At bottom right in photo is RCA's VideoDisc player. Engineer is holding typical 12" VideoDisc.

HERE COME THE HOME VIDEO DISCS

How the three leading video disc systems produce sight and sound from a disc resembling the familiar LP record

BY KEN WINSLOW

AFTER several false starts with magnetic tape and optical film and expensive equipment, a practical home-entertainment video playback system that can be used with any TV receiver is on the horizon. RCA, AEG Telefunken, British Decca, Zenith Radio, N.V. Philips, MCA, Thomson CSF, and others have developed video disc systems, that resemble and can be played like an audio disc. More important, the decks and program material are relatively inexpensive compared to tape and optical film systems.

If the developers have their way, we will no longer be tied to network and local station programming. Soon,

we'll be able to make our own choices of prerecorded video disc color TV programs. In fact, West Germans can *now* buy a video disc player from a local retailer. They can also choose from an initial selection of 200 video disc programs.

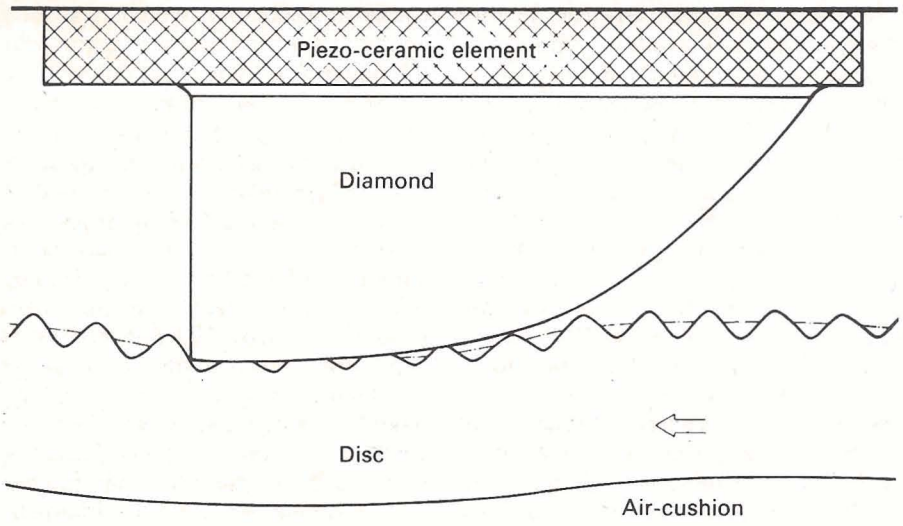
By the end of 1976, it appears that there will be two incompatible systems (produced by RCA and Philips/MCA) in competition for the U.S. consumer dollar. There is also the possibility that other systems, such as West Germany's Teldec system, will join the battle.

The Video Discs. Similar in physical appearance to and played in essentially the same manner as the 12" LP audio record, the video disc will offer just about every form of entertainment imaginable—from motion pictures to plays to opera and even informational and educational programs. Some manufacturers are busily trying to obtain the rights to current-run motion pictures. One manufacturer (Philips/MCA) plans to provide text—illustrations and print—materials that permit the user to scan or read single pages forward, backward, or at random simply by pressing a pushbutton switch.

Although a video disc might look like an audio disc, the similarity is only superficial. By modern high-fidelity audio recording standards, the transient flow of information bits dealt with is calculated to be 300,000 bits/second. Consequently, LP records have the ability to accommodate a density of about 5,000 bits/square millimeter. The result is that a 33⅓ rpm LP disc can easily accommodate 30 to 45 minutes of audio program signal.

The transient information flow required to present a TV picture today is about 100 times more intense than that of sound transmission. A storage medium with the information-density capacity of a video disc would have to offer 100 times more capacity in the same or enlarged surface area for recording the same length (in time) program in video as it does in audio.

An ever-widening variety of dense storage and retrieval techniques and technologies for use with a reasonably sized disc have been demonstrated since 1970. Three leading methods—from RCA, Teldec (Telefunken/Decca), and Philips/MCA—have emerged as of this writing. Because it is the only system currently available, we will take a detailed look at Teldec's pioneering work as an example of the problems faced and as a means for comparing the different solutions to the problems. (Teldec's "TeD" system, a cooperative effort between AEG-Telefunken and British Decca, first demonstrated its solution to dense storage technology with a working monochrome system in June 1970.)



