Developmental Trend for Future Consumer VCR's

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INTRODUCTION

ENIAC, the first electronic computer developed by the University of Pennsylvania during World War II, is considered to be one of the ten most significant technical achievements of modern times. In fact, ENIAC has often been considered as significant a development as the harnessing of Nuclear Energy.

Today one can purchase an electronic calculator as powerful as ENIAC for approximately $30. They weight only a few ounces and fit in the palm of your hand. In comparison, ENIAC weighed approximately 30 tons and occupied an entire floor of a good size building.

In a shorter period of time, specifically since Ampex's demonstration of the first quadraplex video recorder in 1956, the technical art of video recording and the supporting electronic technology, has made equally astounding progress.

In 1983, 18 million video cassette recorders were produced world wide. The production rate of the VCR is approaching that of color television sets with both items essentially equal in cost.

Consumer VCR applications include, delayed viewing of on-air TV programs, home viewing of first run movies and amateur movie making.

What is the next stage of progress in video recording technology?

A color TV set is like an audio amplifier and a pair of loud speakers. It is the last link of the communications chain in the television medium. Audio amplifiers are fed by AM and FM radios, tape players and phonograph players. A color TV set, or more accurately a video monitor, must be fed by a variety of video sources. The VCR is just one of these sources. Conceivably, in time, every video monitor may have a VCR as a source input.

When the average household has upward of ten video monitors scattered around the house, as many VCR's may be in place. And such a time may arrive as early as the late 1980's.

The industry is preparing themselves for this next stage of VCR proliferation in households by developing a number of new product concepts. And, I would like to share with you some of the new development trends.

HIGH FIDELITY AUDIO SUPPLEMENT

Higher video recording density of modern VCR's are making the linear tape speed of VCR's even slower.

A slower tape speed, coupled with a relatively narrow track width allocated for longitudinal channels, makes high quality audio reproduction from a VCR a new technical problem.

Since the quality of video recording is being improved with the introduction of new video head materials and technology, the disparity between video and audio performance has become more apparent. To overcome these limitations, a totally new approach for audio recording was developed.

The approach utilizes FM audio recording by rotating heads. As shown in Figure 1 two FM carriers, 1.3 and 1.7 MHz for stereo recording were chosen. The two carriers are multiplexed to form audio FM channel which is recorded by two additional heads mounted on the rotating head wheel, as shown in Figure 2. Audio and video recorded tracks share the same area of the tape. The differences being that the audio head has a 30° azymuth angle in the opposite direction from the video head and its track width is narrower.

Since the audio FM carrier is approximately 1/3 of the video FM carrier frequency, the required head gap length is substantially longer. Narrower and longer wavelength audio tracks are recorded first and the wider and shorter wavelength video tracks are laid over the audio tracks. The longer gap length of the audio head enables recording to take place deeper in the magnetic layer than the short wavelength video FM recording. The video overlay recording, thus, does not erase the audio carrier to any significant extent.

The system block diagram in Figure 3 shows flow of video and stereo audio signals in both record and playback mode.

Full frequency range (20 to 20,000 Hz) reproduction and a dynamic range of 80dB are available from the system without any noise reduction scheme. Specifications are shown in Figure 4. The dbx noise reduction technique lowers the system noise floor by an additional 10dB, making the total available dynamic range to be 90dB.

SMALL DRUM VHS SYSTEM

The success of any video recording format in the marketplace depends greatly upon the high degree of interchangability among the recorders and recorded tapes. The VHS format for the consumer use, and its high quality deriviative, the M-Format for broadcast and teleproduction applications have been accepted widely throughout the industry because of their complete recorder/recroding interchangability.

Establishment of a single standard, either formal or defact in nature, sometimes impedes technological progress because a new entity must be compatible with current technology.

The overall external dimensions of a portable rotating head recorder depends greatly upon the size of the head scanner itself. Designing a new VHS recorder while trying to achieve a quantrum reduction in its size and weight represents an engineering challenge. A true technical innovation called the "extended wrapping technique" was developed by JVC engineers to overcome this problem.

Figure 5 shows this concept. In order to maintain the compatibility with the current VHS format, the track length, helical angle and all other format parameters must be identical. By wrapping the tape around a scanner to 270 degrees instead of 180 degrees, a smaller diameter scanner can be used while maintaining all format dimensions. The 41mm scanner has four heads instead of the two heads of a standard 62mm scanner. Recording sequences among the four heads are shown in Figure 6.

Lead angle, or the angle between the plane perpendicular to the head rotation and the tape guiding edge on the small diameter scanner, is adjusted so that the vertical displacement of the entire recorded track is exactly the same as the one made on a standard size scanner.

The physical arrangements of the tape transport system consisting of a 41mm scanner and VHS-C (VHS-Compact) cassette are shown in Figure 7.

8MM VIDEO RECORDING FORMAT - Background

In the late 1970's, Matsushita Electric and RCA jointly made the first serious attempt to develope an electronic equivalent of a motion picture camera. Their collaboration on this endeaver resulted with the introduction of the "RECAM" and "Hawkeye" video recording cameras in 1981 for broadcast applications.

The desire of the marketplace to have a consumer version of the video recording camera has led the industry to develop a new video recording format known as "8mm Video".

A relentless push to increase magnetic recording density in th 1970's has accellerated the developmental work on a new magnetic tape beyond what was known as the "high energy tape".

Chromium, or cobolt absorbed/absorbed, high energy Gamma Felex tape of 600 orstead variety has been the mainstay of video recording tape since the mid 1970's.

To increase the head output at a given wavelength, various attempts have been made to increase the coercivity of the tape. One approach has been to develop the metal partical coated tape. Figure 8 shows short-wavelength performance of various video types. The coordinate on 6MHz represents a recording wavelength of 0.6 micro meters at a writing speed of 3.75 meters per second.

At this wavelength, metal coated tape has an output 10dB higher than a conventional high energy tape.

Beyond this wavelength; the advantages of conventional metal coated tape diminish rather rapidly. This is due to the self-demagnetization effects caused by the relatively large thickness of the magnetic layer.

Properly manufactured metal evaporated tape, despite its lower coercivity, extends its short wavelength performance way beyond the metal coated tape because of a lack of self demagnetization.

The predicted reduction of tape usage per unit of time for the 8mm Video Recorder, as shown in Figure 9, depends on the application of the metal evaporated tape, or improved performance metal coated tape.

