.29
2CL-60. 60 min ..... $2.99
2CL-90. 90 min ..... $3.99
2 CL-120. 120 min ..... $4.99
2CL-HC. Head cleaner ..... $1.89

### 8-Track Tapes

Back-lubricated high-output/low-noise gamma-ferric oxide tape. Response 20-20,000 Hz. Three-point Delrin tape suspension; silicone/rubber pinch roller; foam pressure pad; one-piece hub.
8CL-40. 40 min ..... $2.69

8CL-80. 80 min ..... $2.99
8CL-HC. Head cleaner ..... $1.69

### Open-Reel Tapes

High-output/low-noise gamma-ferric oxide tape. Index and timing chart included with all packages.

4CL-1200. 7" × 1200 ft, 1.5-mil polyester ..... $3.75
4CL-1800. 7" × 1800 ft, 1.0-mil polyester ..... $4.49
4CL-2400. 7" × 2400 ft, 0.5-mil polyester ..... $6.19
4CL-3600. 7" × 3600 ft., 0.5-mil polyester ..... $8.29

## HITACHI

### "Ultra-Dynamic" Cassettes

UDC-60, 60 min ..... $3.70
UDC-90, 90 min ..... $4.80
UDC-120, 120 min ..... $6.70

### Low-Noise Cassettes

C-30, 30 min ..... $1.65
C-60, 60 min ..... $2.25
C-90, 90 min ..... $3.20
C-120, 120 min ..... $4.30

All "suggested list" prices

## IRISH

### 190 Series Home-Professional Tape

Standard 1½-mil, acetate base, ¼"
195-131, 600 ft., 5" reel ..... $1.95
195-151, 1200 ft., 7" reel ..... $3.15
Extra-length, 1-mil, acetate base, ¼"
196-131, 900 ft., 5" reel ..... $2.50
196-151, 1800 ft., 7" reel ..... $4.95
Extra-length, 1-mil, polyester base, ¼"
197-131, 900 ft., 5" reel ..... $2.85
197-151, 1800 ft., 7" reel ..... $4.95
Double-length, ¼-mil, polyester tensilized base.
198-131, 1200 ft., 5" reel ..... $4.50
198-151, 2400 ft., 7" reel ..... $7.95

### 200 Series Professional Tape

Standard 1½-mil. acetate base, ¼"
211-131, 600 ft., 5" reel ..... $2.55
211-151, 1200 ft., 7" reel ..... $3.90
Extra-length, 1-mil, acetate base, ¼"
221-131, 900 ft., 5" reel ..... $3.35
221-151, 1800 ft., 7" reel ..... $5.95
Standard, 1½-mil, polyester base, ¼"
231-131, 600 ft., 5" reel ..... $2.75
231-151, 1200 ft., 7" reel ..... $4.25
Extra-Length, 1-mil, polyester base, ¼"
241-131, 900 ft., 5" reel ..... $3.40
241-151, 1800 ft., 7" reel ..... $5.90
Double-length, ½-mil polyester tensilized base.
251-151, 2400 ft., 7" reel ..... $9.50
0.5-mil, polyester tensilized base, ¼"
261-131, 1800 ft., 5" reel ..... $6.95
261-151, 3600 ft., 7" reel ..... $11.95

### 270 Series Low-Noise, Wide-Range

1½-mil, acetate base, ¼"
271-151, 1200 ft., 7" reel ..... $4.00
1½-mil, polyester base, ¼"
273-151, 1200 ft., 7" reel ..... $4.60
1-mil, polyester base, ¼"
274-151, 1800 ft., 7"reel ..... $6.65

### Hi-Fi Series Cassettes

Soft plastic boxes
199-C30, 15 min/side ..... $1.20
199-C60, 30 min/side ..... $1.45

### Professional-Series Cassettes

In album/mailer
261-C30, 15 min/side ..... $1.75
261-C60, 30 min/side ..... $1.85
261-C90, 45 min/side ..... $2.90
261-C120 60 min/side ..... $3.45

### Low-Noise, Extended-Range Cassettes

Flip-top plastic box
262-C60, 30 min/side ..... $2.55
262-C90, 45 min/side ..... $3.35

### Chromium-Dioxide Cassettes

Flip-top plastic box
263-C60, 30 min/side ..... $3.75
263-C90, 45 min/side ..... $4.75

### Cassette Package

Four cassettes plus a storage tray.
261-C60-4P ..... $8.15
261-C90-4P ..... $12.35
261-C120-4P ..... $14.55

### 8-Track Cartridge Package

Four 40-minute, 8-track cartridges, one head cleaner, plus storage tray.
8T-160-P ..... $11.35

### 8-Track Cartridge Package

Four 80-minute, 8-track cartridges, one head cleaner, plus storage tray.
8T-320-P ..... $12.80

## LAFAYETTE

### Tensilized Reel-to-Reel Tapes

Tensilized Mylar. 0.5-mil.
300 ft, 3" reel, double-play ..... $0.69
600 ft, 3¼" reel, double-play ..... $0.99
1200 ft, 5" reel, double-play ..... $2.25
2400 ft, 7" reel, double-play ..... $3.49
3600 ft, 7" reel, triple-play ..... $4.98

### Mylar-Base Reel-to-Reel Tapes

On clear plastic reels.
1200 ft, 5" reel, 0.5-mil ..... $1.75
1800 ft, 7" reel, 1.0-mil ..... $2.14
2400 ft, 7" reel, 0.5-mil ..... $3.10

### Tape for Auto-Reversing Machines

Has metal sensing strip at each end to activate the automatic-reversing mechanism in machines with this feature. May also be used on machines which do not reverse tapes.
1200 ft, 5" reel, 0.5-mil Mylar ..... $1.99
1200 ft, 7" reel, 1.5-mil acetate ..... $1.84
1800 ft, 7" reel, 1.0-mil Mylar ..... $2.89
2400 ft, 7" reel, 0.5-mil tensilized Mylar $3.99

### Chromium-Dioxide Cassettes

Chromium-based coating to provide low distortion, increased high-frequency levels, and reduced inherent tape noise. For recorders with chromium-dioxide bias switches.
60 min ..... $2.49
90 min ..... $3.25

### Criterion Ultra-Dynamic Cassettes

Low-noise, high-output. Wide dynamic range with high-frequency response of 30-20,000 Hz. Head cleaner section at one end, sensing foils at each end to activate machines having reversing mechanism, but may be used on all cassette recorders. Hard, clear plastic storage box.
C-60UD. 60 min ..... $2.25
C-90UD. 90 min ..... $2.99
C-120UD. 120 min ..... $3.99

### Voice-Grade Cassettes

C-30. 30 min ..... $0.79
C-60. 60 min ..... $0.99
C-90. 90 min ..... $1.49
C-120. 120 min ..... $2.19

### 8-Track Mylar Cartridges

35 min ..... $1.69
70 min ..... $1.95
80 min ..... $2.25

## LONGINES SYMPHONETTE

### Music-Grade Cassettes

M40. C-40, 40 min ..... $1.99
M60. C-60, 60 min ..... $2.29
M90. C-90, 90 min ..... $2.99
M120. C-120, 120 min ..... $3.49

### Voice-Grade Cassettes

V40. C-40, 40 min ..... $1.59
V60. C-60, 60 min ..... $1.79
V90. C-90, 90 min ..... $2.29

### All-Purpose Cassettes

AP60. C-60, 60 min ..... $1.29
AP90. C-90, 90 min ..... $1.79
APS60. C-60 three-pack ..... $3.87
APS90. C-90 three-pack ..... $5.37

### 8-Track Cartridges

8M40. 40 min. single in sleeve ..... $2.49
8M80. 80 min. single in sleeve ..... $2.99

### Cassette Tote Box

2AP60C (2-C60's) ..... $2.19
2AP90C (2-C90's) ..... $2.99

## MAXELL

### Ultra-Dynamic Cassettes

UDC-46, 23 min/side ..... $3.15
UDC-60, 30 min/side ..... $3.70
UDC-90, 45 min/side ..... $4.80


UDC-120, 60 min/side ..... $6.70
UD-LP (vinyl library pack) contains 3 each UDC-60 and UDC-90 ..... $29.50

### General-Purpose Tape

1.5-mil acetate
A-50-7, 1200 ft., 7" reel ..... $4.00
A-50-10R, 2500 ft., 10½" reel ..... $10.80
1-mil polyester
E-35-7, 1800 ft., 7" reel ..... $6.20
E-35-10R, 3600 ft., 10½" reel ..... $14.35

