Opto-Mechanical Recording and Scanning Devices

ROBERT M. LANDSMAN*

Abstract: Opto-mechanical recording and scanning devices for both facsimile and television were conceived in the late1800's and brought to fruition in the1920's. The period from1920 to1960 was one of evolutionary system design. Television evolved to an all electronic system while facsimile systems continue to exploit opto-mechanical technology. The development of the laser, the computer, semiconductors and the introduction of low cost worldwide, wideband communication systems has driven the development of a new generation of opto-mechanical scanning systems. This paper provides a historical overview, describes operational requirements and technical features of several new systems developed by Chemco Technologies, Inc.

Background

Opto-mechanical scanning systems used for typesetting, color separations and facsimile transmission of broadsheet newspaper pages have their historical roots intertwined with that of television. The first television systems were opto-mechanical. Interest in the technical aspects of image transmission on the part of the public and professionals during the historical period are difficult to convey to generations which grew up with the technology. Hull (1936), has given a vivid description of an early encounter with television.

"And when it arrives, will it be as ordinary as using the telephone? The author recalls the first time he sat in a darkened booth and unexpectedly saw the face of a friend, whom he knew to be miles away, flash out animated, completely life like; heard his friends voice call him by name, speak to him naturally, the motions of the lips synchronizing with the words; then heard and saw his friend laugh at him for the friend had seen by the authors face that he was startled by the apparition! " Synchronization was a major problem of the time.

*Chemco Technologies, Inc.

Early ideas for image transmission assumed that every picture element had to be transmitted simultaneously over a separate circuit (as suggested by George Carey of Boston in 1875). By 1880 the important principle of rapidly scanning each picture element in succession with reliance on the persistance of vision, or the memory of film, to fill in the image was proposed by W.E. Sayer in the United States and Maurice Leblanc in France. This established the principle of raster scanning and established the use of a single wire or channel for transmission.

In 1884 Paul Gottlieb Nipkow (1860-1940) patented a two dimensional opto-mechanical television scanning system which consisted of a disc perforated with a series of holes in the form of a spiral. In 1925 Herbert Ives and Charles F. Jenkins of the United States conducted a public demonstration of an opto-mechical television system. In England John L. Baird developed a similar system that went into experimental service with the BBC during the period 1929 to 1935. The last vestige of opto-mechanical scanning for television ended when the FCC denied the application of CBS for its version of color televsion in 1947.

Why is it that television has gone all electronic while facsimile systems still use opto-mechanical scanning techniques? Typical opto-mechanical devices have a resolution of 1000 or more pixels per inch (16 to 18,000 pixels per scan line) while a TV line has but 525 pixels. A TV image would occupy less than a square inch of the image of a broadsheet newspaper scanned by a facsimile system. No solid state device is currently available that has the combination of resolution, format, and data rate provided by contemporary opto-mechanical systems.

Figure one shows a 1925 patent which teaches a method for the preparation of images compatible with stereotype printing. A light tint is applied to an image which has been converted to the equivilant of an engraving (a series of parallel lines which convey intelligence by modulation of line width). The drum configuration described in the 1925 patent is similar to that employed in some of the most sophisticated separation equipment sold today. The drum scanner is generally a designers first choice when the objective is to develop a system with uniform image quality over the format, simple optics, high optical efficiency, large format and high resolution. The drum configuration is a poor choice with high data rates (high rotational speeds) as attached media tends to fly off the drum due to centrifugal force. Drum systems are generally more difficult to automate and cannot be used with media which must remain flat.

