COMMUNICATIONS
FORUM

ELECTRONIC STILL PHOTOGRAPHY

October 9, 1986

Seminar Notes

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMMUNICATIONS FORUM

ELECTRONIC STILL PHOTOGRAPHY

October 9, 1986

Seminar Notes

Ken Y. Mano
Sanyo Electric, Inc.

Hugh MacKenzie
Polaroid Corporation

ELECTRONIC STILL PHOTOGRAPHY (ESP)

Hugh MacKenzie - Polaroid Corporation

MacKenzie began by giving a broad definition of electronic still imaging. Like chemical photography, electronic still imaging uses camera, lens, ranging systems, shutters, frames, etc. but instead of immediately producing a hard copy it prints the image on a medium after proceeding through colored filters, CCDs, electronic signal processing, viewing systems, storage systems, signal processing for the printer, and a printing transducer. Talking of image quality he said that in ESP what is critical is the total photographic system and not just the film as in chemical photography. In viewing hard copy images the cut-off point in terms of resolving with the eye is approximately 30% modulation. However, with electronic photography the cut-off point (i.e. limiting modulation) is about 3%. If the image contains a lot of noise, this can be reduced by digitizing the signal and enhancing the image. He then showed samples to support his point.

Talking of the future of ESP, MacKenzie said that unlike the chemical photography companies, where everything evolves around the print, the consumer electronic companies see ESP evolving around the CRT. Thus, the perspective is always a little different. In the future one will be able to go to the store, put a negative or a 47mm disc in a player, view and select the photograph - zoom, crop, or do whatever balancing that is desired, transmit via telephone to another location, put the image in a home computer, and/or home process the image even

adding information if necessary. He suggested that the photo-finishing industry would undergo a radical change and may not even be recognizable in 10 years. Electronics he asserted will be the fundamental base of the future photofinishing industry. There will be a lot of hard copies produced in the future, and beautiful too!

Another important change he noted, is the merging of technologies - computers, electronics, photography, chemistry, optics, etc., with a storage system having an extensive information base. For example, one system could assist the police in identifying a particular vehicle, reviewing driving records, and relating it to its owner (together with a photograph).

Shifting his attention to Polaroid, MacKenzie stated that they were conducting work on low resolution scanning using the high frequency information of the picture itself and handling color correction/matching using laser printers with 128 by 128 monitoring systems. He then showed samples of laser prints of the latest spectral system photographs where it was very difficult to differentiate the original from the copy.

Other systems on the market include include one that prints with a source such as Zenon Arc, where an original can be scanned and colors matched against Polaroid films or negatives from other companies, to finally print it with beautiful photographic color and excellent resolution. However, it is not possible to achieve this with a pocket-type cheap camera. Another system that Polaroid is working on is capable of taking 3 colors, about 4 million bits of information, digitizing it, and

enhancing the image in 1/2 a second. This should be operational, he said, early in 1987. He then used a slide to briefly list the history of ESP (exhibit A). Exhibit B details the features of the ideal electronic camera. However ordinary chemical photography has the comparative advantage of high resolution and low system cost. In the interim, hybrid systems are available which use a fairly expensive scanner unit tied to a computer. This enables the user to take the information and adjust it, finally printing it with the best high resolution on chemical photographic paper. Referring to the shortcomings of current technologies (exhibit C) MacKenzie pointed out that these problems are being worked on and expressed confidence in them being solved.

Exhibit D and E portray the image path and signal flow in ESP. Discussing the factors affecting electronic image quality he listed the following:

- Human vision
- Viewing distance
- Resolution
- Spot shape
- Number of bits
- Signal to Noise Ratio (SNR)

In closing MacKenzie stated that ESP is already here and has scope for the future. However, there are still many technical hurdles to be overcome, particularly with regard to quality, cost and size. Electronics, he said, will continue to expand the photographic space and technologies that were separated in the past will merge to create many new photographic systems in the future.

Ken Y. Mano - Sanyo Electric Inc.

Mano noted that the filmless camera system had been anticipated for a long time and was finally achieved and announced over the last few years. He identified two technical reasons that delayed the introduction of the Electronic Still Camera (ESC). (1) Semiconductor image devices like the CCD were premature to be used practically. (2) A satisfactory printer for the ESC was not completed till recently. In recent years while semiconductor technology dramatically advanced, practical printing methods were also successfully developed to even produce color hard copies from computer graphic terminals.

Exhibit F describes the ESC system. The camera in the system can take either single or consecutive pictures and the 47mm diameter floppy disc has 50 main tracks (or 25 high quality still picture tracks) to store signals. Exhibit L indicates the track pattern on the video floppy disc. Images can be displayed on a home TV monitor and hard copies made using an ink jet or color thermal or video printer. Audio signals can also be recorded on the disc using a sound adaptor.

Mano described the camera imaging section using exhibit G. The camera uses two CCD detectors for video signal and color signal sensing. The ESC system has the following features:

- Immediate reproduction on TV monitor
- Audio and other digital data can be stored in addition to video
- Erasable and re-useable

He stated that there were several methods for producing 'hard copies' but he remarked specially about two popular methods.

Namely the Ink Jet and Thermal Transfer methods.

Exhibit H shows a primitive model of the demand Ink Jet, and the practical print head described in Exhibit I was developed by Sanyo. It has two methods of operation - 'Continuous Stream' method, and 'Drop on Demand' method. Exhibit H describes tne operation of the 'Drop on Demand' Ink Jet method. Exhibits I and J describe the Drop on Demand Ink Jet print head and print mechanism respectively. The Thermal Transfer method consists of two types - Wax Transfer Type, and sublimation Dye Transfer Type. The Wax method is the more popular of the two while the Dye Transfer Type is employed for half-tone printing. The Dye Transfer method is used in the video printer to produce still pictures from TV or video, in either black and white or color prints of rather small size (exhibit K).