### Low-Noise Tape

1.5-mil acetate
LNA-50-7, 1200 ft., 7" reel ..... $4.10
LNA-50-10R, 2500 ft., 10½" reel ... $12.00
1.5-mil polyester
LNE-50-7, 1200 ft., 7" reel ..... $4.75
LNE-50-10R, 2500 ft., 10½" reel ... $12.20
1-mil polyester
LNE-35-7, 1800 ft., 7" reel ..... $6.80
LNE-35-10R, 3600 ft., 10½" reel ... $17.15
0.5-mil polyester
LNE-25-7, 2400 ft., 7" reel ..... $10.00
0.5-mil polyester
LNE-18-7, 3600 ft., 7" reel ..... $11.85

### Extended-Range Tape

Ultra-dynamic, high-energy type.
1.5-mil polyester
UD50-7, 1200 ft., 7" reel ..... $6.75
UD50-10R, 2500 ft., 10½" reel ..... $16.00
UD50-7VP Special vinyl library pack . $9.65
1-mil polyester
UD35-7, 1800 ft., 7" reel ..... $8.55
UD35-10R, 3600 ft., 10½" reel ..... $19.55
UD35-7VP Special vinyl library pack $11.40

### Low-Noise Cassettes

LNC-30, 15 min/side ..... $1.65
LNC-60, 30 min/side ..... $2.25
LNC-90, 45 min/side ..... $3.20
LNC-120, 60 min/side ..... $4.30

### 8-Track Cartridges

8T-200, 40 minutes ..... $2.90
8T-300, 60 minutes ..... $3.05
8T-400 ,80 minutes ..... $3.25

## MEMOREX

### Low-Noise, High-Output Tape

Standard play. 1.5-mil polyester, ¼"
600 ft, 5" reel ..... $2.39
1200 ft, 7" reel ..... $4.59
2500 ft, 10½" reel ..... $10.99

# 5 Blank Tape

Long-play, 1-mil polyester, ¼"
900 ft, 5" reel ..... $3.39
1800 ft, 7" reel ..... $5.69
3600 ft, 10½" reel ..... $15.49
Double-play, tensilized polyester, ¼".
1200 ft, 5" reel ..... $4.59
2400 ft, 7" reel ..... $7.79

### MRX₂ Oxide Cassettes

C-30. 15 min/side ..... $1.79
C-45. 22½ min/side ..... $1.95


C-60. 30 min/side ..... $2.19
C-90. 45 min/side ..... $3.19
C-120. 60 min/side ..... $4.19

### Chromium-Dioxide Cassettes

C-45. 22½ min/side ..... $2.69
C-60. 30 min/side ..... $3.19
C-90. 45 min/side ..... $4.69

### 8-Track Cartridges

45 min ..... $2.49
60 min ..... $2.69
90 min ..... $2.89

### Accessories

Library (6 empty cassette albums) .. $3.29
8-track head cleaner ..... $1.29
Cassette head cleaner ..... $1.29

## NORELCO

### 300 Cassettes

Ferrous-oxide. High-output, low-noise tape with extended frequency range for recording music on standard cassette equipment.
60 min ..... $2.95
90 min ..... $3.95

### 200 Cassettes

Ferrous-oxide. Low-noise, high-quality tape for recording music on standard equipment.
30 min ..... $1.55
60 min ..... $1.95
90 min ..... $2.95
120 min ..... $3.95

### 100 Cassettes

Ferrous-oxide. High-quality tape for general recording: voice, lectures, background music.
60 min ..... $1.45
90 min ..... $2.15
120 min ..... $2.95

## RCA

### Red Seal Reel-to-Reel Tapes

Acetate Base
15A6, 600 ft., 5" reel, 1.5-mil, all-purpose, standard play ..... $2.55
15A12,1200 ft., 7" reel, 1.5-mil, all-purpose, standard play ..... $3.90
Polyester Base
15M6, 600 ft., 5" reel, 1.5-mil, all-purpose, standard play ..... $2.65
15M12, 1200 ft, 7" reel, 1.5-mil, all-purpose, standard play ..... $4.25
10M2, 225 ft, 3" reel, 1.0-mil, long-play in cardboard mailer ..... $1.05
10M9, 900 ft, 5" reel, 1.0-mil, all-purpose, long-play ..... $3.45
10M18, 1800 ft., 7" reel, 1.0-mil, all-purpose, long play ..... $6.00
5TM18TP, 1800 ft., 5" reel, 0.5-mil all-purpose, triple-play ..... $7.40
5TM24, 2400 ft., 7" reel, 0.5-mil, all-purpose, triple-play ..... $9.75

### Red Seal Cobalt-Energized Cassettes

C30, 15 min/side ..... $2.15
C60, 30 min/side ..... $3.15
C90, 45 min/side ..... $4.15
C120, 60 min/side ..... $4.75

### Vibrant Cassettes

CV30, 15 min/side ..... $1.39
CV60, 30 min/side ..... $1.69
CV90, 45 min/side ..... $2.49

### Red Seal 8-Track Cartridges

8TR40-RS, 200 ft. lubricated tape in 40-min cartridge ..... $2.65
8TR94-RS, 440 ft. lubricated tape in 94-min cartridge ..... $3.95
8THC100, Cartridge head cleaner .. $1.95

### 8-Track Cartridges

8TR32, 150 ft. lubricated tape in 32-min cartridge ..... $2.45
8TR64, 300 ft. lubricated tape in 64-min cartridge ..... $2.95
8TR94, 440 ft. lubricated tape in 94-min cartridge ..... $3.70

### Cassette Head Cleaner Tape

10R121, Non-abrasive cassette head cleaner in plastic box ..... $2.00

## SCOTCH

### Cassettes

High Energy
Features "High Energy" cobalt-energized tape for quality sound; fully compatible with all cassette recorders. Has "Posi-Trak" back treatment. Album package.
45 min ..... $2.75
60 min ..... $3.00
90 min ..... $4.50
Low-Noise/High-Density
Multi-purpose cassette featuring full dynamic range throughout the audible sound spectrum. "Posi-Trak" back treatment. Album package.
45 min ..... $2.25
60 min ..... $2.50
90 min ..... $3.75
120 min ..... $5.00
Highlander/Low-Noise
For all-purpose cassette use. Polyester base.
45 min ..... $1.30
60 min ..... $1.40
90 min ..... $2.25
120 min ..... $3.80

### Open-Reel Tapes

High-Output/Low-Noise
Provides 50% increase in signal output and additional 3 dB in dynamic range over conventional low-noise tapes.
No. 206. Polyester base, "Posi-Trak" backing, leader, and trailer. 1.5-mil. 60 min at 7½ ips; 7" reel ..... $6.10
No. 207. Polyester base, "Posi-Trak" backing, leader, and trailer, 1-mil. 90 min at 7½ ips; 7" reel ..... $7.70
Low-Noise/Dynarange
Provides high-fidelity recording even at 3¾ ips. Multi-purpose tape providing full dynamic range throughout audible spectrum. S/N is 4 to 6 dB better than standard tapes.
No. 211. Polyester backing, white yellow trailers. 1.5-mil. 30 min at 7½ ips (5" reel); 60 min (7" reel). 30 min ..... $2.70
60 min ..... $4.05
No. 212. 1.0-mil. 45 min at 7½ ips (5" reel); 90 min (7" reel). 45 min ..... $3.75
90 min ..... $6.67
No. 213. 0.5-mil tensilized. 120 min at 7½ ips (7" reel) ..... $10.00
No. 214. 0.5-mil tensilized. 90 min at 7½ ips (5" reel); 180 min (7" reel). 90 min ... $6.65
180 min ..... $11.95
Highlander/Low-Noise
All-purpose economy tape for vocals as well as speech.
No. 228. 1-5 mil. 60 min at 7½ ips (7" reel) ..... $3.10
No. 229. 1-mil. 90 min at 7½ ips (7" reel) ..... $5.00

### 8-Track Cartridges


Features low-noise oxide coating on heavy-duty lubricated polyester backing.
High-Output/Low-Noise
Full 2-dB increase in output over premium tapes. Captures full balanced sound.
8TR-45 HO/LN. 45 min ..... $3.05
8TR-90 HO/LN. 90 min ..... $3.68
Low-Noise/Dynarange
All-purpose cartridge
8TR-45. 45 min ..... $2.50
8TR-90. 90 min ..... $3.05