Elastic deformation of Teldec video disc with pressure pickup.

The standard LP audio disc contains 250 to 350 grooves/radial inch, with information recovery dependent upon a side-to-side (lateral) stylus excursion. Teldec discovered that, by adopting a frequency-modulation carrier oscillation technique, a single cutting amplitude could be employed during disc mastering to handle the full required frequency range of the video and audio signals within a constant track width. This also permitted the use of an up-and-down (vertical) stylus excursion method for signal information recovery. Teldec was able to almost eliminate the guard space allowance between the tracks, with the result of raising the number of tracks to 3500/radial inch. This gave the needed 100-fold increase in storage capacity from the same surface area used in audio discs, and it made possible a 12" disc.

The problems of TV's high-frequency range and dense information storage encountered in making the recorded video disc are similarly overcome in retrieving the information from the disc. The stylus for an LP can easily respond as mechanical movement at audio frequencies. However, the mass of the stylus of an audio cartridge is too great to permit such response at the much higher TV frequencies. Needless to say, the various companies have solved the problem in their own special ways.

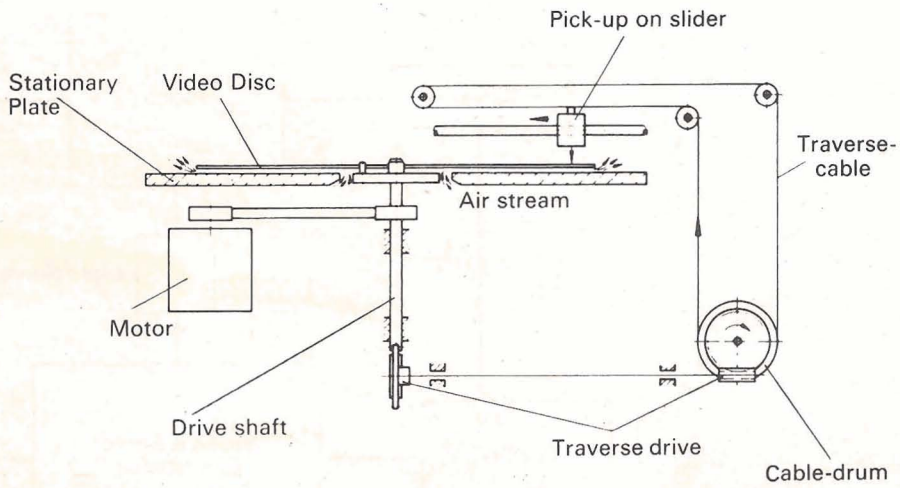


Diagram shows mechanical details of Teldec's disc drive and signal pickup system.

Teldec's "Stylus" Player. In the Teldec system, the information is recorded as deformations in the groove track over which a diamond rides and is sensed as changes in pressure. The stylus tip is in the shape of a sled runner with a gradual radius on the leading edge (relative to disc rotation) and a sharp trailing edge. During playback, the leading edge glides smoothly along the groove over the deformations without damaging them. As the deformations move under the stylus, they become compressed. The sharp trailing edge of the stylus runner passes over the compressed deformations, causing them to spring back to their original shape. In doing so, the signal on the stylus is registered as a constantly varying pressure. The diamond stylus is rigidly fixed to a piezoceramic element that converts pressure variations into electrical picture and sound signals. The sound, recorded in the same fashion as the video, is recovered as pulses that appear during the blanking interval between horizontal line scans.

Consisting of 30 frames/second (equivalent U.S. standards), Teldec's color TV picture is recorded on the disc with each frame occupying one full rotation of the disc. The disc must rotate at 1800 rpm, which is readily accomplished in synchronization with the power line frequency. Rather than riding on a conventional turntable, the disc is center-positioned on a spindle and is supported on a cushion of air above a stationary platter. Instead of being freely guided by the groove, as with an LP, the video disc's stylus assembly traverses the disc's surface by a simple drum, cable, and pulley arrangement run by the same motor that turns the disc spindle. (The easily scratched disc is not handled by the user. An automatic mechanism extracts it from the protective envelope and returns it after play when the envelope is inserted into the machine by the operator.)