8MM VIDEO -- CONCEPT AND SPECIFICATIONS

Figure 10 shows the schematic view of the 8mm video tape format developed through cooperation of over 100 member companies of the special industrial committee. It is a worldwide standard applicable to both 525 line/60 field NTSC and 625 line/50 field CCIR television scanning rate.

Linear tape speeds are 14.345mm (.565") and 20.051mm (.789") per second for the respective two standards. 7.75 meter long tape held in the cassette provides 90 minute and 60 minute recording time respectively for the 525 and 625 line standards.

Video signals are recorded by using the time proven color under method.

As previously discussed, the problem of providing high quality audio reproduction at a linear tape speed of less than 1" per second from a tape with an ultra thin magnetic coating, is very difficult to overcome.

The problem has been solved by providing two alternate audio recording methods. Primary audio recording is done through FM and PCM technique by rotating heads. In addition, the format has provisions for two other longitudinal tracks for audio and cue channels. Rotating head FM carrier frequency allocations are shown in Figure 12.

Placement of the luminance FM carrier and the low frequency converted chrominance signal provides 2.2 MHz and 0.4HMz bandwidth capability for these two component signals. The audio FM carrier, located at 1.5 MHz, has an allocated deviation of plus minus 0.1 MHz.

An interesting technical feature of the 8mm video format is the automatic head tracking system with four pilot tones designated as f1 through f4, as shown in Figure 13.

The video head, with its track width slightly larger than the recorded track, picks up the pilot tone from both the right and left adjascent tracks. The capstan servo is driven to have the amplitude of the two hetrodyne tones generated by its own pilot tone and the adjasent track pilot tones sequal.

All pilot tone frequencies as well as the down converted chrominance carrier, are locked to the basic video scan rate in a relationship shown in Figure 14.

The pertinent components of the basic recorder/reproducer, and outline dimensions of a proposed cassette are shown in Figure 15 and 16.

SUMMARY

The 8mm Video Cassette Recorder, combined with a solid state or small diameter single tube color camera, is the first electronic image recorder system with the size and weight of an 8mm cartridge film motion picture camera. An alternate approach to further enhance the video quality of 8mm video, based on the time compression and expansion technique, is now being considered.

The introduction of digital color television receiver is expected in the near future. With this, the next logical development will be that of a digital consumer VCR to complement the transfer of TV receiver technology from the analog to digital domain.

Introduction of the 8mm VCR to the marketplace is not the end, but rather the beginning of a new era of consumer electronic technology.

Koichi Sadashige, a native of Japan, received his Bachelor of Science degree in 1947 from the University of Chiba. He attended the California Institute of Technology where he received his Master of Science degree in 1953. Until 1978, he worked for RCA Broadcast Systems, Camden, NJ in an engineering and engineering management capacity. While at RCA he was engaged in the development of color television cameras, video recording equipment, scientific instruments and optical systems.

In 1979 Koichi Sadashige joined Matsushita Electric Corp. of America as the Director of Engineering Development. At present, he is directing the overall activities of the New Technology Products Group, Panasonic Industrial Company, Secaucus, NJ. Mr. Sadashige has published 38 technical papers in the United States, Germany, Great Britain and Japan. He is currently a member of the SMPTE Video Recording and Reproduction Technology Committee and on the Board of Editors for SMPTE. He was elected a Fellow of SMPTE in 1980.

VHS Hi-Fi Recording Spectrum

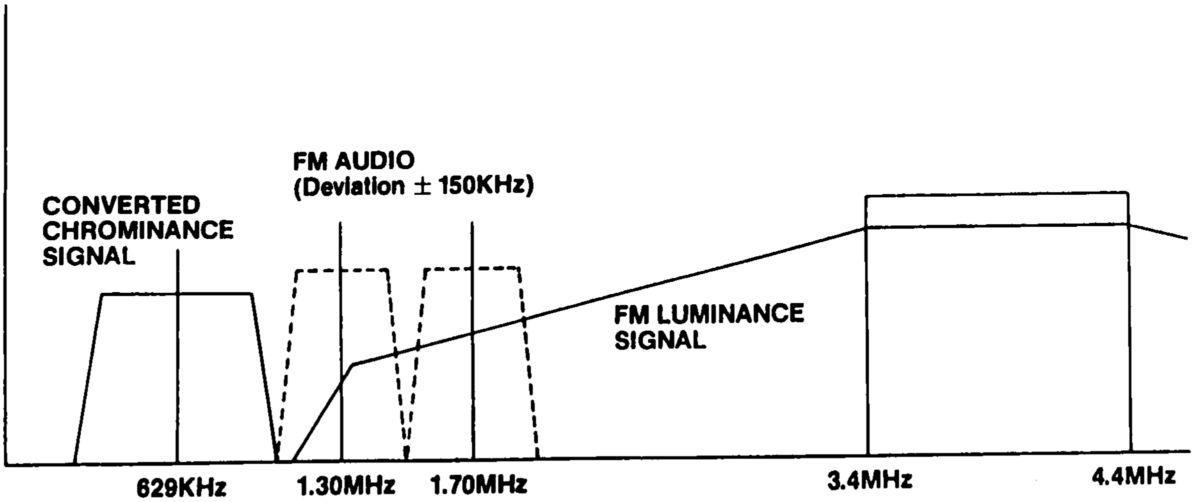

Fig. 1. VHS Hi-Fi Recording Spectrum.

