

United States Patent

Applequist et al.

[15] 3,688,656

[45] Sept. 5, 1972

[54] MICROFILM PRINTER

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[73] Assignee: **Image Products Corporation**, Santa Clara, Calif.

[22] Filed: **Oct. 6, 1969**

[21] Appl. No.: **864,036**

[52] U.S. Cl. **95/4.5, 355/26, 355/19, 355/40, 355/46**

[51] Int. Cl. **B41b 13/00**

[58] Field of Search **95/4.5; 355/19, 26, 40, 46**

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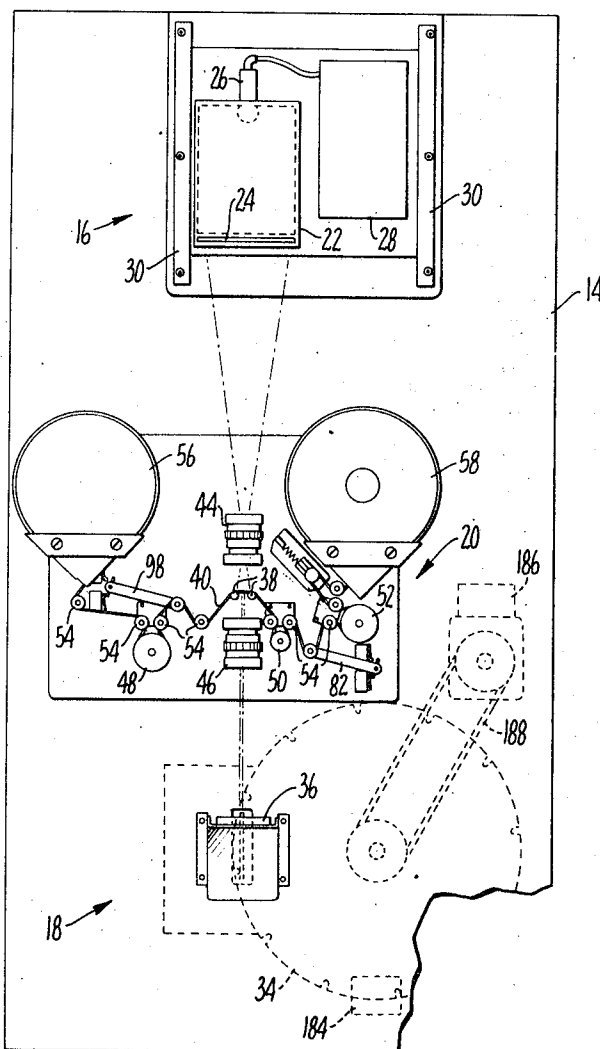
Primary Examiner—John M. Horan

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[57] ABSTRACT

A microfilm printer is disclosed for printing computer output data on microfilm. This film is advanced along a transport incrementally one line for each line of computer output data, and a line of data is imaged on one side of the film while the film is stopped between incremental advances. Periodically, generally much less often than the imaging of data lines, the image of a form is projected onto the film from the other side so that the film where finally developed displays the data entered in the form.