## SONY/SUPERSCOPE

### Professional Recording Tape

Extra-heavy-formula Oxi-coat homogenized oxide coating; polyester back, "lubri-cushion" impregnated lubricant.
PR-150-3. 300 ft, 3¼" reel, 1 mil .... $2.29
PR-300-6. 600 ft, 3¼" reel, 0.5 mil ... $2.95
PR-150-9. 900 ft, 5" reel, 1 mil ..... $3.49
PR-200-12. 1250 ft, 5" reel, 0.5 mil .. $4.79
PR-150-18. 1800 ft, 7" reel, 1 mil .... $4.89
PR-200-24. 2400 ft, 7" reel, 0.5 mil .. $7.69

### Low-Noise, High-Output Tape

On 1-mil polyester base.
SLH-180-18. 1800 ft, 7" reel ..... $6.49

### Auto-Sensor Cassette Tape

C-30. 30 min ..... $1.39
C-60. 60 min ..... $1.49
C-90. 90 min ..... $2.19
C-120. 120 min ..... $3.19

### Ultra-High-Fidelity Cassette Tape

With Auto-Sensor.
UHFC-60. 60 min ..... $1.99
UHFC-90. 90 min ..... $2.99
UHFC-120. 120 min ..... $5.99

### 8-Track Cartridges

8T-60. 60 min ..... $3.19
CRO-60. 60 min. chromium-dioxide . $3.29

### Empty Tape Reels
Computer-styled tape reels, with box.
7" ..... $0.99
5" ..... $0.79
3¼" ..... $0.69

## SOUNDCRAFT

### Cassette Tapes
2SC-30. 30 min ..... $0.79
2SC-40. 40 min ..... $0.89
2SC-60. 60 min ..... $1.39
2SC-90. 90 min ..... $1.69
2SC-120. 120 min ..... $1.99
2SC-HC. Head cleaner ..... $1.39

### 8-Track Tapes
8SC-40. 40 min ..... $1.69
8SC-80. 80 min ..... $1.99
8SC-HC. Head cleaner ..... $1.29

### Open-Reel Tapes
4SC-1200. 7" × 1200 ft ..... $2.69
4SC-1800. 7" × 1800 ft ..... $3.29
4SC-2400. 7" × 2400 ft ..... $4.99
4SC-3600. 7" × 3600 ft ..... $6.99

## TDK

### "Extra Dynamic" Cassettes
Highly refined type of gamma ferric oxide for wide dynamic range, low noise, and low distortion. Response 30-23,000 Hz. Includes new 40-min "record-album-length". Polyester base.
C-40ED, 40 min ..... $2.50
C-60ED, 60 min ..... $3.00
C-90ED, 90 min ..... $4.00

### "Super Dynamic" Cassettes
High-performance gamma ferric oxide for wide dynamic range, low noise, and distortion-free output. 30-20,000 Hz. Polyester back.
C-30SD, 30 min ..... $1.89
C-60SD, 60 min ..... $2.29
C-90SD, 90 min ..... $2.99
C-120SD, 120 min ..... $3.99

### "Krom-$O_2$" Chromium-Dioxide Cassettes
Outstanding linearity in the high frequencies. Use on machines with $CrO_2$ bias. Polyester back. Packed in plastic boxes.
C-60KR, 60 min ..... $2.99
C-90KR, 90 min ..... $3.99

### Deluxe Low-Noise Cassettes
Good performance in all general recording. Includes new 3-hour "4-record-album length" cassette plus new single-album length 40-min cassette. Polyester back.
C-30LN, 30 min ..... $1.29
C-40LN, 40 min ..... $1.39
C-60LN, 60 min ..... $1.49
C-90LN, 90 min ..... $2.19
C-120LN, 120 min ..... $2.99
C-180LN, 180 min ..... $4.49

### "Maverick" Cassettes


For all general recording. In mailing cartons.
C-30F, 30 min ..... $0.99
C-60F, 60 min ..... $1.19
C-90F, 90 min ..... $1.69

### Head Cleaner Cassette
Chromium trioxide removes deposits, laps and polishes pitted heads. Unique check-off chart on box keeps record of cleaner life.
HC-1 ..... $1.19

### "Endless" Cassettes
Endless-loop design with safety feature against accidental reversal. Usable in conventional cassette machines. Polyester backing. Packaged in plastic boxes.
EC-20S, 20 sec ..... $4.00
EC-30S, 30 sec ..... $4.00
EC-1,1 min ..... $4.00
EC-3, 3 min ..... $4.20
EC-6, 6 min ..... $4.60
EC-12, 12 min ..... $5.50

### "Super Dynamic" 8-Track Cartridges
Full-fidelity 8-track cartridges with gamma ferric oxide. Response 20-23,000 Hz. High saturation and output level (MOL). Has broad dynamic range, high S/N, and minimum distortion.
8TR-40SD, 40 min ..... $2.99
8TR-80SD, 80 min ..... $3.99

### "Super Dynamic" Open-Reel Tape
High-resolution gamma ferric oxide for wide


dynamic range, low noise, and distortion-free output. Response 20-30,000 Hz.
1200-SD, 1200 ft, 7" low-torque reel . $3.59
1800-SD, 1800 ft, 7" reel ..... $4.99
3600-SD, 3600 ft, 10½" NAB reel .. $12.49

### Deluxe Low-Noise Open-Reel Tape
Premium tape with good frequency response, S/N, output level, and dynamic range.
150-5, 900 ft, 1.5-mil, 5" reel ..... $2.59
100-7, 1200 ft, 2-mil, 7" reel ..... $2.89
150H-7, 1200 ft, 1.5-mil, 7" low-torque reel ..... $3.09
150-7, 1800 ft, 1.5-mil, 7" reel ..... $3.99
200-7, 2400 ft, 1-mil, 7" reel ..... $5.49

## WABASH

### Primus Master Reel-to-Reel
A cobalt-modified tape for extended range.
1800 ft, 1-mil, 7" reel ..... $11.95
3600 ft, 1-mil, 10½" reel ..... $25.95

### Primus Master Cassettes
A cobalt-modified tape for extended range.
C-60. 30 min/side ..... $3.79
C-90. 45 min/side ..... $5.39

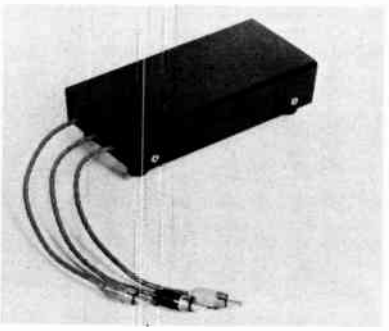
### Primus Premium Reel-to-Reel
Low-noise, extended-range tape.
1.5-mil polyester
600 ft, 5" reel ..... $2.95
1200 ft, 7" reel ..... $4.95
1-mil polyester
900 ft, 5" reel ..... $4.25
1800 ft, 7" reel ..... $6.95
0.75-mil polyester
1200 ft, 5" reel ..... $5.95
2400 ft, 7" reel ..... $9.95

### Primus Premium Cassettes
Low-noise, extended-range tape.
C-30. 15 min/side ..... $2.29
C-60. 30 min/side ..... $2.79
C-90. 45 min/side ..... $3.99
C-120. 60 min/side ..... $5.39

### Love Pack Cassette Photo Mailer
C-30. 15 min/side ..... $1.98

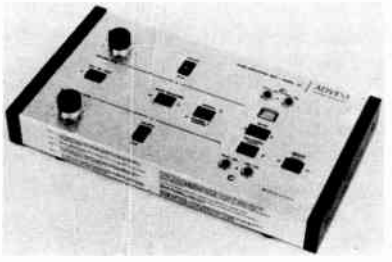
# 5 Miscellaneous

## ADVENT

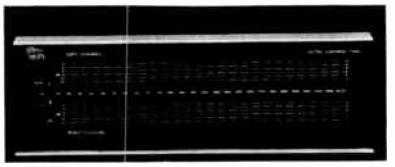
### MPR-1 Microphone Preamplifier
For use with low-impedance balanced or unbalanced microphones. Switchable gain for either

40 or 60 dB. Operated by power supply of Advent 201 cassette deck. 5¾" × 2¾" × 1" D ..... $25.00

### 100A Dolby System
Noise-reduction unit with Dolby system for home tape recording/playback. Also plays Dol-

by-encoded pre-recorded commercial tapes and FM broadcasts. Provides four-input mixing (two on each channel), headphone monitoring, and sound-on-sound recording. Harmonic and IM distortion 0.1%. 5" × 12⅞" × 8¾" D. Cabinet extra ..... $250.00

### 101 Dolby System
Similar in principle to Model 100A, but can

only be used in record or playback mode (uses same circuitry), but not simultaneously for two operational modes ..... $125.00

## ALTEC

### 729A "Acousta-Voicette"
Used to modify combined response of room and speaker as required for optimum flatness of frequency response in specific listening area.