In closing, Mano stated that the resolution on both thermal and Ink Jet printing are not as good as conventional camera photo print, but it is much cheaper (approximately $0.50 compared to $5.0 per copy of size 8" x 10"). He also added that several proolems had yet to be solved to obtain satisfactory print images.

Speakers' Comments and Responses to Questions

Responding to a question on ESC pricing Mano said that prices would have to drop to at least the high end of the traditional camera market (i.e. about $500) to make it attractive to potential users. MacKenzie stated that the canon ESC was

about $2600 (without accessories). He believed that by 1990 the million pixel camera would be available and priced in the region of $350 - $400. As for the quality of print, he asserted that it would depend on the type of printer which would of course vary with cost.

A member of the audience referred to Kodak's move to disc cameras, trading convenience for resolution, and inquired how these features would apply to the ESC. MacKenzie stated that the issues involved are that of convenience, cost, and quality. He stressed that from his point of view quality is very important and as for convenience the electronic camera would be no different to the normal camera. Mano added that the convenience /advantage of ESC is the re-useability of the recorded disc, and its transmittability via the telecommunication network.

Responding to a querry regarding high resolution in CCDs Mano said that the normal figure is about 400,000 pixels though someone he said had announced a much higher resolution. MacKenzie pointed out that Canon and Fuji have produced resolucions of 380,000 pixels. He added that resolutions of 1.2 million and 1.4 million pixels that have been claimed are most prooably only laboratory figures (not attainable in actual practice).

EXHIBIT: A

BRIEF HISTORY OF ELECTRONIC STILL PHOTOGRAPHY

1974 VIDEOPRINT GESELLSCHAFT... VIDEO STILL SYSTEM

1976 TI INSTANT PHOTOGRAPHIC SYSTEM

1977 KODAK ELECTRONIC STILL CAMERA: CCD, DIGITAL, AUDIO TAPE

1979 CANON: CCD, SINGLE FRAME, DISC

1979 POLAROID ELECTRONIC IMAGING CAMERA WITH PREVIEW

1981 SONY MAVICA DEMONSTRATED: 570x490 CCD, 50 COLOR IMAGES ON DISC, THERMAL PRINTER

1982 KODAK FILM VIDEO PLAYER: ZOOM, SCAN, ROTATE, CROPPING

1984 L.A. OLYMPICS: SONY & CANON

1985 47MM "STILL VIDEO FLOPPY" STANDARD

1985 FUJI MARKETS TV-PHOTO PLAYER USING 47MM DISC

1985 TAMRON, KODAK PHOTO/ELECTRONIC HYBRIDS

EXHIBIT: B

IDEAL "ELECTRONIC CAMERA":