VHS Hi-Fi Recording Format

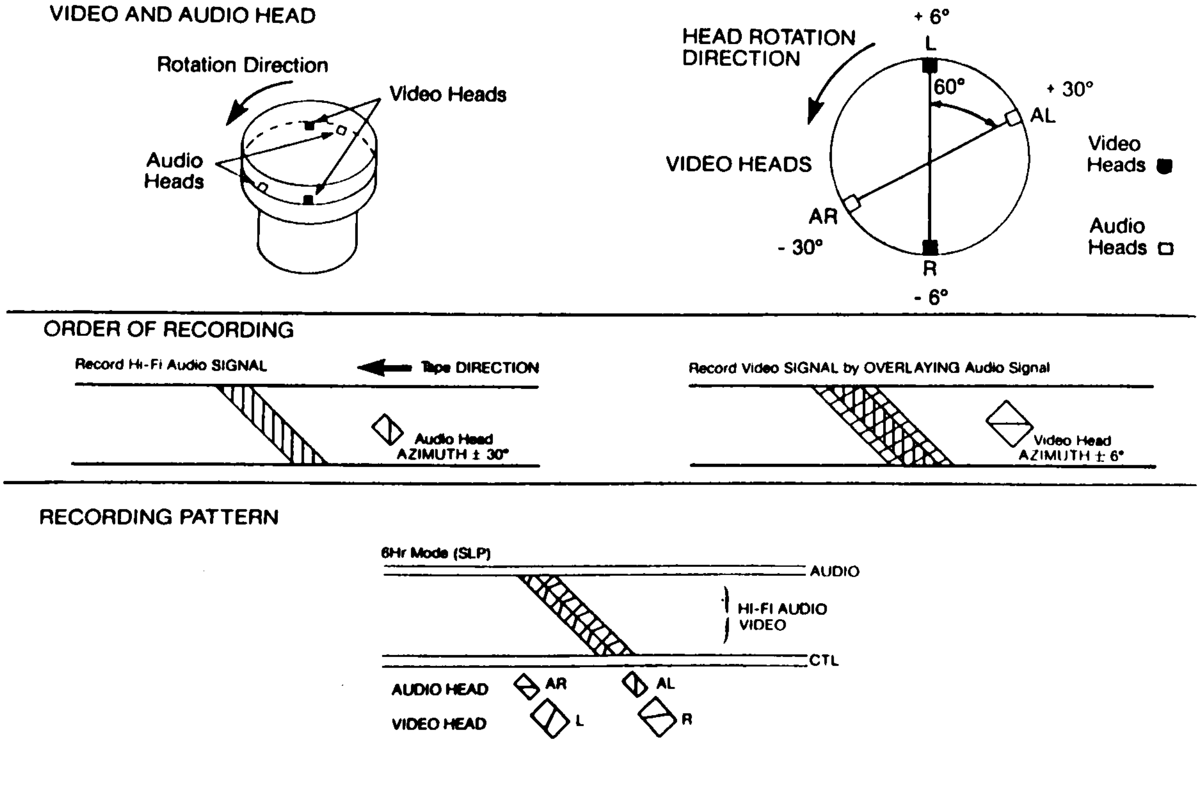

Fig. 2. VHS Hi-Fi Recording Format.

VHS Hi-Fi Recording System

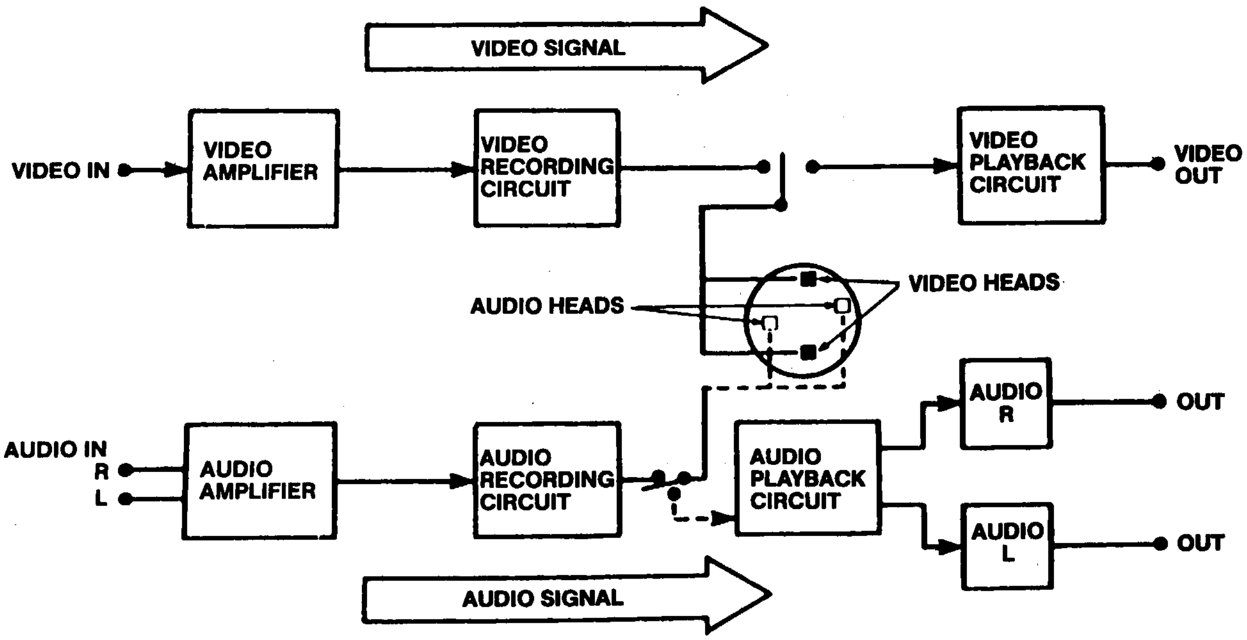

Fig. 3. VHS Hi-Fi Recording System.

Audio System Comparison Chart

	CONVENTIONAL VHS	VHS HI-FI
Audio Head	Stationary Head	Rotary Head
Recording System	AC Bias Recording	FM Azimuth Recording
Relative Head to Tape Speed	1 - 5/16 I.P.S. (SP Mode)	228 I.P.S.
Noise Reduction	DOLBY SYSTEM	HD dbx System
Frequency Response	50 - 12,000 Hz	20 - 20,000 Hz
Dynamic Range	50dB	More Than 80dB
Distortion	3%	Less Than 0.3%
Wow & Flutter	0.15%	Less Than 0.005%
Channel Separation	40dB	More Than 60dB

Fig. 4. Audio System Comparison Chart.