The entire player, with its electrical circuits, is about the size of a large briefcase. It is independent of the TV receiver, providing a modulated r-f sound-and-picture signal on an unused channel through the receiver's antenna terminals.

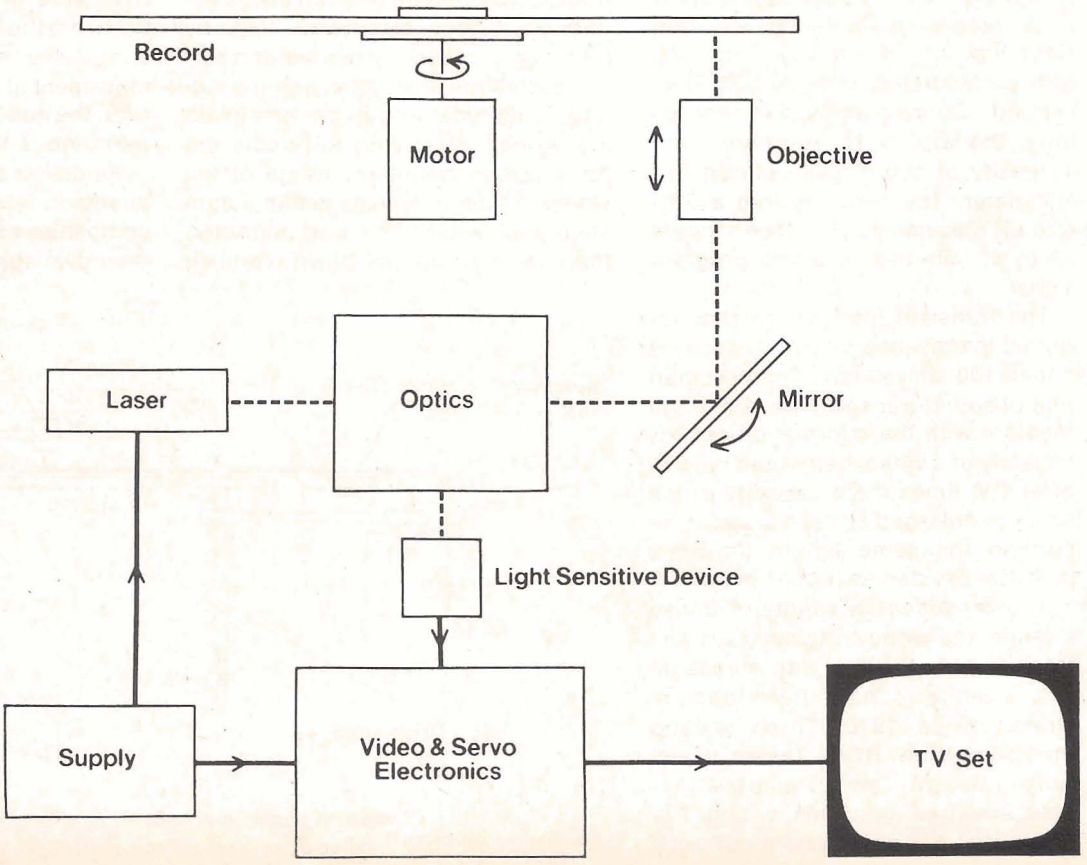
As the system is currently designed, Teldec's video disc has a playing time of 10 minutes.

P/M's Laser Player. Philips/MCA and RCA have taken the video disc considerably further than Teldec has to date in terms of playing time. Both companies pack greater numbers of grooves to each inch on their disc. Also, both have developed their own unique information recovery transducer sytems that are said to be less expensive per hour of use, cause less wear on the disc, and have longer operating lives. Their discs are also designed to be more rugged and easier to handle than are Teldec's.