Has narrow-band adjustable filters, each covering ⅓ octave. Stereo design with 24 filters for each channel covering center frequencies be-

# 5 Miscellaneous

tween 63 and 12,500 Hz. Loss/octave adjustable from 0 to 12 dB. 17 dB gain each channel to compensate for equalization losses. $850.00

## BSR-METROTEC

### FEW-1 Frequency Equalizer
Two-channel, five-zone frequency equalizer. Frequency response: flat setting 5-100,000 Hz ±1 dB; tone-control range ±12 dB 60, 240, 1000, 3500, and 10,000 Hz. IM dist. 0.05% at 2 V output; HD 0.05% at 2 V output (20-20,000 Hz). Max. output 9 V. 4⅝" H × 8¾" W × 5½" ..... $101.20

## CHEMTRONICS

### Tape Head Cleaner
Aerosol cleaner formulated for cassette, reel-to-reel, and 8-track recorders and players. Removes dirt, film, and oxides from heads, tape guides, capstan rollers, and other critical parts. Furnished with spray extender for pinpoint application. #THC-6 ..... $2.49
**504-3.** Same except 2-oz. bottle with special felt applicator ..... $1.49

### Drive/Belt Restorer
Restores hardened and glazed rubber drives and belts. Fast drying. Prevents slippage and insures uniform speed. 2 ounces. #507-7 ..... $1.50

### Cassette Head Cleaner
Non-abrasive buffing tape. Cleans graphite deposits from tape head. To be used the same as regular cartridge. #CHC ..... $1.98

### Cassette Maintenance Kit
Performs double cleaning function of tape head and capstan shaft cleaner. Uses special cleaning liquid applied directly to non-abrasive buffing tape. #CHC-Kit ..... $2.98

### 8-Track Head Cleaner
Cleans graphite deposits from tape heads with gentle wiping action. In use it is inserted in tape player and run for 30 seconds for every 50 hours of operation. #TR-8 ..... $1.98

### 8-Track Maintenance Kit
Cleans player head and capstan shaft with special cleaning liquid applied to tape. Prepared cartridge is inserted in player and job is done in seconds. Designed to be used weekly. #TR-8 Kit ..... $2.98

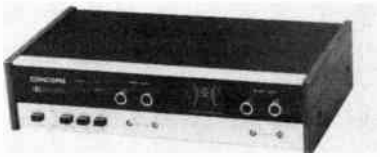
### Double-Head Cleaner
Requires no liquids or solvents. Works automatically in seconds. Has click timer. Removes graphite deposits from magnetic head and capstan shaft and prevents build-ups which often cause tape pull-out and breakage. Use after every 40 hours of play. #DH-8 ..... $3.49

## CONCORD

### DBA-9 Dolby Adapter
Record/playback noise-reduction system using Dolby-B type circuits. Has individual record and output level controls; dual VU meters. Input imp. 25,000 ohms. Sensitivity 30 mV; output

0.58 V adjustable. Output imp. 2500 ohms. Response 20-15,000 Hz ±0.5 dB. HD 0.2%. Noise reduction 8 dB at 2000 Hz & 10 dB at 5000 Hz. Supplied with Dolby-level pre-recorded tape (1 cassette & 1 3" reel) for calibration. 10⅜" W × 3" × 7½" D ..... $99.95

### DBA-10 Dolby Adapter
Record/playback noise-reduction system using Dolby B-type circuitry. Has individual input/



output channel-level controls with calibration adjustments available from front panel. Includes a built-in calibration tone signal and twin DIN/Dolby NAB meters. Response 20-20,000 Hz ±0.5 dB, HD 0.4%. Input sensitivity 30 mV, output 0.58 V adjustable. Noise reduction 8 dB at 2000 Hz, 10 dB at 5000 Hz. 13½" × 3½" × 7¼" D ..... $129.95

## dbx

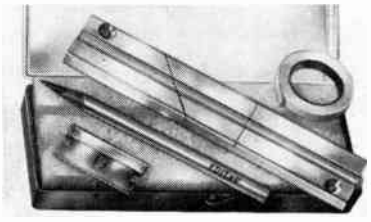
### 117 Noise-Reduction System
A compressor/expander that permits listener to restore up to 20 dB of the dynamic range miss-


ing from records, tapes, or FM broadcasts. As a classical compressor/expander, allows the recordist to make full dynamic range tapes on moderately priced recorders and obtain 20 dB or more improvement (S + N)/N ..... $159.00

## EDITALL

### KP-2 Editing Kit
Complete kit includes splicing block, 30 splicing tapes, demagnetized razor blade, and grease pencil ..... $4.00

### KS-2 Editing Kit
For ¼" tape, includes a 4" × ¾" × 1¼" block,



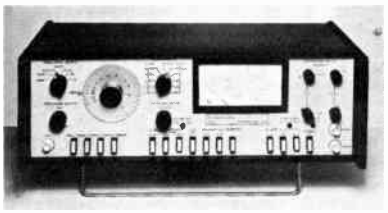
marking pencil, roll of splicing tape, and cutting blade ..... $10.00

### KS-3 Editing Kit
Same as KS-2 except includes larger block (5¾" × 1" × ⅜") ..... $12.00

### Metal Splicing Blocks
S-1, For 150" cassette-type tape .. $10.50
S-2, For ¼" tape compact machines $9.00
S-3, For ¼" tape console machines $10.50
S-3.5, For ½" tape ..... $26.00

## FERROGRAPH

### RTS-1 Recorder Test Set
Will test wow & flutter, frequency response, (S + N)/N ratio, gain, distortion, crosstalk, era-



sure, input sensitivity, output power, and drift. Input required 35 mV to 5 V. Has output for oscilloscope. 17⅜" × 10" × 5⅝" H. .... $1200.00

## FINCO

### FMSL-12 FM Antenna
FM "Stereo Log" multiple-drive broadband (88-108 MHz) antenna featuring very narrow pattern, maximum gain, and a high front-to-back ratio (up to 26 dB). Five driven elements, 6 directors, and 1 reflector. 13-ft boom, 87-inch turning radius. Gold Corodized ..... $57.90

### FM-5 Antenna
Ten-element, deluxe gold Corodized antenna. Has twin drive elements and maximum gain over full FM band ..... $41.85

### FM-3 Antenna
Four-element broadband FM yagi. Features narrow directivity pattern. Aluminum construction, gold Corodized ..... $15.70

### FM-4G Antenna
Twin-drive FM antenna with impedance-control "T" match stubs. Six elements, wideband (88-108 MHz) yagi. Aluminum construction, gold Corodized ..... $28.60

### FMT-1 Antenna
All-directional FM antenna kit with two folded dipoles at right angles with quarter-wave phasing stub for 360-degree pickup pattern without rotor. Supplied with 50-ft, 300-ohm twin lead, 5-ft mast, mounting hardware. Gold Corodized ..... $15.40

### FM Stereo "S" Antenna
All-directional "S" type design. High gain. Gold Corodized ..... $4.35

### 75-Ohm FM Antennas
75-ohm versions of the Models FMSL-12, FM-5, and FM-4G. To be used with coax-cable transmission lines in difficult, high-interference areas. Furnished with indoor matching balun transformer to balance 75-ohm coax to 300-ohm input of set.
CX-FMSL-12 ..... $67.50
CX-FM-5 ..... $51.75
CX-FM-4G ..... $38.55

### 65-7 FM Signal Amplifier
Indoor, behind-the-set design. Features high gain (20 dB nominal), low-noise transistorized, with passive filter input circuit designed to reject strong signals outside FM band. Can be

used to improve reception of weak signals in deep or medium-fringe areas. 300-ohm input. Will drive one or two 300-ohm loads. 1¾" × 4" × 4½" ..... $26.20

### 7512-AB Matching Transformer Kit
Complete kit to permit matching any 300-ohm antenna to 75-ohm coax cable transmission line. Includes outdoor antenna or mast-mount-

ed 300-to-75 ohm matching transformer with weatherboot, fittings, and mounting hardware and indoor behind-the-set 75-to-300 ohm matching transformer with fittings .... $8.35

**3007 FM Bandpass Filter**
Designed to eliminate interference to FM reception. Will pass only FM signals. Insertion loss less than 1 dB; 20 to 40 dB attenuation of all interfering signals outside FM band. Can be mounted on the boom, eave, floor, mast, wall, or back of set ..... $8.05

**G-20 VHF-FM Preamplifier**
A solid-state, single-channel preamplifier to be used where it is necessary to amplify a weak signal from one channel to a usable level. 20 dB minimum gain with a noise figure of 4 dB on low band and 5 dB on high band. Weatherproof die-cast housing with an aluminum base plate ..... $66.00