Standard and Small Drum VHS Scanning System

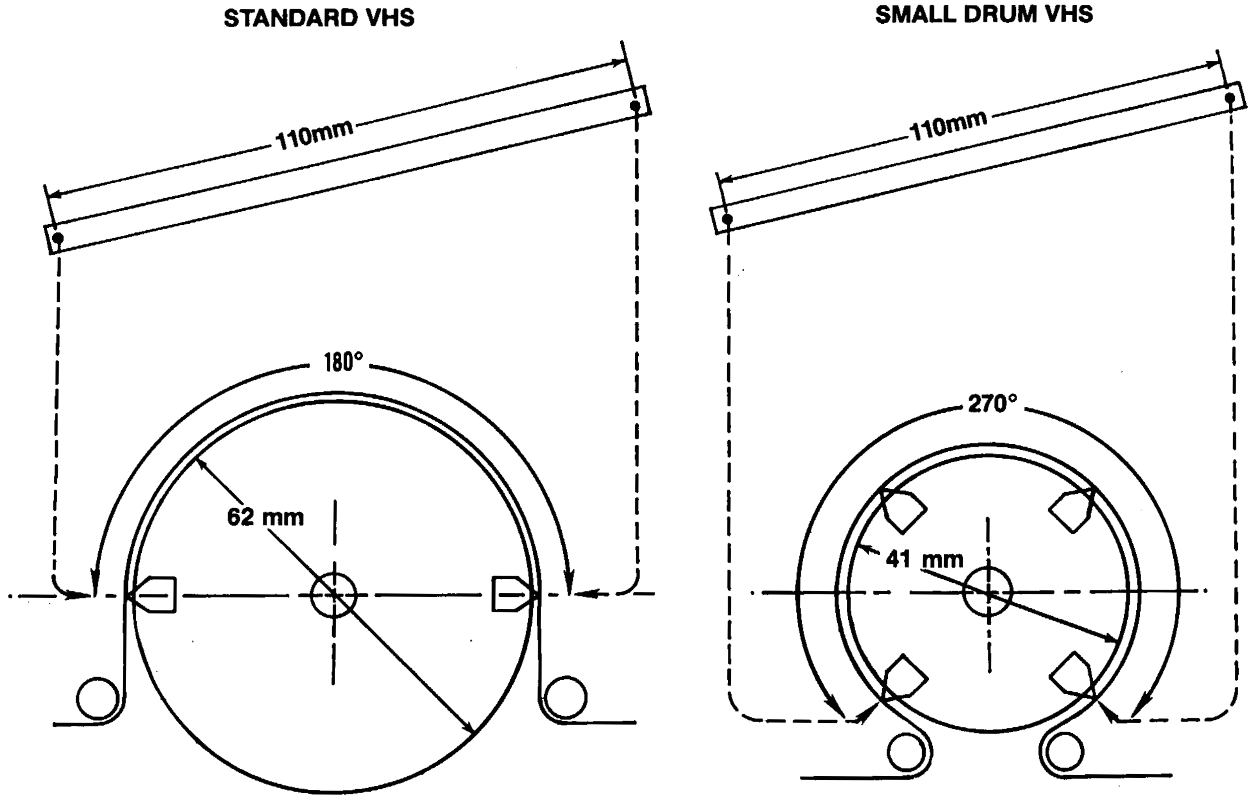

Fig. 5. Standard and Small Drum VHS Scanning System.

Small Drum VHS Head-Track Relationship

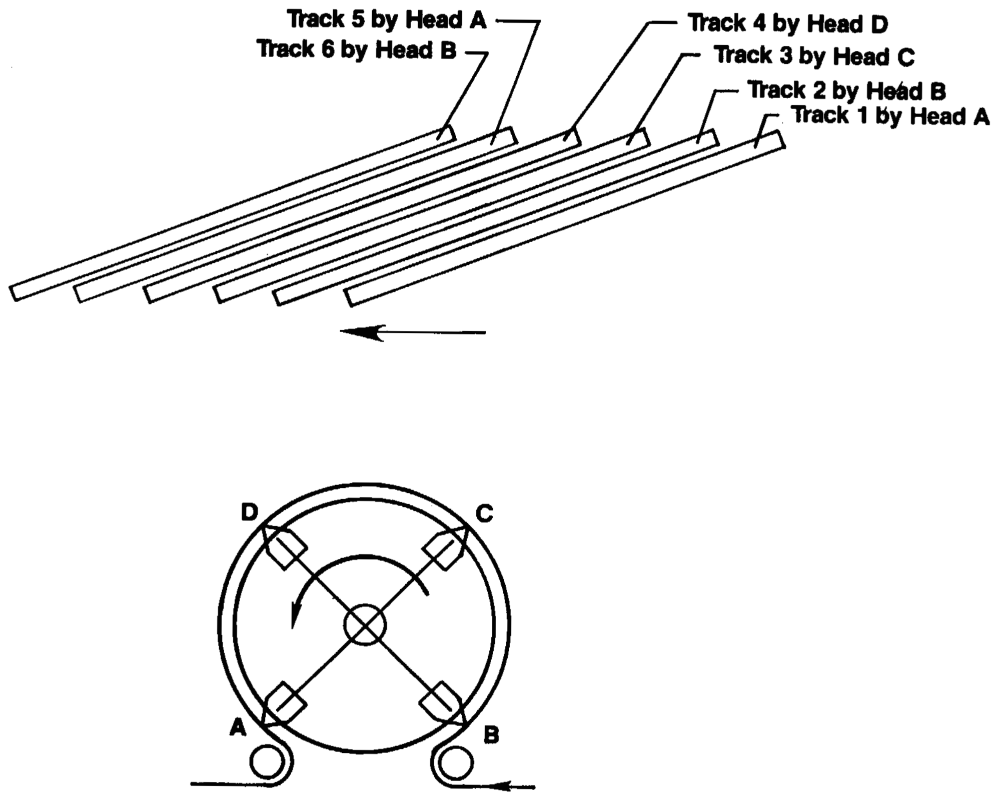

Fig. 6. Small Drum VHS Head-Track Relationship.