N.V. Philips and MCA initially pursued separate development of laser/optical systems but have recently combined their efforts. In March of this year, an impressive demonstration of the joint venture was given. Magnavox, now a subsidiary of North American Philips, is said to be planning to manufacture a U.S. P/M video disc player by the fourth quarter of 1976. The large entertainment conglomerate of MCA will be handling programming and disc mastering and replication for the U.S. market.

The P/M system employs a very precisely controlled laser beam to record information on and recover it from the video disc. In recording, a laser is used to cut minute oblong depressions that represent sound, color, and brightness information. About 0.7-micron wide, the depressions vary by 0.8 to 2.5

VIDEODISC PLAYER



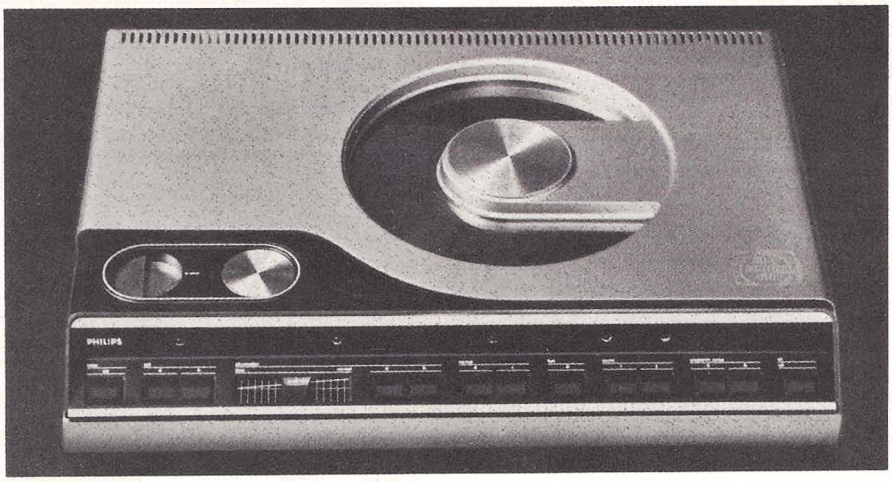
Complete Philips/MCA optical laser player system is shown here in block diagram form.

microns in length and follow a continuous spiral path. Because of this extremely small size and the fact that the tracks can be spaced less than 2 microns apart, P/M is able to achieve about 12,500 tracks per radial inch. This is almost three times more than is possible with the Teldec approach.

The P/M disc consists of three parts: protective layer, information layer, and highly reflective layer of aluminum.

A laser beam in the player is used as a non-contact optical "reader" to recover audio and video information from the disc. Light from a 1-mW helium-neon laser is focused onto the video disc as a spot 1 micron in diameter. This is reflected back from the aluminum layer through a recovery lens that focuses it on a photo detector. The detector converts the beam into an electronic sound-and-picture signal. The spot of light follows the rotating track and intercepts the depressions that contain the video information. As the light rides over each track depression, the amount of light reflected back is modulated by the length/depth characteristics of the depressions.

A number of different control and servo systems perform various functions: to select and preserve accurate spot tracking and focus; to maintain time-base stability in case of unevenness of the disc surface due to irregularities or warping and center-hole location eccentricities; and to ignore the accumulation of surface dirt and scratches on the protective transparent coating. Since there is no stylus or physical contact with the disc, the P/M player is a "no-wear" system, and the video disc should theoretically last forever.



Philips/MCA player has controls located on front panel. To left of center is slide-type slow-motion control. Remaining controls on panel are pushbuttons.

The disc rotates at 1800 rpm. As a consequence of the 30-frame/second U.S. NTSC TV sytem, the disc makes one revolution of 360° for each frame. A radial deflection mirror forms part of the laser beam control system. P/M says that the radial deflecting mirror can easily be made to control the beam during the vertical interval to repeat the same track, jump back one or more tracks, or jump forward one or more tracks. Since this occurs during the vertical blanking period of the frame, and provided that not too big a jump is made during this limited time, all manner of still, fixed, and variable slow forward and reverse motion, and random-access effects can be obtained by "playing" the controls. A digital index counter is used to help pinpoint the location of a specific selection or frame.