**G-920 VHF-FM Broadband Amplifier**
A v.h.f.-TV plus FM amplifier for a 300-ohm home system. Covers TV channels 2-13 and the

FM band. 300-ohm input and four 300-ohm outputs using conventional TV twin lead. 6 dB gain to each of four 300-ohm outputs with a response of ±0.25 dB across any 6-MHz channel. 9½" × 3" × 1½" ..... $33.95

## JVC

**SEA-10 Sound Effects Amplifier**
Five-zone sound-effects amplifier/equalizer circuit, switchable to 40, 60, 250, 1000, 5000,

10,000 and 15,000 Hz. Permits sound equalization during recording as well as playback. 5¼" × 7½" × 10" D ..... $109.95

**ECA-102 Reverb Amplifier**
For 2- and 4-channel use. Calibrated reverb

time from 0 to 3 milliseconds. Dual tape-monitor system. 5⅞" × 9⅝" × 13¾" D .... $129.95

**NR-1020 ANRS Noise-Reduction Unit**
Automatic noise-reduction unit for use with reel-to-reel, cassette, and cartridge tape decks. Improves (S + N)/N by 5 dB at 1000 Hz and 10 dB at 10,000 Hz. Includes built-in 400-Hz oscillator, two meters, two recording-level and two playback-level controls, reel-to-reel and cas-

sette calibration tapes. 3⅝" × 13⅛" × 7½" D... ..... $129.95

## KENWOOD

**KF-8011 Audio "De-Noiser"**
Will reduce undesirable background noise in the audio high frequencies of any program source by 6 to 15 dB. Has four individually controlled, narrow, sharp filters which divide the frequencies between 3 and 15 kHz into four frequency ranges. Connects into tape record and play terminals. Response 10-80,000 Hz ±0.5 dB, amplification factor 0 dB ±1 dB. HD 0.09% at 5.5 kHz, 1 V input .. $219.95

**KC-6060A Audio-Lab Scope**
Oscilloscope designed for audiophile. May be used to display audio sine waves from either

stereo channel. Includes its own test signal. Variable sweep rate 10-100,000 in four steps. Has internal synchronization. Will also display complex musical waveforms and can be connected to an FM stereo tuner or receiver to display multi-path effects. 3" CR tube. 5⅝₂" × 16⅝₁₆" × 11" D ..... $224.95

## LAFAYETTE

**Professional Bulk Tape Eraser**
Tape degausser for erasing up to 1" tapes and demagnetizing tape, magnetically stripped film, tools, and watches. Erases ¼" tapes in one operation, without reversing. Reduces tape hiss to the level of new tape. Has custom-finished case, non-magnetic top, "on-off" switch, power cord, built-in fuse, and pilot light. For 3", 5", 7", or 10½" reels. Two separate coils draw over 9 amps. 6¼" × 7⅞" × 3½" ..... $34.95

**Deluxe Bulk Tape Eraser**
Tape degausser for erasing ¼" tapes or smaller and demagnetizing tape, magnetically stripped film, tools, and watches. Has custom-finished case, non-magnetic top, "on-off" switch, power cord, built-in fuse, pilot light, and non-magnetic Bakelite plate for reel rest. Separate spindle positions for 10½", 7", 5", and 3" reels. Coil consumes 5 amps. Metal case. 7¼" × 4¼" × 3½" ..... $12.50

**Cordless Tape Eraser**
Erases cassettes, 8-track cartridges, and reel-to-reel tapes. Powerful rotating magnets work on self-contained d.c. source. Has "on-off" switch, plastic case. Requires four "AA" penlite batteries (not included). 4⅝₁₆" × 3⅞" × 2¹/₁₆" ... ..... $8.95

**Tape Head Demagnetizer**
Pencil-shaped with one extending probe which allows for reaching all heads in all positions. With "on-off" switch ..... $2.95

**Telephone Pickup Coil**
Designed to feed into the microphone input of tape recorder of any high-gain amplifier. Easily fastened to the telephone by rubber suction-type attachment. Has 4¼-ft shielded cable with ⅛" miniature plug ..... $0.89

## LAMB

**PML-420 Mixer**
Four-channel input; stereo or mono output. Has individual faders on each input channel; separate high, medium, and low-frequency equalization; pan pots; and echo send controls. Group faders on each output channel. Limiters have adjustable threshold and release. Two VU meters monitor the output. Cannon XLR termination at inputs; jack sockets at outputs ..... $549.00
**LPS-10.** Mixer power supply ..... $49.00

**DLB-220 Dolby-B Noise-Reduction Unit**
Stereo Dolby-B processor for open-reel, cassette, or cartridge machines or for decoding

Dolby-B encoded FM broadcasts. Response 20-15,000 Hz ±1 dB; 15,000-20,000 Hz at 2 dB. Has multiplex filter for deprocessing FM. Produces up to 10 dB attenuation of noise. Comes complete with connecting cables and calibration tape for two- or three-head recorders ..... $159.00
**LDB-240.** Same as DLB-220 except with stereo encoders and stereo decoders allowing simultaneous decoding for monitoring on three-head machines. Monitor signal is at all times in non-processed form ..... $225.00

**"Mini Studio"**
Completely portable professional recording studio. Consists of Revox A77 half-track stereo

tape recorder (15 and 7½ ips), including variable pitch and sel-sync and remote control unit; Lamb PML-420 mixer; two Beyer M-500 dynamic, one Soundstar X1N, and one M-101 microphones; DT-100 stereo headset for monitoring. Comes complete with mike stands, booms, clamps, and all interconnecting cables. ..... $2428.00

## MAGNESONICS

**Erasette Tape Eraser**
Will erase a cassette or 8-track cartridge to −65 dB from 0 reference. Battery operated (four

# 5 Miscellaneous

"A" cells). 4" × 3½" × 2¾" ..... $15.95

## MURA

### A-10 Stereo Volume Control
Stereo/mono switch enables headset to be used with radio, TV, electronic organ, or other mono program sources. Features electronic slide controls and 15-ft extension cord ..... $9.95

## NORTRONICS

### 5600 Quadrasonic Record/Play Heads
Four-track, four-channel, laminated core heads with all-metal hyperbolic face construction.
#5601. Special record-only head, low imp., 50 mH, 500 μin gap spacer. For use with vacuum-tube or transistor circuits. No-mount type ..... $99.00
#5602. Low imp., 90 mH, 100 μin gap spacer. For use with vacuum-tube or transistor circuits. No-mount type ..... $99.00
#5603. Medium imp., 370 mH. 100 μin gap spacer. For use with vacuum-tube or transistor circuits. No-mount type ..... $99.00

### Professional Tape/Head Cleaner
A fluorocarbon solvent formulated to clean without leaving any residue. There is no silicone lubricant, allowing use on capstans and pressure rollers. Safe for plastics, rubber, metals, painted surfaces, and elastomer parts. Meets all standards of MSFC No. 237A. Chemicals used in this cleaner have low surface tension and high density to penetrate into small crevices. Has high dielectric strength and quick-drying qualities. Is relatively non-toxic and non-flammable.
QM-108, 8 oz. liquid (can) ..... $3.40
QM-116, 16 oz. spray (can) ..... $3.75

### QM-102 Liquid Head Cleaner
Will remove impacted dirt and oxide deposits. Can be used on plastics, rubber, metals, painted surfaces, epoxies, elastomer parts. High dielectric strength and quick drying. Leaves no residue. Contains no silicone lubricant. 2 oz. .. ..... $1.50
**QM-103.** Same as QM-102 except in 3-oz. spray can with 5" extension tube ..... $2.25

### QM-140 Cassette Head Cleaner
Features special non-abrasive belt to remove accumulated oxide and dirt from cassette heads ..... $2.25
**QM-141.** Same as QM-140 but supplied with a liquid cleaner for removing heavier accumulations of oxide and dirt ..... $3.15

### QM-180 8-Track Cassette Head Cleaner
Special non-abrasive endless belt of woven Dacron and cotton which removes accumulated oxide and other contaminants. Sensing tab for proper indexing to clean entire head face ..... $2.80
**QM-181.** Same as QM-180 except supplied with liquid cleaner ..... $3.50

### QM-182 8-Track Head/Capstan Cleaner
Accessory unit which has a special non-abrasive endless belt on one end for removing oxide and other contaminants and on the other end a capstan cleaner made from Microlon ..... $3.50