Small Drum VHS/VHS-C Cassette Tape Path Diagram

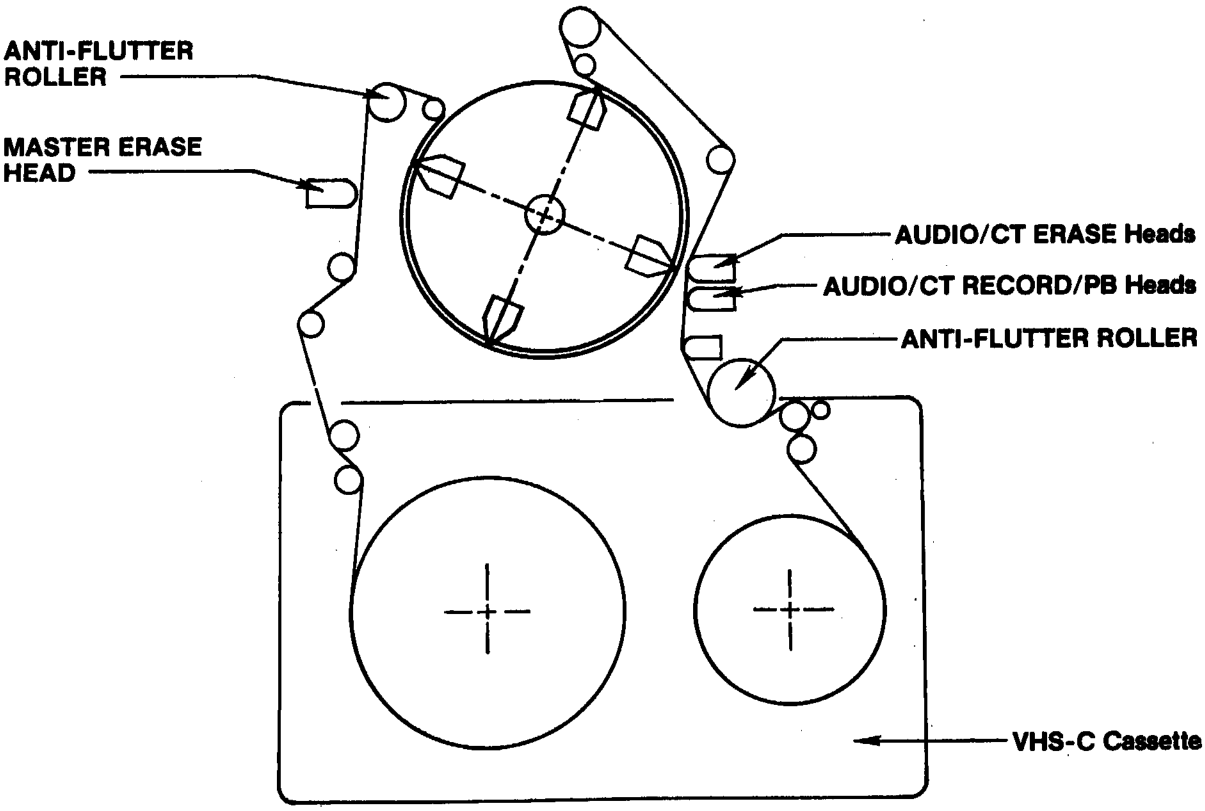

Fig. 7. Small Drum VHS/VHS-C Cassette Tape Path Diagram.

Tape and Recording Density Metal Coated Tape and Metal Evaporated Tape

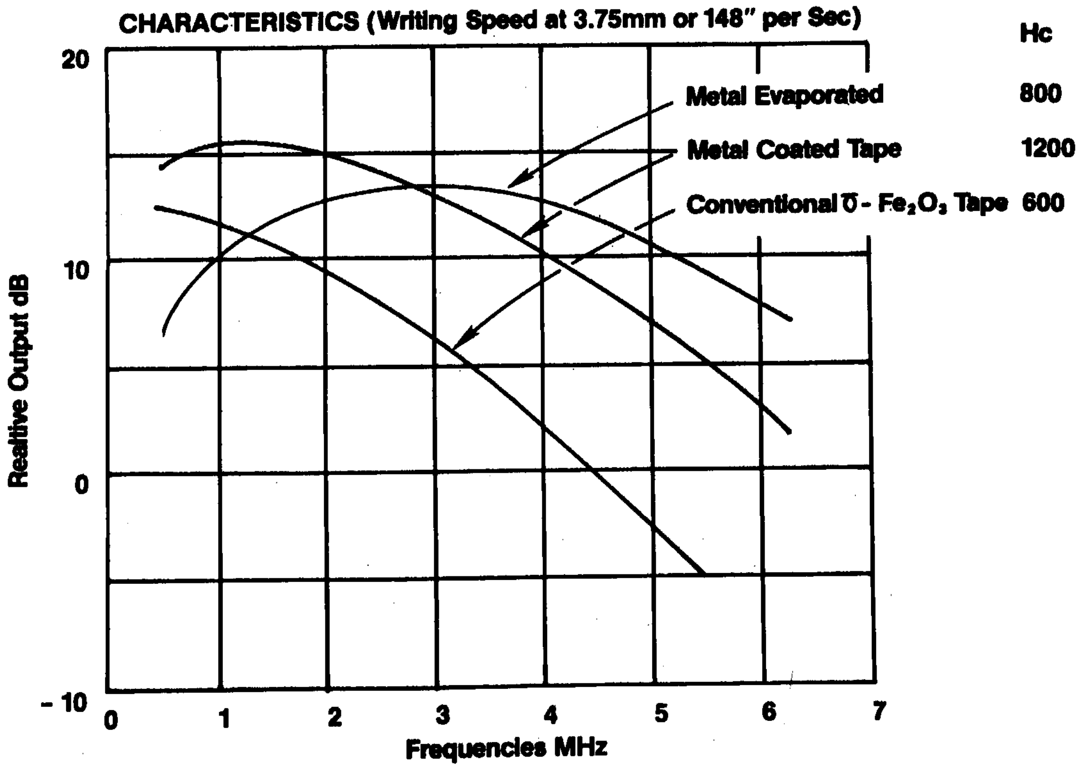

Fig. 8. Tape and Recording Density—Metal Coated Tape and Metal Evaporated Tape.