The disc will be single-sided and will contain up to 30 minutes of program material. Company spokesmen say that they will be able to meet the announced price of $500 for the player and still be able to offer the stop/slow/variable-frame display system that the player seems so uniquely able to provide.

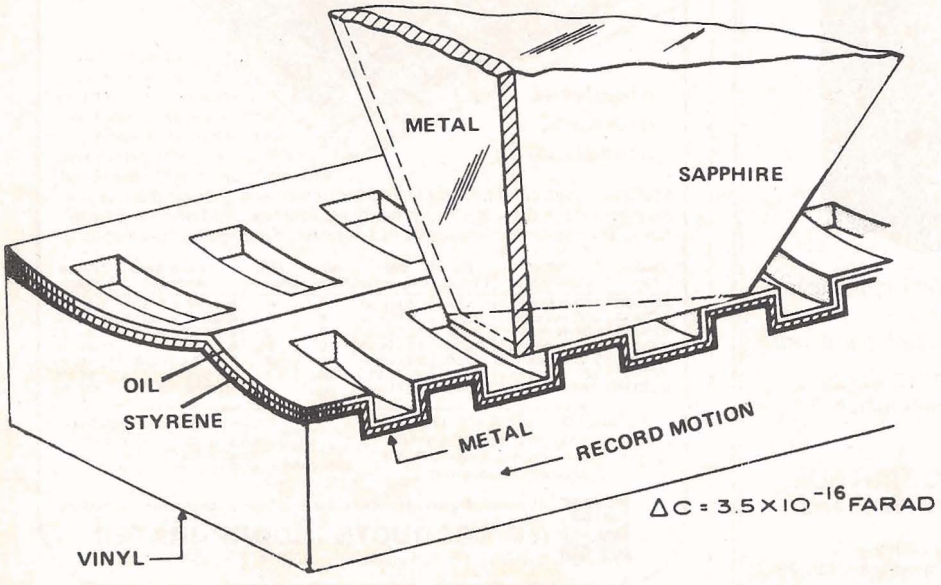
As announced, the P/M player will offer modulated r-f picture and sound signals through the antenna input of any conventional TV receiver. Two separate 15,000-Hz audio output channels will also be provided for feeding into a stereo audio system.

VIDEO DISC SYSTEM COMPARISON CHART

	TELDEC	PHILIPS/MCA	RCA
DISC:			
Composition	PVC	Mylar/reflective aluminum	vinyl/metal dielectric/oil
Diameter	8"-10"	8", 12"	12"
Playing time	10 min.	30 min.	60 min. (2 sides)
Speed	1800 rpm	1800 rpm	450 rpm
Tracks/inch	3500	12,500	5555
Information scheme	groove deformations	long longitudinal pits	transverse slots in grooves
Average life	100 plays (min.)	indefinite	100 plays (min.)
Estimated cost	$4-$10/disc	$2-$10/program	$10/disc
PLAYER:			
System type/ transducer	mechanical contact/pressure	no-contact/ optical laser	mechanical contact/capacitive
Estimated price	$500	$500	$400
PICKUP:			
Type	diamond stylus	laser	sapphire stylus
Estimated life	70-100 hours	NA	200 hours (min.)
Replacement price	NA	NA	less than $10 for stylus/cartridge assembly

NA = Information not available at this writing.

RCA's "Capacitive" Player. In a number of respects, RCA's capacitive-mechanical video disc system falls between the Teldec and P/M systems in terms of storage-density and playing capability. RCA spokesmen say that a calculated choice was made to design a system that offers a player/disc component system that keeps the difficult parts in the factory and the noncritical parts in the home. By using a stylus tracking system, a capacitive-sensing signal-detection technique, and a 450-rpm disc speed, RCA believes it has struck the best possible balance in manufacturing, reliability, operational simplicity, low purchase/operating cost, and duration of available playing time. Except for the stylus assembly, the company states that the electrical and mechanical assemblies for the player are largely off-the-shelf items.



Detail view of RCA's stylus tip and cutaway view of VideoDisc surface. Metal layers on disc and sapphire stylus form two plates of capacitive element.