March 6, 1928. 1,661,167

A. B. CLARK ET AL

SYSTEM OF PICTURE TRANSMISSION

Filed Jan. 23 1925

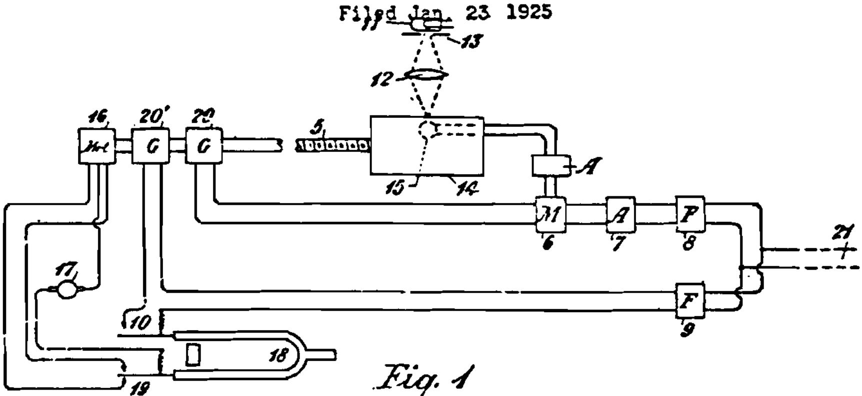


Fig. 1

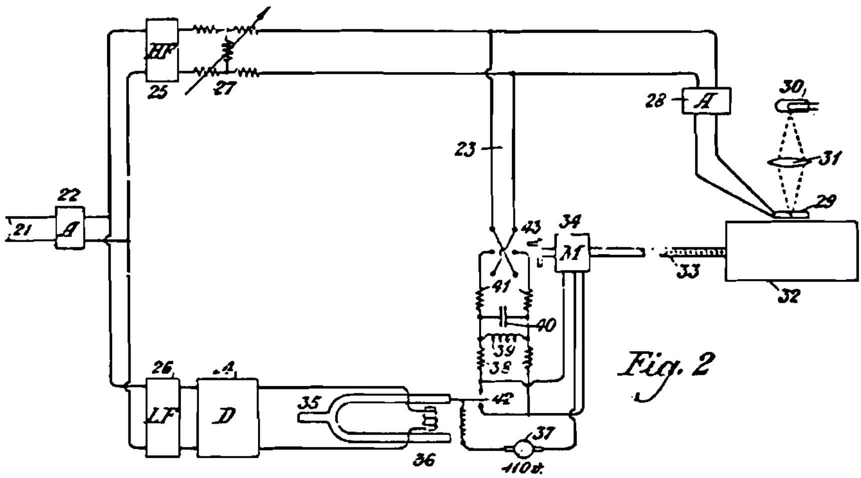


Fig. 2

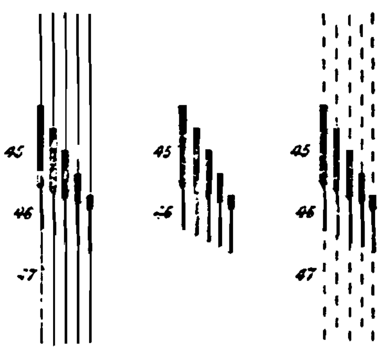


Fig. 3 Fig. 4 Fig. 5

INVENTORS
A. B. Clark & D. K. Gannett
BY
ATTORNEY

Figure two traces some of the events driving the development of opto-mechanical scanning systems. The designer of today has a rich repertoire of technology and is driven by several constituencies. The trend is away from the drum configuration in favor of flatbed systems. Flatbed systems take advantage of new technology to simplify the design problems associated with material handling and registration. First generation flatbed systems appear to have been fabricated of laboratory and commercial sub systems and then packaged for commercial sale. Systems designed from the ground up are now beginning to appear.

Chemco Technologies has conducted a study to assess requirements for future imaging systems. The study results emphasized the need for image quality, compact design, simplicity, reliability, automation, several formats and registration suitable for color. Three new image systems, designated The Spectrum Series, have been developed with the study results guiding the designs.

The Spectrum X-II, is a high resolution system available as a recorder, input scanner or as a combination unit. The main user benefits of this sytem are compact design, obtained by driving the optical assembly instead of the platen as in more traditional systems and an automated dual cassette media transport and punch register.

The dual cassette arrangement provides the user with several options. The system can be operated with film and PTS material with selections inter-mixed. Media selection is made at a computer console and executed with no interruption of throughput as material for the next image is selected and staged during the recording interval. This arrangement reduces dead time between transmissions. Automatic switchover is used to assure uninterupted, unattended operation when one cassette has but a few feet of film.

Image artifacts are reduced by use of a single facet polygon which eliminates facet to facet error. Other periodic disturbances are eliminated by mounting the optical system on air bearings and driving it with a linear electric motor dispensing with all gears, belts and pulleys. The recording sub-system is mounted on an active vibration isolation platform. This arrangement allows the transport to be operated to select and stage material for the next image without introducing image artifacts.

Two platens are provided, a glass platen for use with transparencies, the other a conventional vacuum platen. Platen selection is made from the operators console.