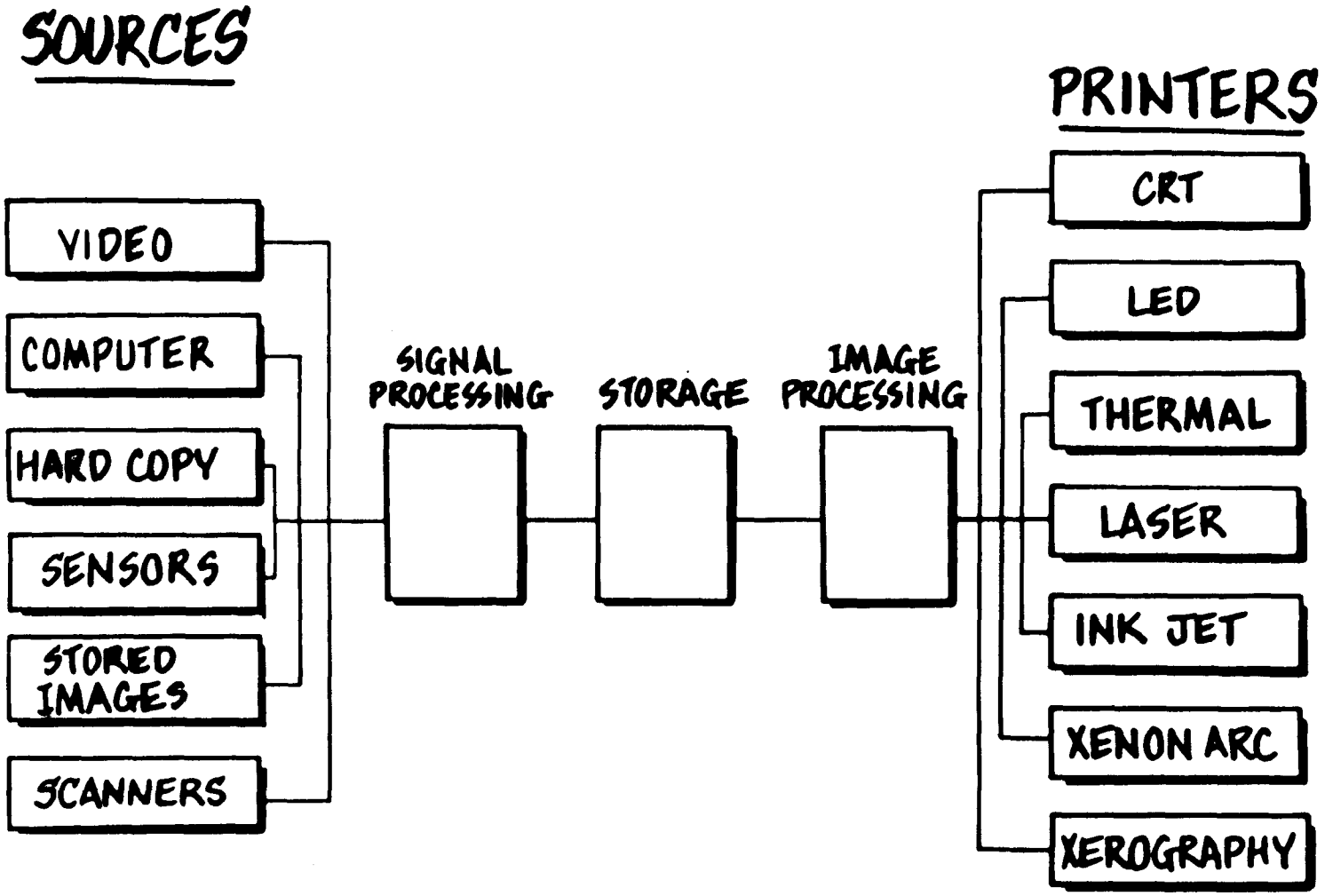
EXPANDS THE CAPABILITIES OF PHOTOGRAPHY

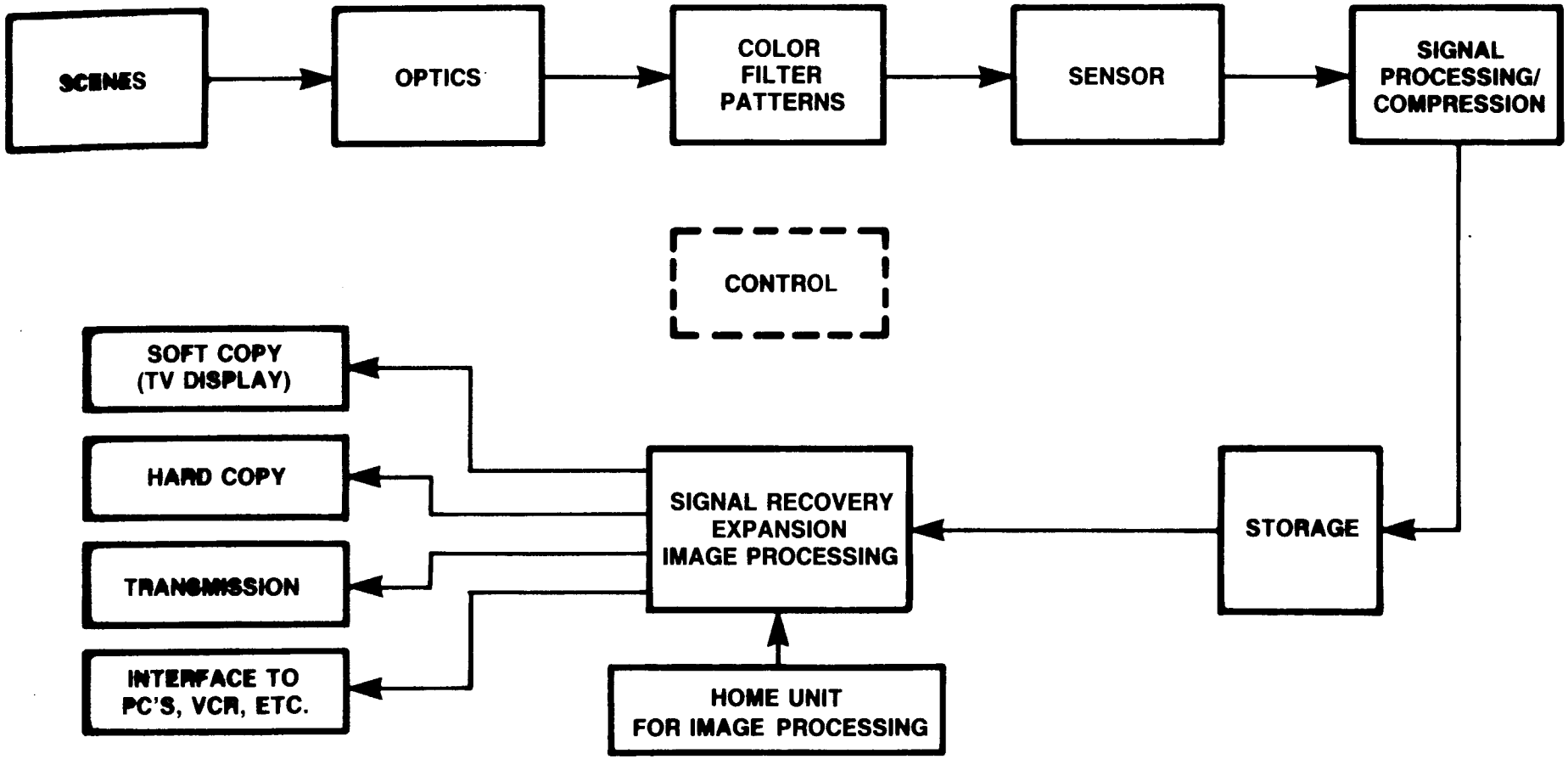
- FLEXIBILITY
- INSTANT ELECTRONIC REVIEW
- IMAGE PROCESSING
- INTERFACE TO HOME VIDEO SYSTEMS AND COMPUTERS
- IMAGE TRANSMISSION
- TEXT ANNOTATION
- SOUND TRACK
- INEXPENSIVE REUSABLE MEDIA
- PIZAZZ