### QM-201 Wand Head Demagnetizer
Professional unit that removes residual magnetism from heads, tape guides, and capstans. Flat tip reaches most heads without removing cover plate. Tip is specially coated with soft plastic material that will not scratch head surfaces. Comes with momentary switch and 6-ft. cord. 110-120 V a.c., 50-60 Hz ..... $13.90

### QM-210 Bulk Tape Eraser
Hand-held unit which bulk erases an entire reel, cassette, or cartridge in seconds. Re-

duces background noise levels to below that of virgin tape. Built-in momentary switch. Supplied with a.c. cord. ..... $21.90

### QM-240 Cassette Head Demagnetizer
Removes residual magnetism from cassette heads. Operates on 110-120 V a.c., 50-60 Hz. Comes with a.c. cord ..... $10.35

### QM-280 8-Track Cleaner/Demagnetizer
Dual-purpose accessory which demagnetizes heads in 8-track machines and provides end-


less cleaning belt for removing dirt and oxide from the head. Supplied with a.c. cord for operation on 110-120 V a.c., 50-60 Hz ... $12.50
**QM-281.** Same as QM-280 but designed for operation on 12-V d.c. automotive battery. Supplied with cigarette lighter plug ... $13.40

### QM-301 Splicer
For rapid tape editing and repair of all ¼" tapes. Provides both diagonal and waist-type cuts. Tape guides and hold-down fingers secure tape firmly ..... $5.00
**QM-340.** Same as QM-301 except designed for use with 0.150" cassette tapes ..... $5.00

### QM-311 Tape Splicing Block
For ¼" tape. Supplied with single-edge stainless-steel cutting blade & ten splicing tabs ..... $12.00
**QM-312.** For 0.15" cassette tape ..... $12.00
**QM-313.** For ½" video and audio tape . $18.00

### AT-120 Alignment Tape
7½ ips full-track tape for checking record/play heads of all types. 50-15,000 Hz. Recorded for checking azimuth, equalization, and head wear ..... $26.50

### QM-440 Cassette Alignment Tape
3¾ ips full-track tape for checking cassette record/play heads of all types. 31.5-10,000 Hz. Original recorded tones for zero reference, azimuth, and frequency-response tests .. $23.50

### QM-501 Splicing Tape
A ½" × 150" roll of Mylar splicing tape that will not bleed or creep ..... $1.50
The company has prepared a 16-page "Maintenance Guide" which is available without charge from local Nortronics distributors. It covers the problems that degrade performance and sound quality. It describes a preventive maintenance program which allows the user to obtain maximum performance from his tape recorder at all times.

## OLSON

### M-335 Stereo Mike Mixer
Has six inputs: 4 mike for high & low impedance and 2 magnetic phono. 9-V battery operation. 9¾" × 7" × 1¾" ..... $59.98

### HF-176 Stereo Frequency Controller
Solid-state frequency controller which shapes response curve to match characteristics of the listening room. Has five sliding controls for boost or cut by 10 dB at 120, 480, 1900, 3800, and 7680 Hz. Walnut-vinyl cabinet. 6" W × 3¾" H × 4⅞" D. ..... $54.95

## PIONEER

### SR-202W Reverberation Amp
Double-scatter system blends direct signals

from source with reverb effect. Reverb time 0-2.5 seconds at 1 kHz. HD less than 0.2% at 1 kHz reverb time. Minimum output level 330 mV. Response 20-35,000 Hz ±2 dB (min. reverb time) and 20-50,000 Hz ±10 dB (max. reverb time). (S + N)/N 65 dB at 330 mV output. Universal power supply. 13 1/16" × 5½" × 10⅜" D ..... $99.95

### SD-1000 Stereo Display
Five separate circuits for testing operation of every part of sound system. Has oscilloscope,

two level meters capable of measuring 10 mV to 20 mV signals, audio oscillator, an input circuit, and microphone amplifier (for checking room acoustics & speaker balance). Checks amplifier specifications except distortion; tuner signals; multipath distortion; displays amplified phono signals; checks frequency response, trackability, and channel separation of phono cartridges; response & separation of tape decks; stereo speaker balance; and room acoustics. $549.95

### SD-1100 Stereo Display
Designed for measurement and scoping of all audio components and stereo characteristics. Will show any waveform and measure voltage

level and phase shift. Has built-in audio oscillator 20-20,000 Hz with automatic or manual sweep. Can also be used for 4-channel analysis. With universal power supply. 17" × 7½" × 13¾" ..... $599,95

## ROBINS

### Cassette Storage Units
Modular, walnut-grained units each holding 12 cassettes. Can be mounted on wall or placed on bookshelf. #TCS-6 ..... $3.70

### Cassette Storage Album
Library-designed album holds 12 cassettes. Built-in stops prevent tape from unwinding and becoming slack. Walnut wood-grained cover. 10⅜" × 9⅜" × 1¼". #TSA-1W ..... $3.65

### Cassette Tape Mailers
18 cardboard mailers ready for addressing. Has stops to protect tape from unwinding. #TCB-18 ..... $1.65

### Cassette Head Demagnetizer
Removes excessive magnetic build-up. Designed to be used every 15-20 hours of player/recorder use. Built-in pilot light. 110 V, 50-60 Hz operation. #TD-10 ..... $9.95

### Head Cleaner Tape
Non-abrasive tape for cleaning cassette recorder/player heads. Removes accumulated oxide, grime, and foreign particles. #THC-4 .. $2.50

### Test/Clean Cassette
Performs three functions to help maintain optimum recorder/player performance: cleans heads, tests for correct head alignment, and tests stereo balance equalization between channels. #THC-6 ..... $2.95

### Cassette Tape Splicing Block
Precision splicing block cuts tape at 45 or 90 degree angle. Comes in self-contained, pocket-size carrying case complete with cutting block and 25 pre-cut self-stick splicing patches. #TS-215 ..... $10.50

### Cassette Bulk Tape Eraser
Removes recorded sounds from entire tape in seconds. #TMC-1 ..... $22.00

### Bulk Cartridge Erasers
Erases any cartridge in seconds. Operates from 110 V, 50-60 Hz source. #TMC-2 Deluxe model ..... $34.85
#TMC-3 Professional, heavy-duty model. UL listed ..... $66.50

### Cartridge Head Demagnetizers
Removes excessive magnetic build-up from recorder/player heads. Use after 15-20 hours of player/recorder use.
#TD-12 For home cartridge units. 110 V, 50-60 Hz operation ..... $12.95
#TD-15 For auto cartridge units. Plugs into cigarette lighter in car ..... $16.50

### Cartridge Storage Units
Walnut-grained storage unit for 8- and 4-track cartridges. Holds 12 tapes. Can be mounted on wall or set on bookshelf. #TCS-8 ..... $5.50

### Cartridge Head Cleaner
Special polyester non-abrasive tape which removes oxide, grime, and dust particles from heads. #THC-10 ..... $2.50

### Test-n-Clean Cartridge
Performs five functions to maintain trouble-free cartridge player/recorder performance: cleans player heads, tests track selector, tests stereo channel balance, tests speaker phasing, and tests head alignment. #THC-11 ... $5.30

### Head Demagnetizer
Demagnetizer for reel-to-reel recorder heads. Probe has soft plastic shield for safe contact with heads and angled to reach recorder heads without removing cover plates. 3½" × 1¼" dia. Operates from 110 V, 50-60 Hz. #TD-3. $7.30

### Bulk Tape Eraser
Reduces background noise levels of tape from 2 to 4 dB below erase-head level. For ¼" tapes on reels up to 7" dia. 2⅜" × 3¾" × 6¼". Operates from 110-120 V, 50-60 Hz sources. #TM-77 ..... $32.20

### Stereo Tape Splicer
Splices 4-track stereo tapes without sacrificing program material on the outer tracks. Cuts tape diagonally and trims "Gibson Girl" waists on sides of splices to prevent adhesive from contacting critical parts of recorder. See-through windows of operating lever show cut and trim positions. Integral tape dispenser comes with roll of ½" × 100" splicing tape. #TS-8D. $14.30

### Tape Splicing Block
Splicing block has tape guide to secure tape and a cutting groove to guide hand-held block. Sliding tray holds 25 self-stick splicing patches and blades. #TS-5 ..... $4.05

## SANSUI

### CD5 Electronic Crossover
Solid-state unit with a choice of 8 crossover frequencies (200, 340, 560 & 900 Hz between low & mid ranges; 2500, 3600, 5000 & 7000 Hz between mid & high ranges). Frequencies are selected by means of rotary switch. Can be used as a bi-amp or tri-amp crossover. Has cut-off characteristic switches with safety button, direct output terminal to bypass crossover, and separate level controls for stereo balancing. Maximum input voltage 3 V; rated output 2 V. THD 0.3% at rated output; hum & noise −70 dB at rated output. Load impedance 100,000 ohms. 110/117 V a.c., 50/60 Hz. 4⅜" × 6" × 10⅜" D ..... $99.95