TECHNOLOGY AUDIT

SCANNING PRINCIPLES
SeleniumCell
Neon (Crater) Tube

FACSIMILE

- Drum scanners
- Electrolytic marking
- Analog wirephoto
- Color Separations
- Digital operaton
- Flatbed Scanners

TELEVISION

- Nipkow Disk
- Cathode Ray Tube
- Iconiscope
- Color Wheel
- Shadow Mask Tube

MODERN FLATBED SCANNERS

COMMUNICATIONS

- Telegraph
- Telephone
- Radio
- Vacuum Tube
- Satellite
- Fiber Optics

PRINTING

- Hot Metal
- Linotype
- Offset Printing
- Phototypsetters
- Digital Type
- CRT Typesetter

PHOTOGRAPHY

- Halftones
- Photopolymers
- Infra Red Films

SEMI-CONDUCTORS

- Transistor
- LSI
- CCD Arrays
- 256 Mbyte RAM
- Microprocessor

COMPUTER

- System Modeling
- Editors
- Spellers
- Digital Image Systems
  - Color
  - MonoChrome
- Compression

OPTO - MECHANICS

- AO/EO Modulators
- Lasers
- Flat field optics
- Galvanometers
- Polygon Fabrication
- Polygon Correction
  - Electro-optic
  - Optical

The Spectrum LF-36 is a large format, high resolution scanning system implemented with array technology instead of the traditional flat field lens and polygon. Two hundred and fifty six scan lines are simultaneously swept across the stationary image. At the end of each swath the platen is incremented. Preliminary specifications for this system include a format of 26 by 36 inches, a dual cassette film feed system similar to that in the Spectrum X-II, built in punch registration and a scan efficiency of 90%.

The Spectrum XP is a large18 x 26 inches (16 by 26 inch image) electro-photographic, plain paper imaging system for proofing. The unit is driven from a Raster Image Processor and interfaces some typesetters. The imaging source is a solid state laser. Start stop operation is not supported. The Spectrum XP uses low cost non-silver paper and liquid toner for the preparation of high quality proofs.

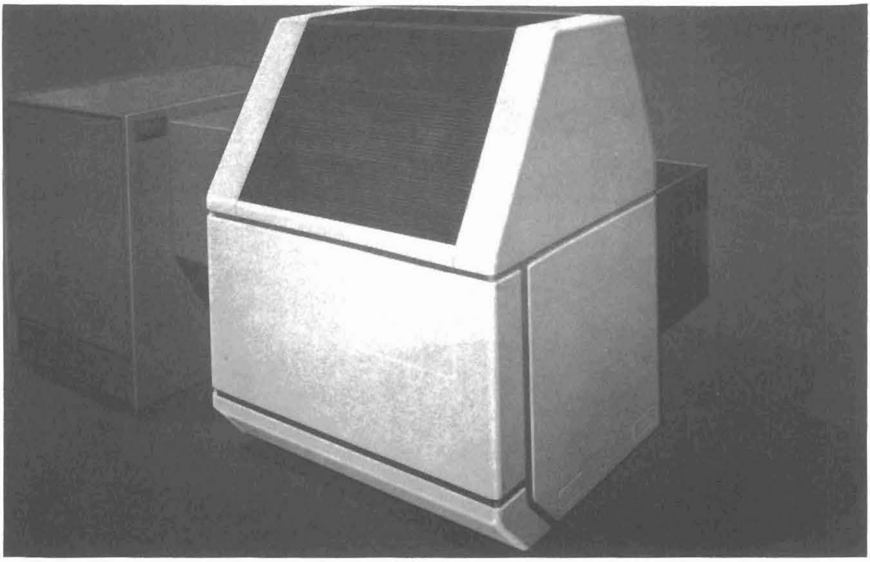
Speculation: Early in this paper the need for opto-mechanical scanning in this age of electronics was addressed. With the end of this paper we note that CCD, LED and magneto-opto arrays are are starting to replace opto-mechanical elements perhaps marking the beginning of the end for opt-mechanical scanning.