EXHIBIT: C

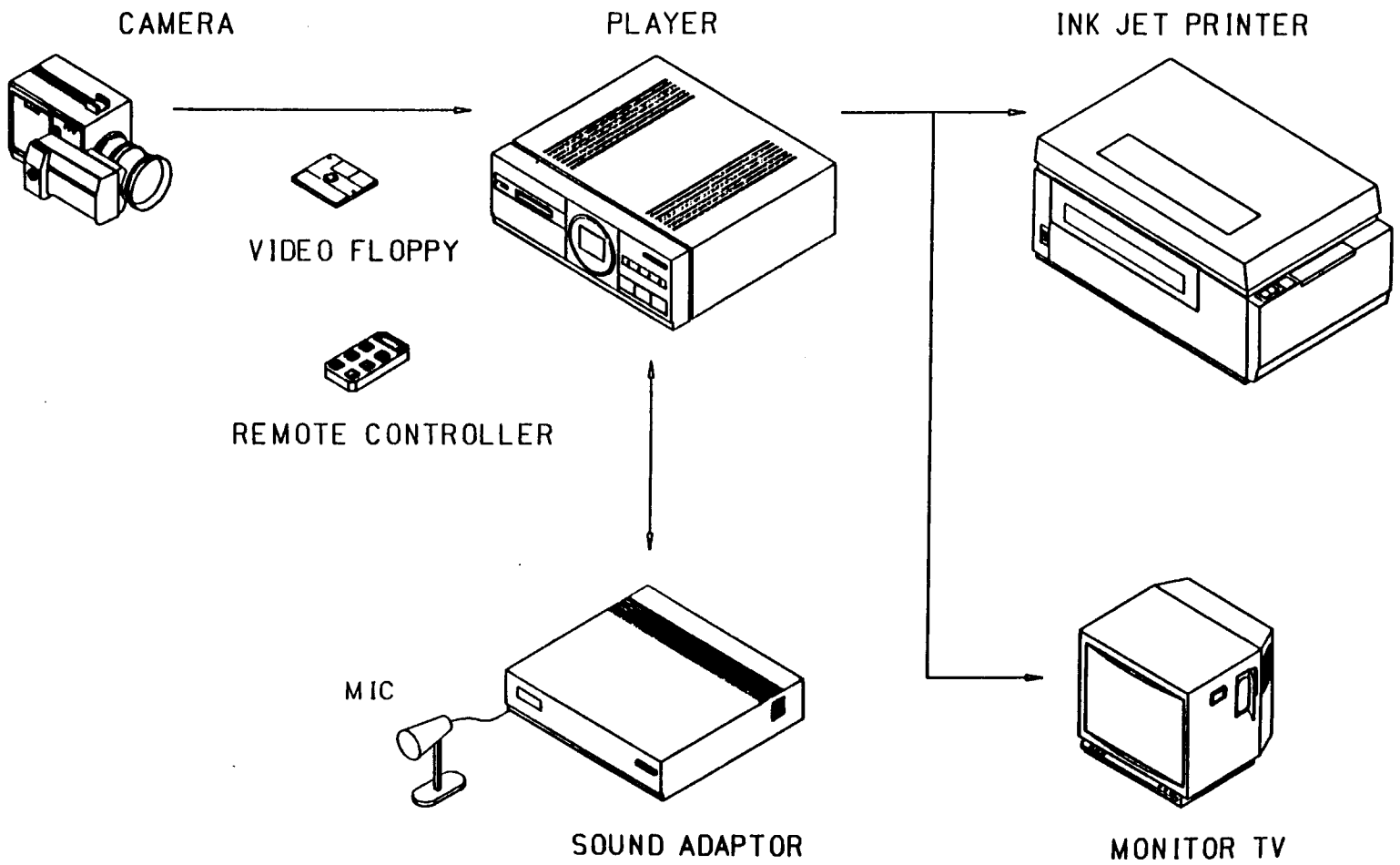
SHORTCOMINGS OF CURRENT TECHNOLOGIES

- SENSORS WITH HIGH RESOLUTION AND HIGH SENSITIVITY
- COMPACT LOW-POWER SIGNAL-PROCESSING CIRCUITRY
- ULTRA-HIGH DENSITY STORAGE
- ENVIRONMENTAL ROBUSTNESS