Similar to Teldec and unlike P/M, RCA uses a grooved disc that mechanically guides the stylus over the signal track. The grooves are spaced 4.57 microns apart (center to center). There are 5555 grooves per radial inch. The disc itself consists of five layers of material sandwiched together. The vinyl core contains the information slots that vary in length between 0.23 and 1.23 microns. (The slots are cut in the master by a high-resolution electron beam in a vacuum chamber.) Metallic and styrene coatings are then applied to both sides of the disc. Finally, a layer of oil that increases the life expectancy of both the

disc and the stylus is applied to both sides of the disc.

The signal is recovered from the disc by capacitively sensing the information elements pressed as transverse slots in the groove. A plow-shaped sapphire stylus, when in contact with the groove, extends about 3 to 10 microns along the groove. A thin coating of metal on the flat trailing edge of the stylus serves as one plate of a capacitor, while the metallic layer in the disc represents the other plate. The styrene coating on the disc serves as the capacitor's dielectric.

As the stylus travels along the groove over the information slots, the capacitive voltage relationship between the insulated plates fluctuates by amounts that depend on whether or not the area immediately beneath the stylus is or is not a slot cavity. The changing capacitance is sensed by a tuned circuit, of which the stylus "plate" is one element, thereby providing the signal information for amplification and processing into a standard video/audio signal.

Variations in disc speed caused by power-line frequency fluctuations, as well as disc imperfections caused by warping and centering problems, must be corrected to insure a steady, fault-free picture. While P/M uses various compensating servo loops, RCA says it has made a special design effort to keep such complexity, with corresponding chances for misadjustment and malfunction, to a minimum. RCA has designed a single servo stylus "arm stretcher" arrangement that consists of a small electromechanical transducer similar to the moving coil in a speaker that continuously drives the stylus arm back and forth along its long dimension according to the variations.

The arm stretcher is housed in a cage driven by a toothed belt to follow the basic groove spiral pitch of the disc. The entire arm sweeps across the disc's surface in a manner similar to that used by Teldec. RCA says that this combination of a belt-driven arm cage and the mechanically tracking stylus, guided by the actual groove spiral, preclude the necessity of holding to difficult mechanical manufacturing tolerances. The player has a built-in-one-line horizontal delay for substitution of a preceding picture when a noise or similar defect occurs in an upcoming picture line.

Teldec and P/M have chosen an 1800-rpm playback speed that equates to one frame every 360° of disc rotation, making it potentially easy to use the disc for still/slow/single-frame viewing. RCA's choice of 450 rpm, equating to four frames per 360° revolution (one frame every 90°), while not precluding these framing effects, makes providing for such features more complex and expensive. The company says that its choice of a 90° frame is critical to greater utility.

RCA is able to design an overall system that can currently offer a combination of the longest playing time with high picture quality. A two-sided disc that will give up to a 60-minute per disc program playing time will be offered with the RCA system.

The slower speed of the RCA player contributes to its ability to offer a less expensive system. The use of a simple stylus arm stretcher is also said to be less expensive than the means adopted by P/M to stabilize signal timing. RCA's lower-speed player enables its more complex stylus assembly to handle the expected amount of disc unbalance, eccentricity, and warp during playback.

While not yet committed to a market entry date, RCA says it could begin to provide players and discs in small retail quantities in the third or fourth quarter of 1976. Prices for the player and individual disc have been tentatively set at $400 and $10, respectively. The disc will give some 100 (minimum) plays in normal use, and the operating life of the stylus will be a minimum of 200 hours. A user-replaceable stylus/cartridge assembly is expected to sell for less than $10. The player's modulated r-f output is set to an unused channel of any TV receiver, and separate outputs to drive a stereo system will be provided.

Conclusion. In this article, we have placed the emphasis on three systems that are almost certain to be available by the end of 1976. However, a host of other systems are under development. These include magnetic card (Sony) and magnetic disc (Bogen) systems that can record and erase and an optical disc system (i/o Metrics) that can record but not erase.

One thing is certain: separately or together, these home video systems will herald a new era in home entertainment. The prices will be right. And if all goes as expected, the programming will be on a par with the best live and film entertainment available anywhere today. ◈