Trend of Magnetic Recording Density Improvement

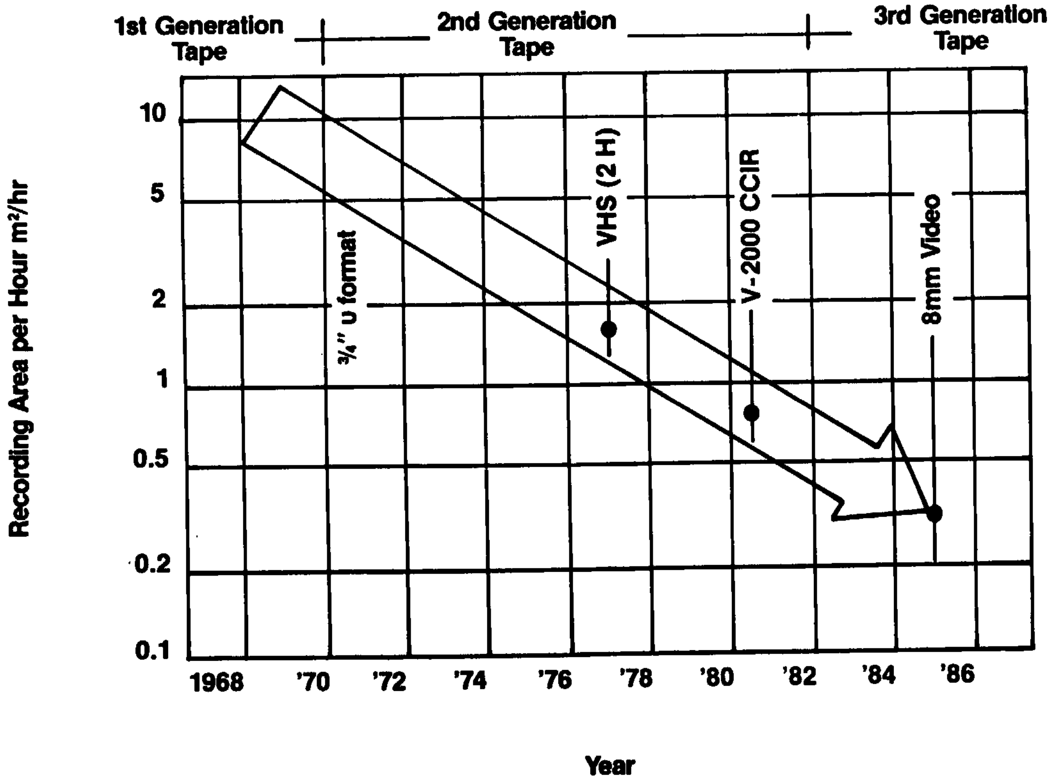

Fig. 9. Trend of Magnetic Recording Density Improvement.

Record Track Dimensions (1)

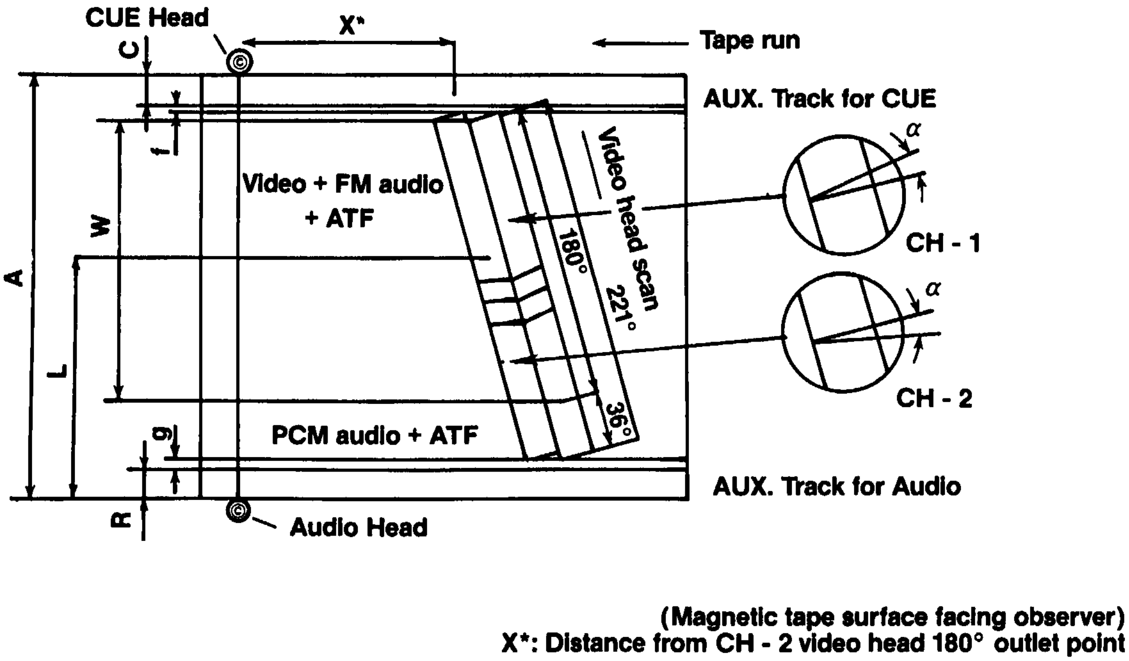

Fig. 10. Record Track Dimensions (1).

Record Track Dimensions (2)

Item	
1. (A)	Tape Width
2. (V_t)	Tape Speed
3. (Ø)	Drum Diameter
4. (V_h)	Writing Speed
5. (P)	Video Track Pitch
6. (W)	Video Effective Width
7. (L)	Video Track Center
8. (T)	Video Track Width
9. (C)	Auxiliary Track for CUE
10. (R)	Auxiliary Track for Audio including optional Edge Guard (0.1)
11. (f)	Video-to-AUX. Track Guard Width
12. (g)	PCM Audio-to-AUX. Track Guard Width
13. (Θ)	Video Track Angle (Tape stop)
14. (Θ)	Video Track Angle (Tape runs)
15. (α)	Video Head Gap Azimuth Angle
16. (X)	Position of Audio and CUE Head
17. (α_H)	H-Alignment

Fig. 11. Record Track Dimensions (2).