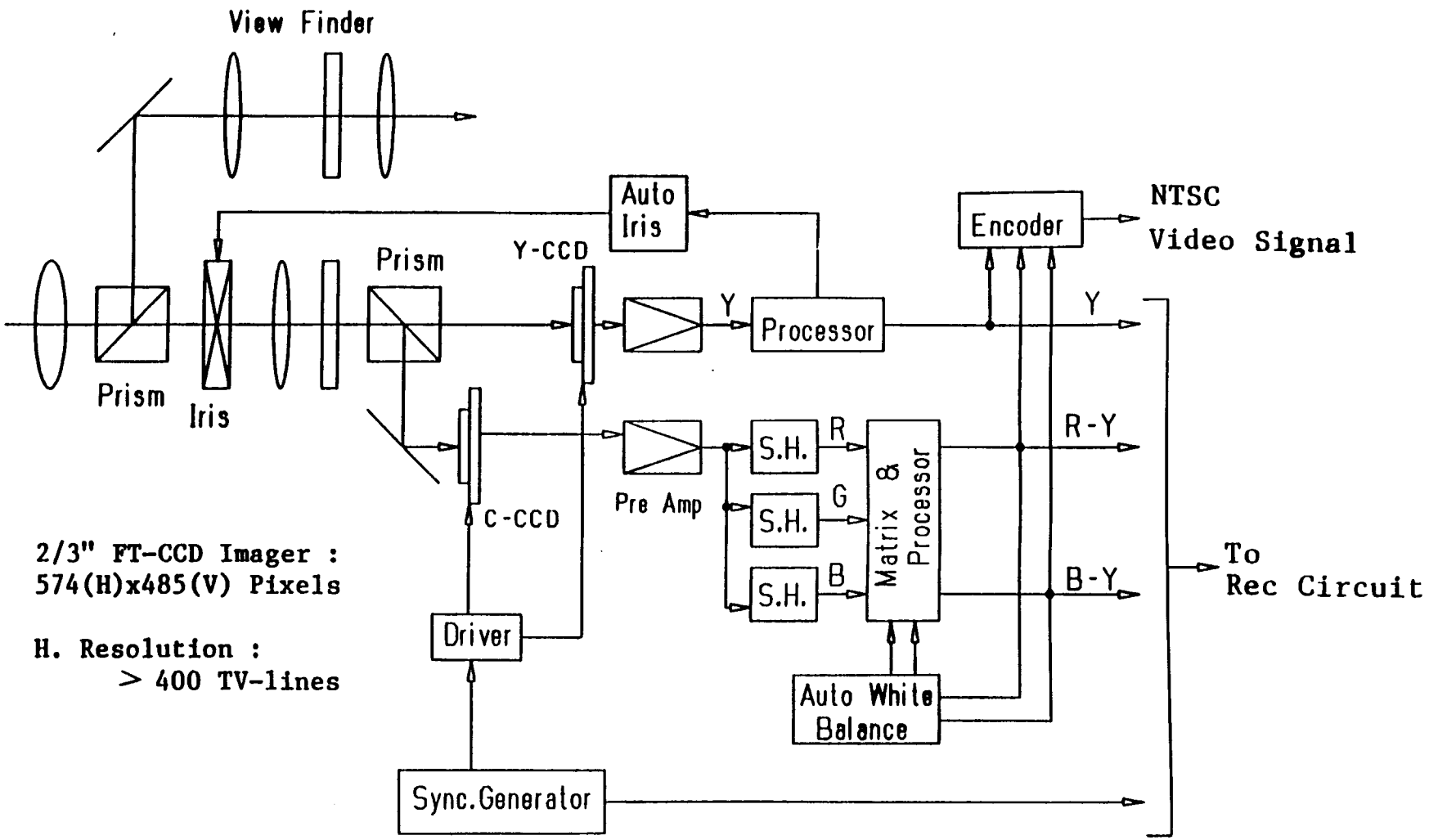

SOURCES
VIDEO
COMPUTER
HARD COPY
SENSORS
STORED IMAGES
SCANNERS
SIGNAL PROCESSING
STORAGE
IMAGE PROCESSING
PRINTERS
CRT
LED
THERMAL
LASER
INK JET
XENON ARC
XEROGRAPHY