Selected Bibliography

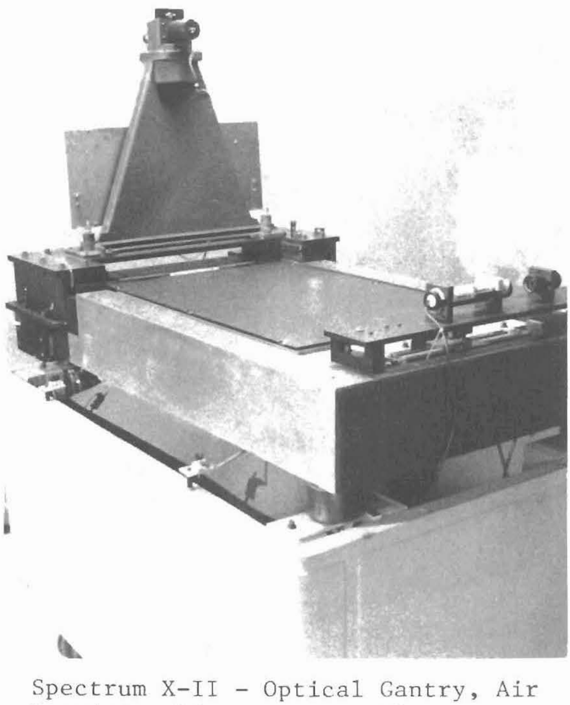
Hull, Gordon F.
1936 "An Elementary Survey of Modern Physics," The MacMillan Company
pp 382-383

Meyer, Herbert W.
1971 "History of Electricity and Magnetism," Burndy Library
pp. 198-223

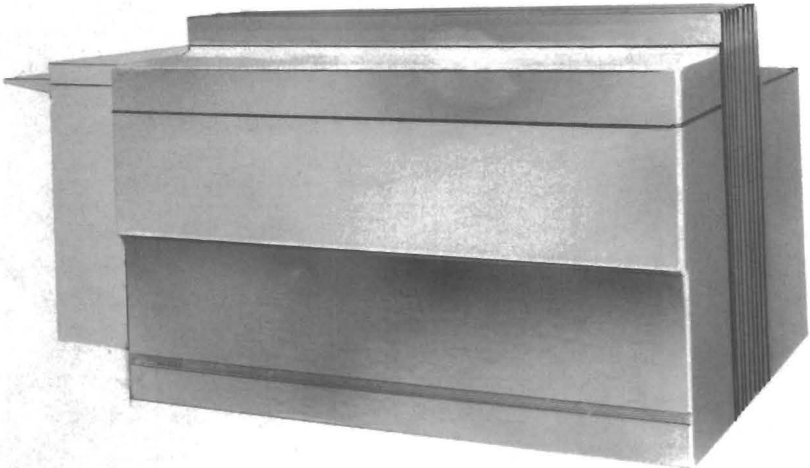
Barnouw, Erik
1975 "Tube of Plenty," Oxford University Press
Chronology



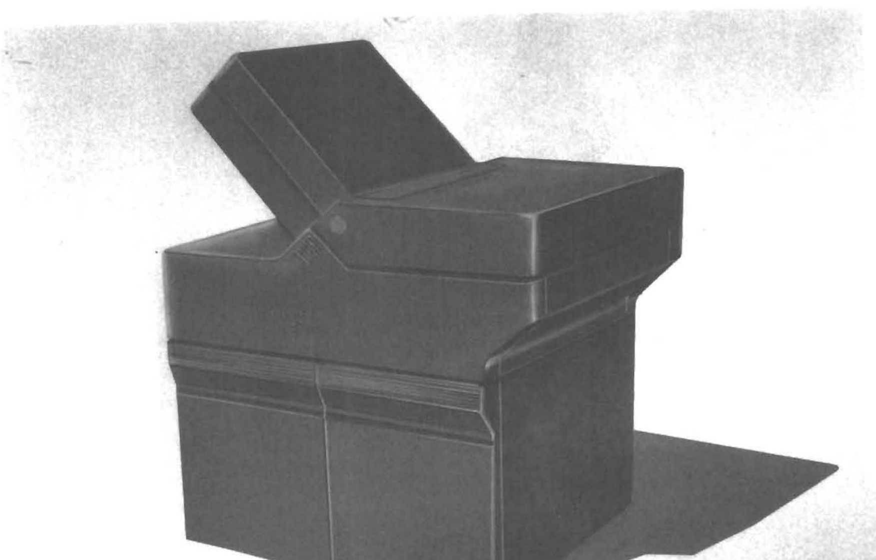
Spectrum X-II



Spectrum X-II - Optical Gantry, Air Bearings, Linear Motor, Platen.



Spectrum XP



Spectrum LF-36