8 mm Video Cassette Recorder Format A Frequency Allocations

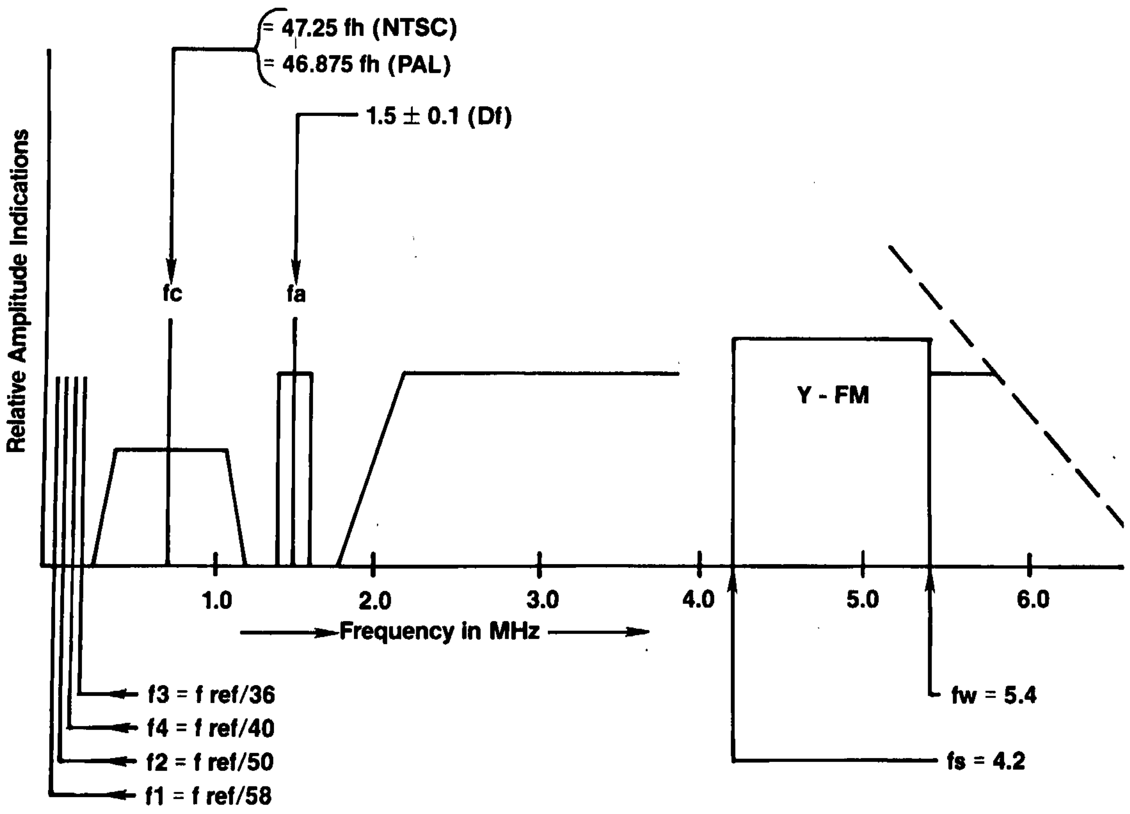

Fig. 12. 8-mm Video Cassette Recorder—Format A Frequency Allocations.

Head Auto-Tracking System

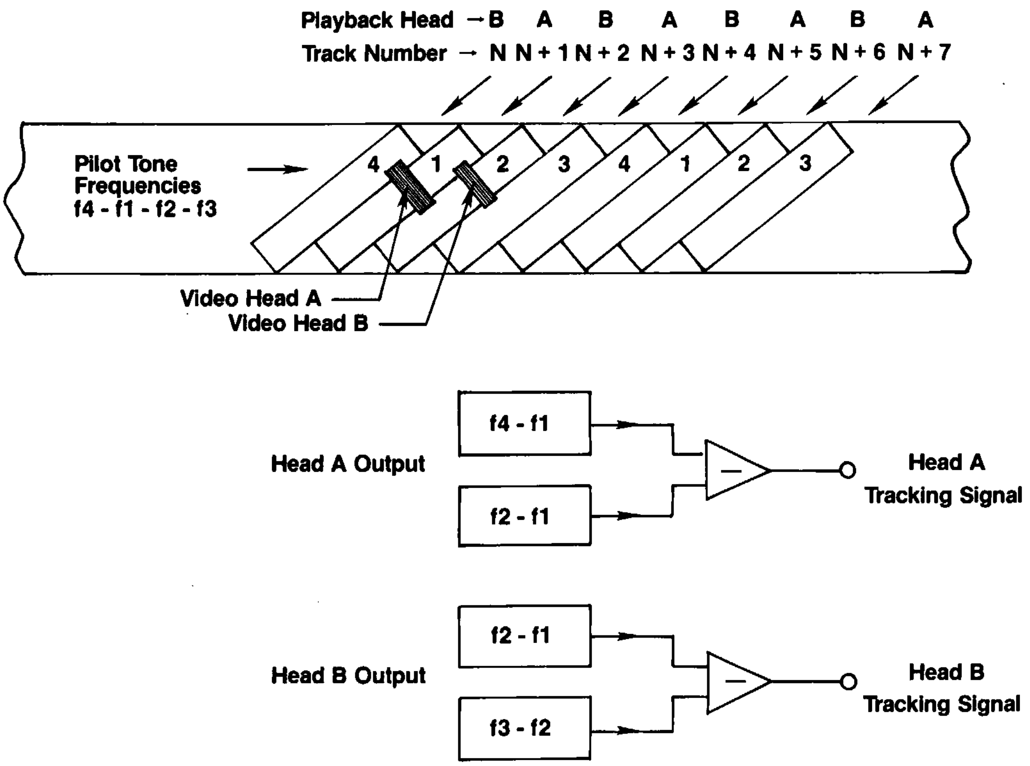

Fig. 13. Head Auto-Tracking System.