SIGNAL FLOW IN AN ELECTRONIC STILL CAMERA SYSTEM



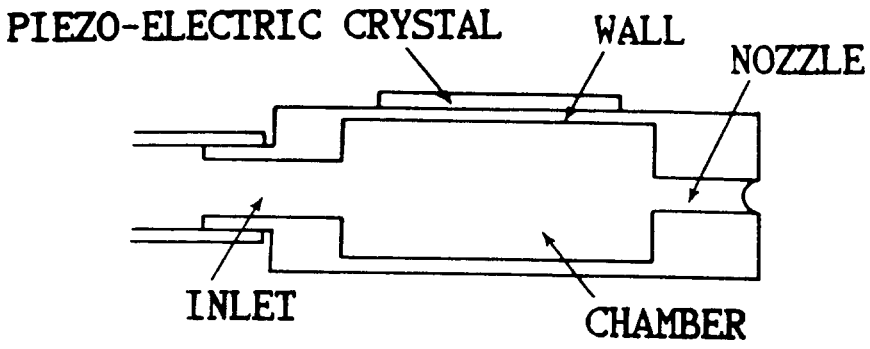
The Electronic Still Camera System



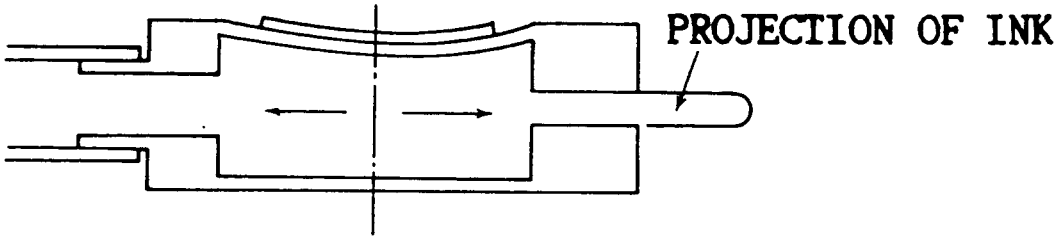
Block Diagram of Camera Imaging Section

EXHIBIT: H

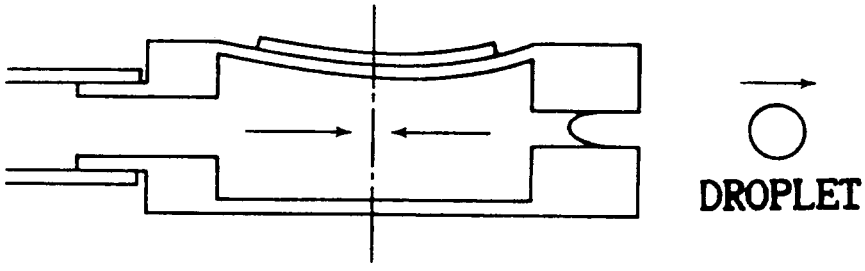
(1) INITIAL CONDITION