## SHURE

### SA-1 "Solo-Phone"
Stereo amplifier for headphones. Permits two sets of phones to be used simultaneously. Has balance control, dual input for tape/tuner or phono. Inputs: phono 47,000 ohms equalized for magnetic cartridge, tuner 250,000 ohms. Output 8 ohms, 100 mV. 10¼" × 3½" × 3⅞" D ..... $32.00
**Model SA-1F.** Same as SA-1 except panel-mounting version ..... $38.00

### M68 Microphone Mixer
Five channels. A transistorized portable mixer for p.a. and tape recorders. Has four mike inputs for high- or low-impedance microphones, one high-level auxiliary input for tape, tuner & accessories, individual volume control to balance each of five inputs, and a master volume control to simultaneously control level of all inputs. Has high-impedance mike and auxiliary outputs. 105-130 V, 50/60 Hz ..... $84.00

### M67 Microphone Mixer
Four low-impedance balanced mike inputs & one line input. Has built-in tone oscillator for calibration. Response 20-20,000 Hz ±2 dB. Has automatic switchover to battery if power fails. Gain 90 dB max. (150-ohm mike into 600-ohm line). Battery power supply $25.00 extra. 11⅜" × 7½" × 2½" ..... $162.00

### M688 Stereo Microphone Mixer
For use with stereo tape recorders which do not have built-in mixing. Accepts four high- or low-impedance mikes through four inputs plus a stereo auxiliary high-level input, each with its own volume control. Three of the mike inputs have front-panel switches for left- or right-channel output, fourth microphone input has pan control. A stereo master volume control adjusts level of all inputs. (list) ..... $114.00

### M63 Audio Control
For use with mike mixers. Provides volume, bass, treble & high- and low-frequency rolloff. Has VU meter, two high-level inputs for mike mixer, tape recorder, tuner. Five different outputs: 600 ohms balanced line, high-imp. high-level, high-imp. mike level, low-imp. mike level (balanced), and headphone ..... $96.00

### M62V Audio Level Control
Automatic microphone volume control. Prevents blasting. Output adjustable to predetermined level. Response 20-20,000 Hz ±2 dB. Compression 40 dB input change, 6 dB output. For single mike. Has "on-off" bypass switch. Can be battery operated or from M68 mixer. 11⅜" × 5¼" × 2½" D ..... $62.00

### M64 Stereo Preamp
Provides gain and equalization to operate magnetic phono cartridges and tape playback heads with amplifiers without equalization. Response flat 20-20,000 Hz ±2 dB, phono RIAA curve 40-15,000 Hz ±2 dB, tape for 7½ ips NAB curve 50-15,000 Hz ±2 dB. Max. input phono & tape 100 mV, flat 250 mV .... $22.67

### A97A Matching Transformer
Designed to permit transistorized tape recorders to be used with high-quality, low-impedance microphones. Designed to improve the overall audio input signal as well as permit the use of long cables without loss of high frequencies and without hum and noise pickup. 2½" long × ¾" diameter ..... $12.60

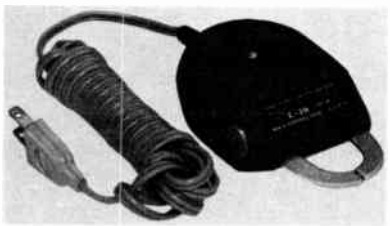
## SIGNAL SCIENCE

### Signal Commander Sound Switch
Sound switch for controlling tape recorders,

receivers, amplifiers, or any other electrical equipment rated at up to 300 watts. Red indicator light remains on when unit is plugged in; first hand clap lights yellow control bulb; second clap activates the controlled unit. This light/timing device prevents false triggering. Simulated walnut and black plastic enclosure. 8" W × 2¾" H × 3¾" D ..... $29.95

## SONY/SUPERSCOPE

### HE-2 Head Demagnetizer
Designed with high flux density to provide



maximum reduction of residual magnetism ..... $13.95

### BE-7 Cassette Bulk Eraser
Erases all cassettes without a.c. power or batteries ..... $24.95

### MX-16 8-Channel Mixer
Has 8 mike/line inputs plus four fixed and four variable outputs. Features "front center" signal distribution capability which allows a third channel to be added to the stereo mix between outputs #1 & #2. In addition, the input atten-

## TAPE RECORDER GUIDE SUMMER 1973 ADVERTISERS INDEX



### IF YOU NEED. . .

. . . additional information on any of the products listed in this directory, don't hesitate to write directly to the manufacturers themselves. They will be more than pleased to help with your questions. See list of company addresses beginning on page 11.

# 5 Miscellaneous

uator pad for each channel has a mike/line selector switch & a straight-line gain pot. Has four VU meters ..... $479.95

### MX-6S Stereo/Mono Mixer

Connects to all Sony solid-state recorders and provides mixing facilities for up to three mikes

& three high-level sources. Can be used for both stereo & mono. Required for sound-on-sound recording with Models 252-D, 666-D, 560D, and 225 ..... $29.95

### MX-12 Stereo/Mono Mixer

Six-channel, battery-operated solid-state design. Has straight-line graphic level controls, level reset indicators, dual outputs for driving both p.a. & tape recorder. Features mono/stereo selector, battery condition/VU meters, mike & high-level inputs. Response 30-

25,000 Hz ±1.5 dB. 117 V a.c. operation. 15¾" × 7⅞" × 7" D ..... $109.95

## SOUNDCRAFT

### "Magna-See" Tape Checker

Non-toxic, non-flammable chemical solution that makes magnetic track recorded on tape visible. Can be used to check head azimuth, track uniformity, balance, and head wear 6SC-10 ..... $12.80
6SC-11. ½ pint solution refill ..... $3.60

### Splicing Tape

Pressure-sensitive 1½-mil polyester splicing tape.
6SC-12. 7/32" × 66 ft ..... $1.99
6SC-13. ½" × 66 ft. ..... $2.39

### Colored Leaders

Available in five colors (green, blue, yellow, red, and white) on a 3" reel. ¼" × 150 ft. . . . $2.25
Available in five colors plus clear. ¼" × 1200 ft on 7" plastic reel ..... $4.50

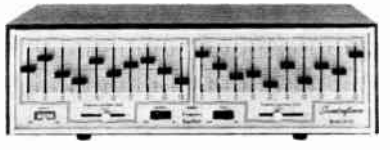
### Conductive Cueing/Reversing Tape

Cueing tape metalized on one side, pressure-sensitive on other. 7/32" × 90 ft. 6SC-25 ..... $1.99

## SOUNDCRAFTSMEN

### 20-12 Audio Frequency Equalizer

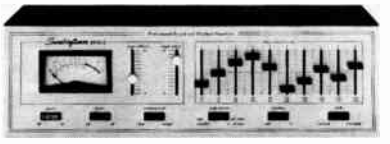
Incorporates both active & passive circuitry for simplified adjustment of 10 individual octaves, each channel for precise frequency balancing.



Zero setting for flat response. An equalization test record (supplied) provides pink-noise tone alternating each frequency band with 1000-Hz reference tone for rapid equalization of room conditions. Total available boost up to +18 dB; total cut down to −24 dB. Rack mount or walnut cabinet ..... $299.50

### RP10-12 Single-Channel Equalizer

Provides precise monitoring of input/output levels. Has calibration, full-frequency, and indi-



vidual octave frequency controls coordinated with metering bypass, selection, tape bypass, and equalizer bypass switches. 12 dB boost/cut per octave plus 12 dB cut or 6 dB gain of full frequency spectrum. Response 20-20,000 Hz ±¼ dB; 7 V output; 0.01% THD; (S + N)/N 95 dB. Walnut grain case with brushed gold/black panel. 18" × 11" × 5¼" ..... $349.50

## TEAC

### AN-180 Outboard Dolby System

Record/playback control center with Dolby noise-reduction system. Recording section

contains microphone & line preamps plus Dolby recording circuitry. Playback section has playback line preamps & Dolby playback circuitry. Can be used with any good tape deck. Has separate input level controls for mike and line inputs for each stereo channel, two VU meters, internal test-tone oscillator, Dolby level standard tapes, source/tape monitor switch. A multiplex filter prevents recording interference from pilot tone frequencies or unsuppressed multiplex carrier by tuner ... $319.50