Record Reference Frequencies

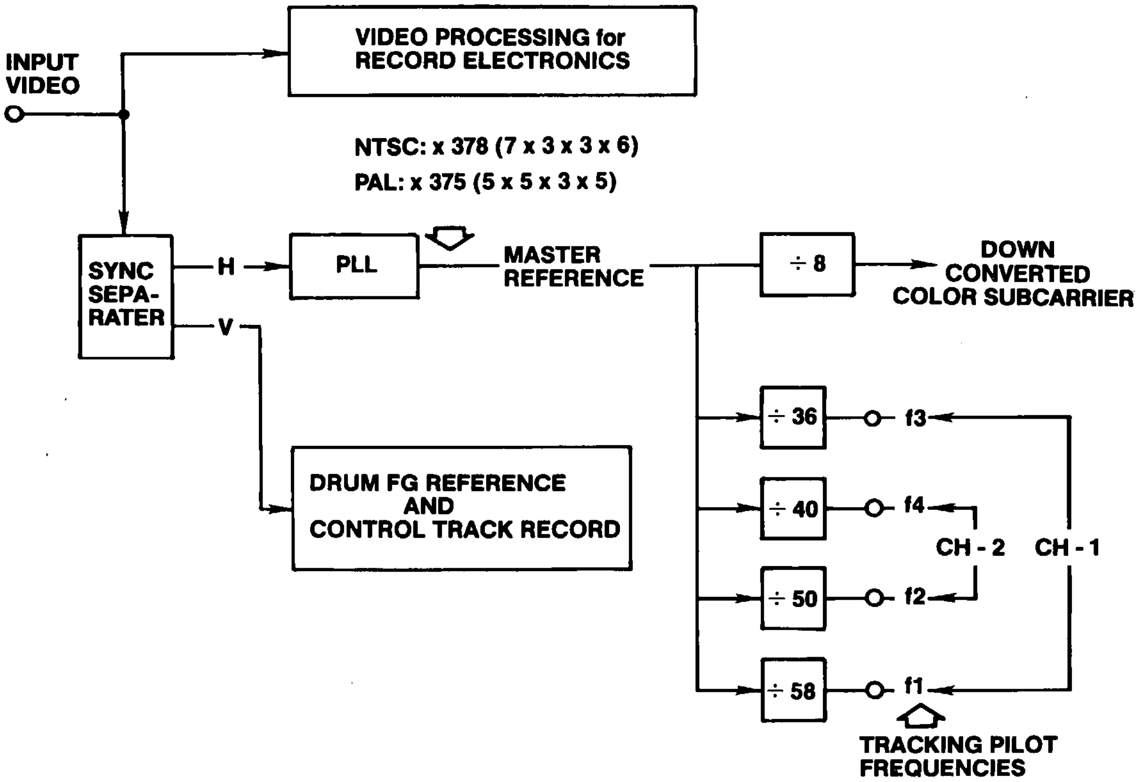

Fig. 14. Record Reference Frequencies.

Block diagram of recording NTSC or PAL color video signal

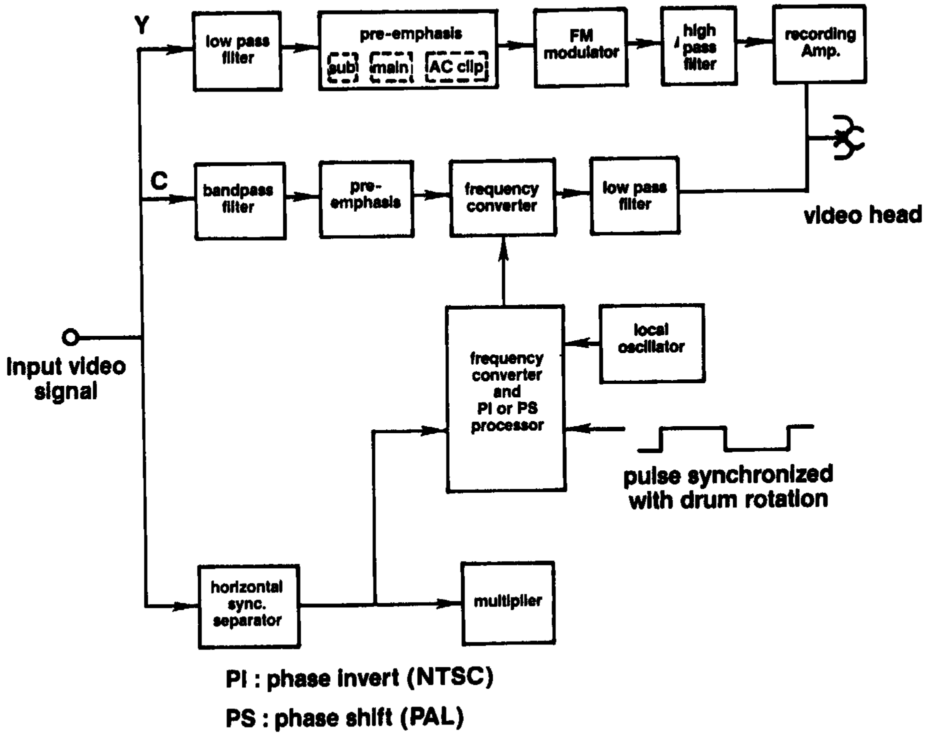

Fig. 15. Block Diagram of Recording NTSC or PAL Color Video Signal.

Outline Dimensions/8 mm Video Cassette

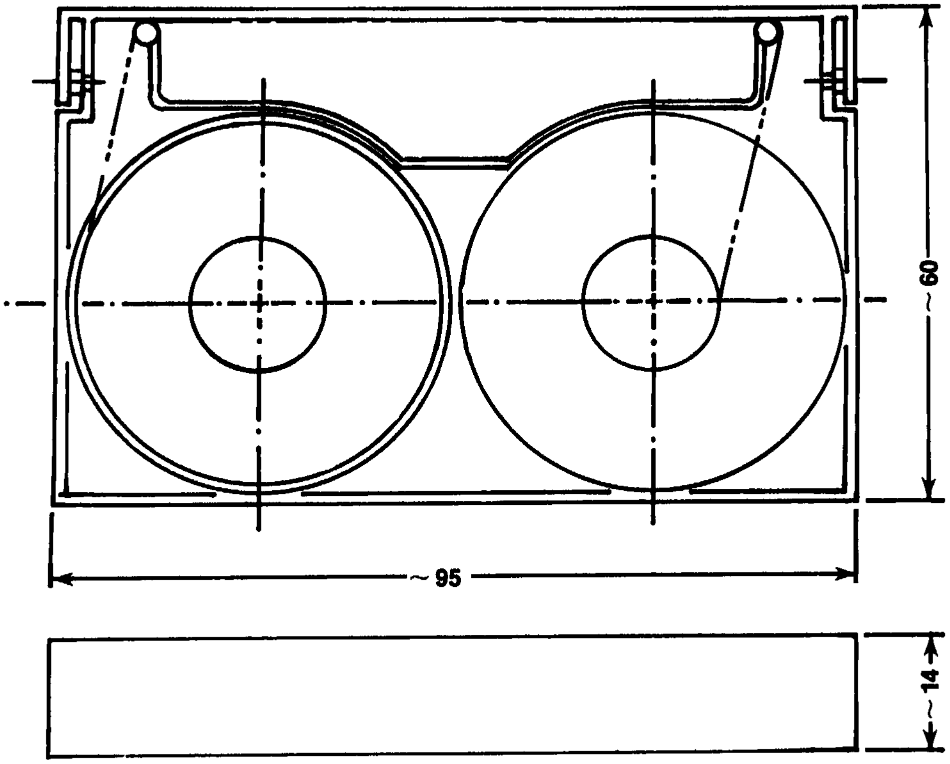

Fig. 16. Outline Dimensions/8-mm Video Cassette.