(2) VOLTAGE APPLIED TO THE CRYSTAL



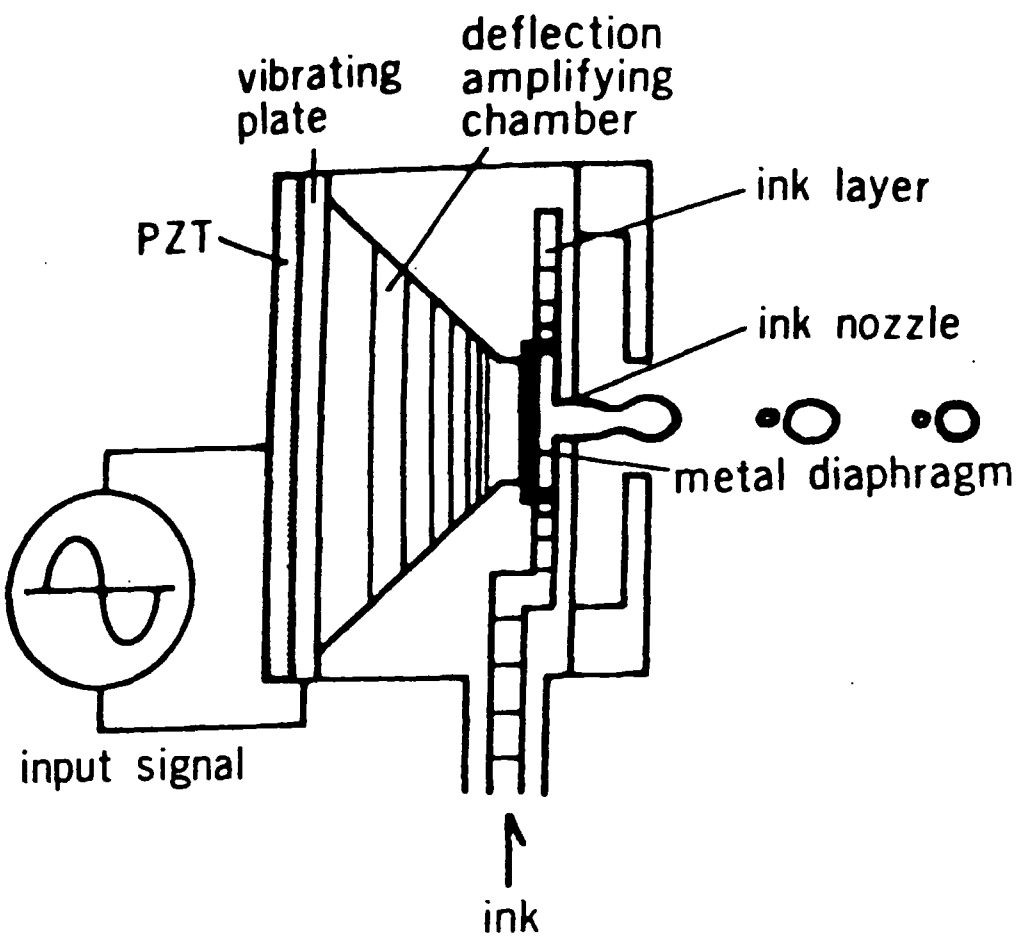
(3) SEPARATION OF DROPLET



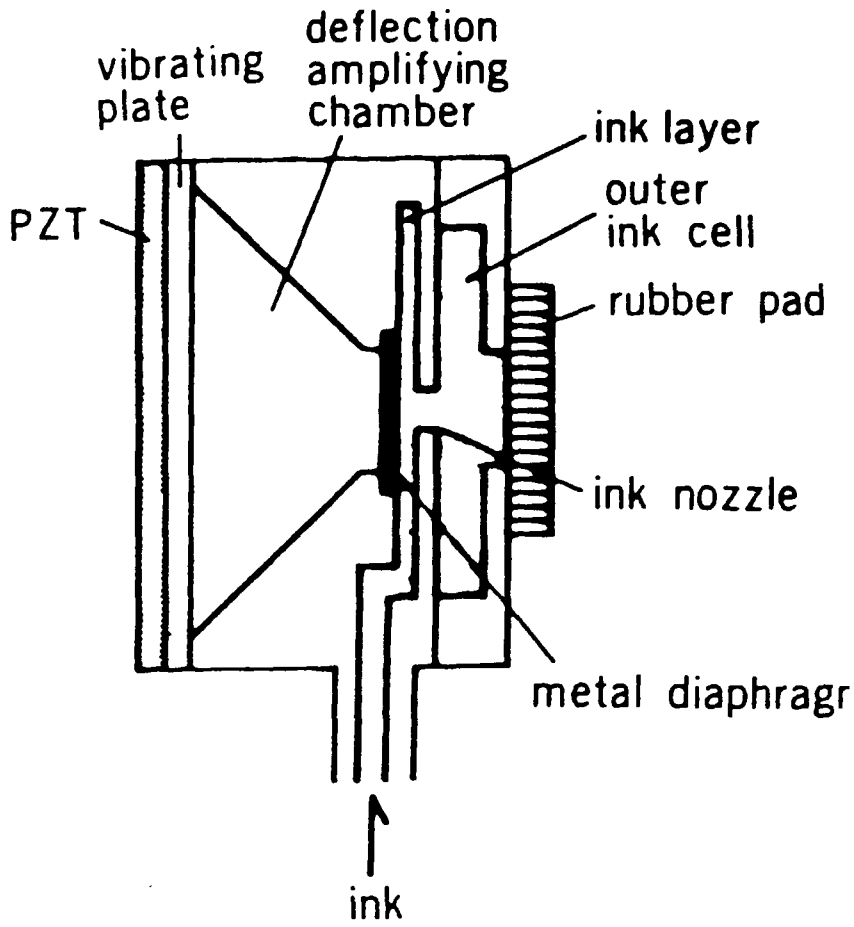
DROP ON DEMAND

EXHIBIT: I

PRINT HEAD



(a) Printing Condition

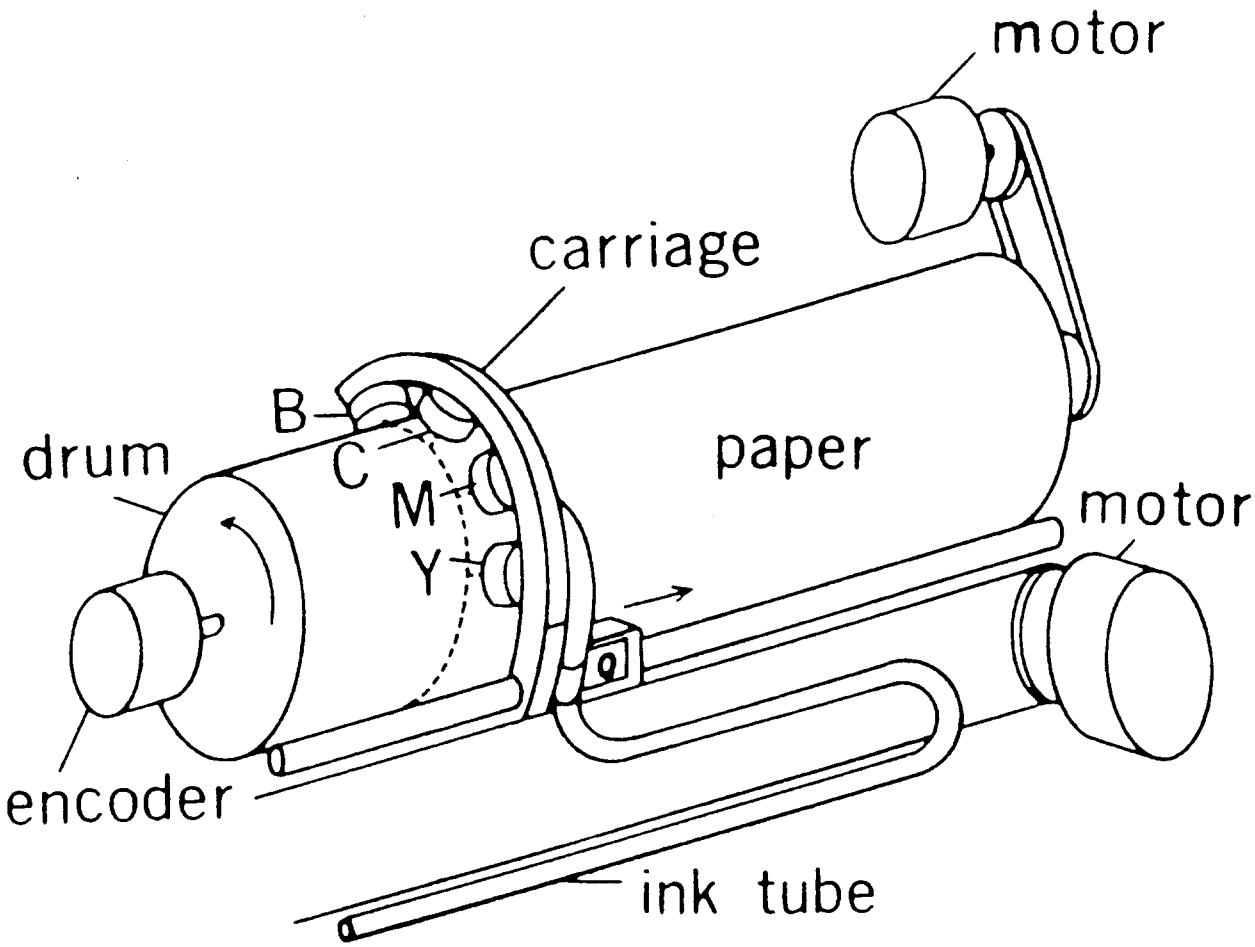


(b) Stand-by Condition

DROP ON DEMAND
(METAL DIAPHRAGM)