### AN-80 Outboard Dolby System

Less elaborate version of AN-180. Input mixing

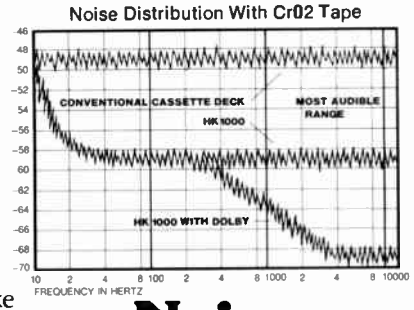
feature omitted and only one Dolby circuit per channel. Circuit operates for recording, then playback, but not together. Provides 10 dB noise reduction ..... $149.50

### AN-60 Outboard Dolby System

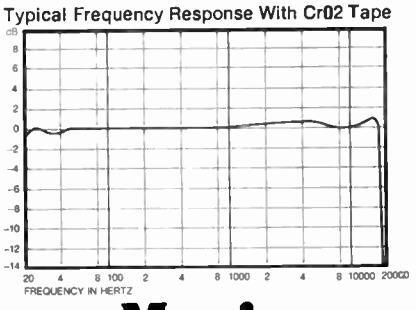
Frequency response 20-15,000 Hz ±2 dB. Increased (S + N)/N 10 dB at 10,000 Hz & 5 dB at


1000 Hz. Input sensitivity 0.1 V. Output to tape deck 0.3 V & line 0.58 V. Has 400-Hz tone oscillator & a reference meter for calibration. Dolby calibration tape for both open reel & cassettes supplied. 3¾" H × 6⅜" W × 10⅝" D .. $89.50

# Never before has this little noise accompanied this much music.




## Noise.




## Music.

If you're sophisticated enough to be reading this magazine, you're probably familiar with the two main characteristics of cassette decks: hiss and nonlinear frequency response.

Which should make you thoroughly unfamiliar with the performance capabilities of our new HK-1000. As the charts indicate, it behaves more like reel-to-reel than a cassette deck:

Signal-to-noise (unweighted) is −58 dB with Dolby and −70 dB in the audible hiss level above 4,000 Hz. The frequency response curve is essentially flat from less than 30 to beyond 15 kHz, ±1.5 dB, with $CrO_2$ tape. (This curve is due largely to the way we drive our heads. Instead of the conventional constant *voltage* drive to the head, the HK-1000 is designed for constant *current* drive. Many studio model reel-to-reel decks are designed the same way.)

Because of a new low in noise and a new wide in frequency, the HK-1000 brings you a new clarity in music.

Ours is the first cassette deck designed for maximum phase linearity. Square wave response is better than every other cassette deck and even some expensive reel-to-reel decks. And the better the square waves, the cleaner and more transparent the music.

Discriminating audiophiles will also appreciate the wide selection of controls to take control of. There are two "peak-reading" VU meters; automatic shut-off in all transport modes; separate controls for recording playback and microphone levels; a "memory" rewind feature that lets you key a selection to the exact start location; a Dolby test oscillator; both record and Dolby playback calibration adjustments on the top panel; and so on.

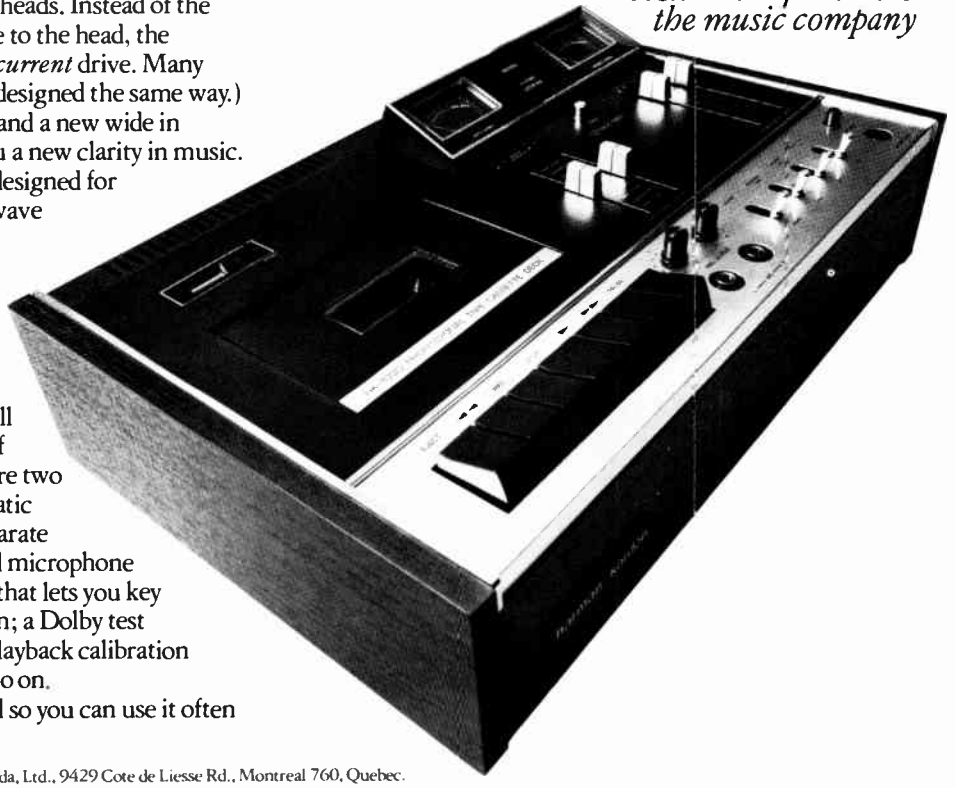
The HK-1000 is also designed so you can use it often without endangering it. Plug-in printed circuit boards are used for simplicity and reliability of operation. Heads are easy to reach and clean. And the transport is the most reliable we've ever tested; it even closes with the sort of reassuring "thunk" you normally hear only by closing the doors of expensive hand-built cars.

The price is $300.

Never before has that small a price tag accompanied this much cassette deck.

For complete details and specs, write Harman/Kardon Incorporated, 55 Ames Court, Plainview, N.Y. 11803*

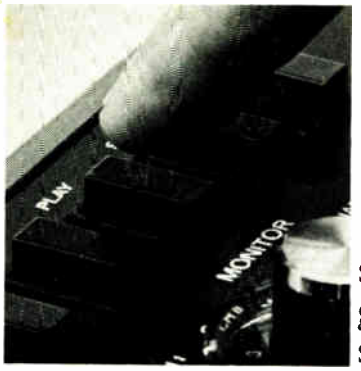
**harman/kardon**
*the music company*



*Distributed in Canada by Harman/Kardon of Canada, Ltd., 9429 Cote de Liesse Rd., Montreal 760, Quebec.

CIRCLE NO. 12 ON READER SERVICE CARD

# The 400 millisecond miracle.




Most people seem to take for granted the smooth, effortless way in which a Revox works.

And that is as it should be.

For a great deal of time, effort and sophisticated engineering have gone into translating extremely complex function into lightning quick, responsive operation.

For example, when you press the play button of a Revox, you set in motion a sequence of events that take place with the precision of a rocket launching.

It begins with a gold plated contact strip that moves to close two sections of the transport control circuit board.

Instantaneously, the logic is checked for permissibility. If acceptable, a relay is activated.

Within 15 milliseconds, power is supplied to the pinch roller solenoid, the brake solenoid, the back tension motor, a second relay and, at the same time, the photocell is checked for the presence of tape. If present, Relay One self-holds.

Elapsed time, 25 milliseconds.

At 30 milliseconds, Relay Two closes and puts accelerating tension on the take-up motor.

The logic checks are now complete and power is available to actuate all necessary functions.

From 30 milliseconds to 300 milliseconds, mechanical inertia is being overcome and the motors and solenoids are settling down.

By 300 milliseconds, the brakes have been released, the pinch roller is in contact with the capstan shaft, the tape lifter retracted, the playback muting removed and the motors have come up to operating speed.

At 350 milliseconds power is cut off from Relay Two, which changes over to another set of contacts, releasing the accelerating tension on the take-up motor and completing a circuit through Relay One that, in turn, restores normal tension to the take-up motor.

Total elapsed time, 400 milliseconds. The Revox is now in the play mode.

And it's all happened in a fraction of the time it takes to read this sentence.

The 400 millisecond miracle. **More proof that Revox delivers what all the rest only promise.**


**Revox Corporation** 155 Michael Drive, Syosset, N.Y. 11791. Calif.: 3637 Cahuenga Blvd. West, Hollywood 90068
England: C.E. Hammond & Co., Ltd., Lamb House, Chiswick, London W4 ZPB. Available in Canada.

CIRCLE NO. 22 ON READER SERVICE CARD