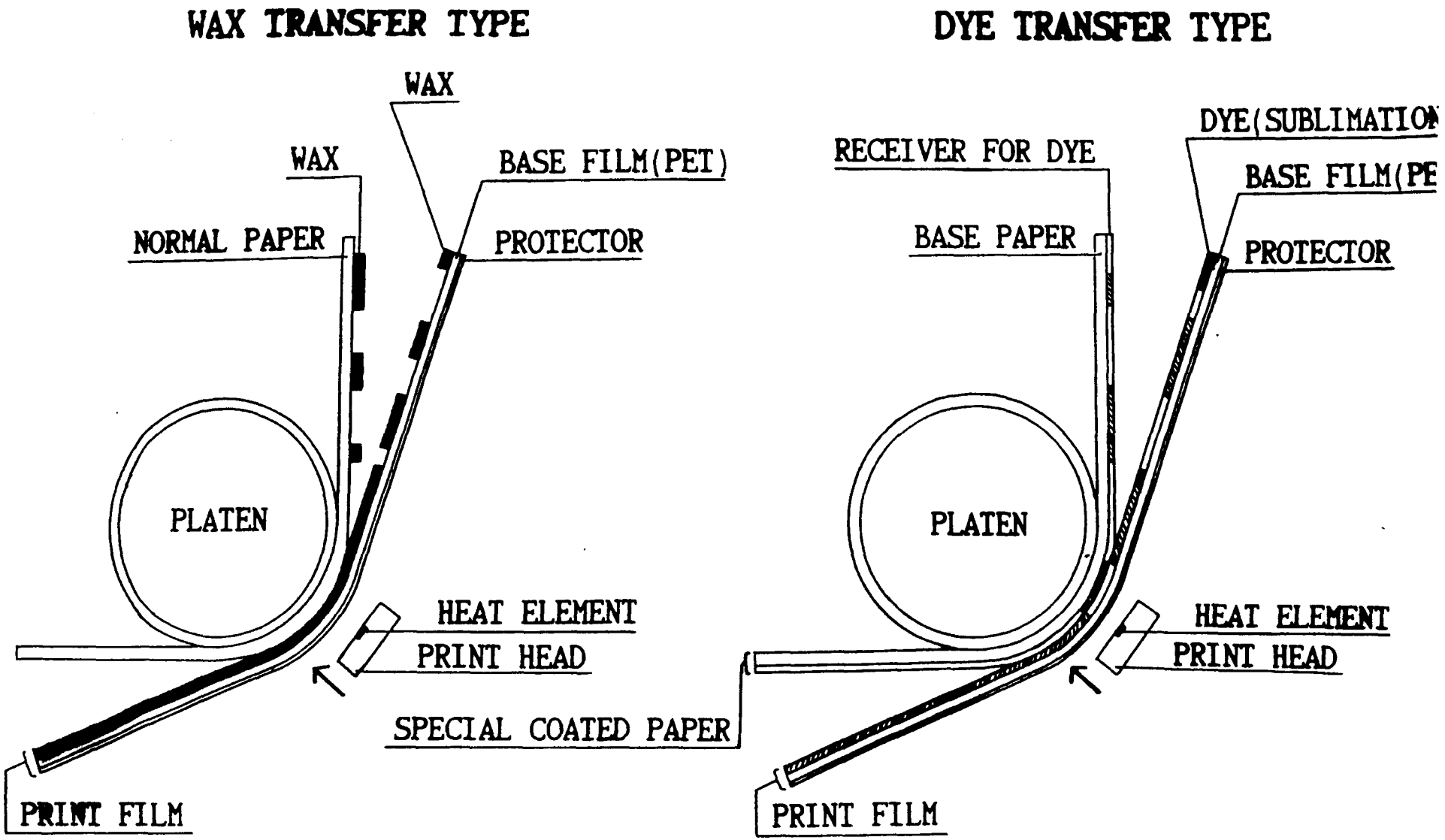
EXHIBIT: J

PRINT MECHANISM

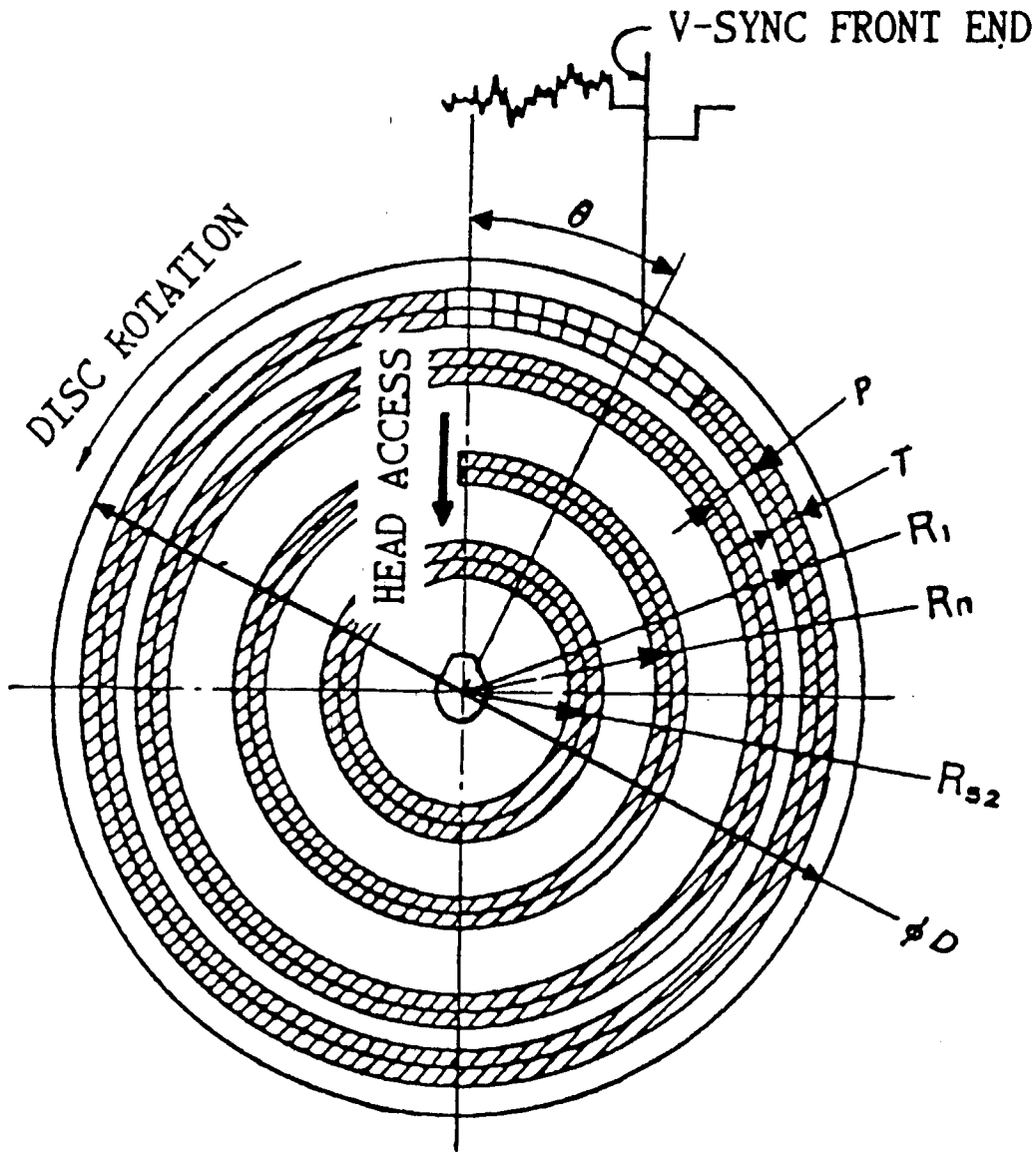


DROP ON DEMAND
(METAL DIAPHRAGM)

EXHIBIT: K



THERMAL TRANSFER PRINTER



TRACK PATTERN OF THE VIDEO FLOPPY

EXHIBIT : L