5 Claims, 12 Drawing Figures



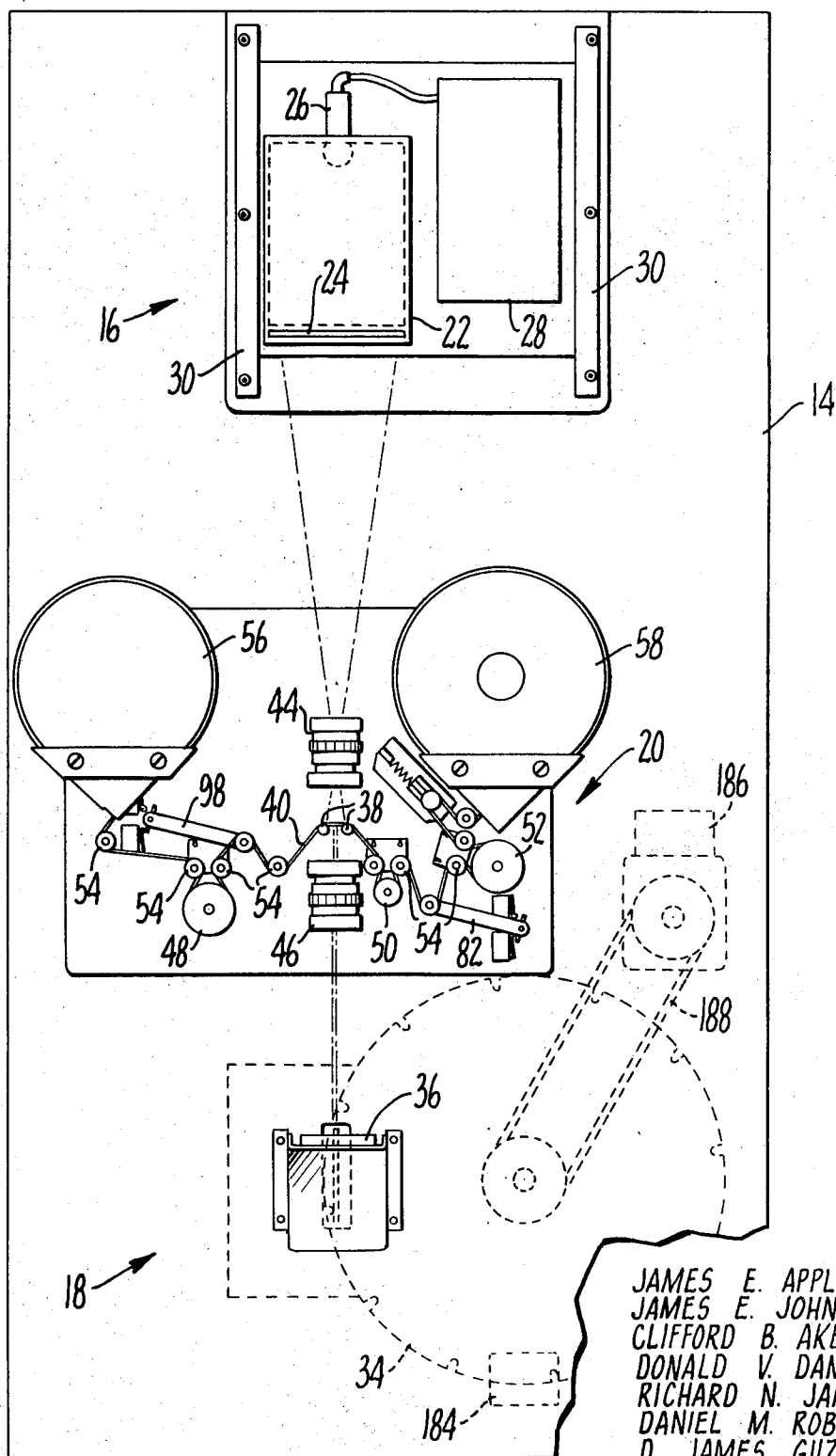


FIG. 1.

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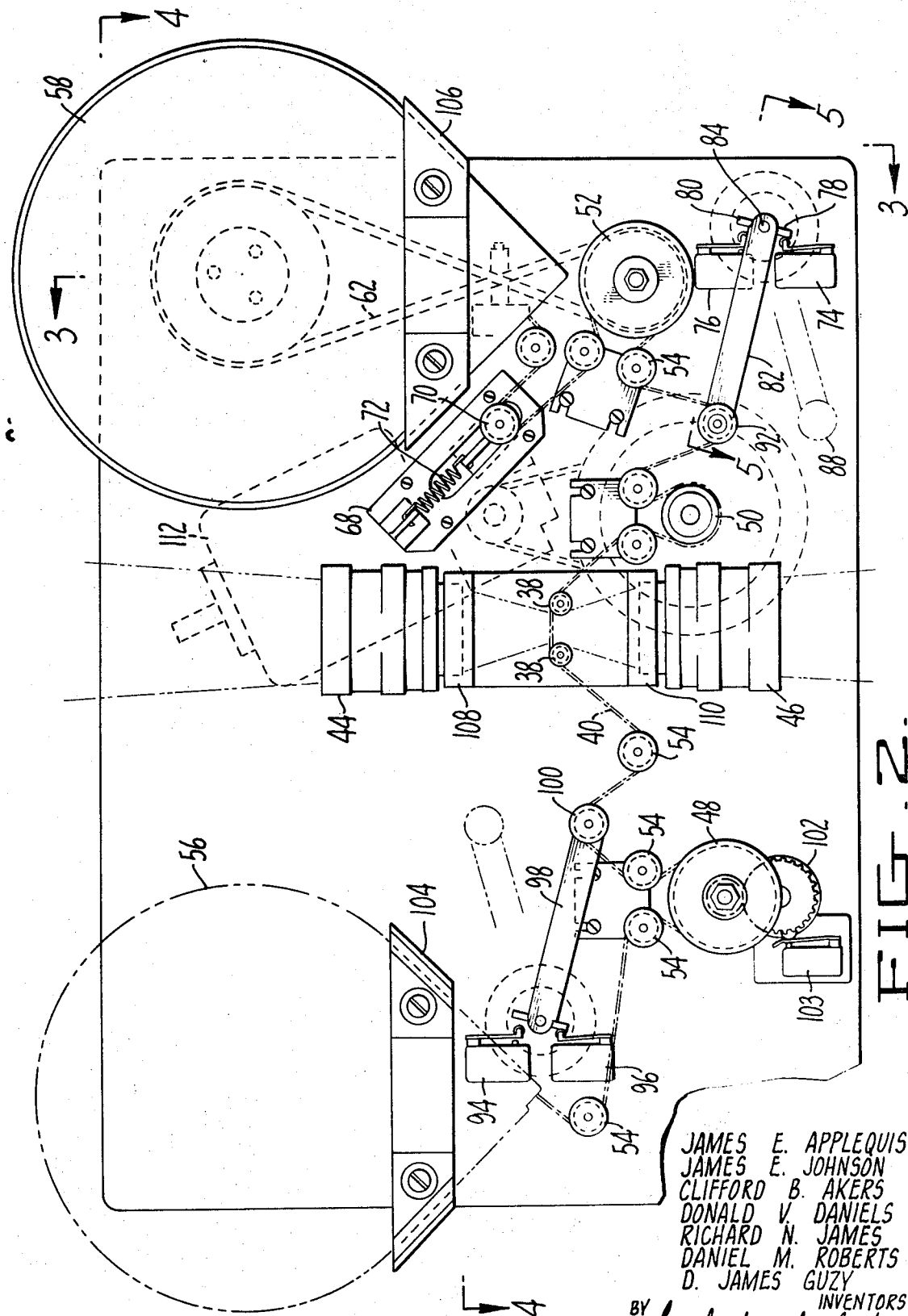


FIG. 2.

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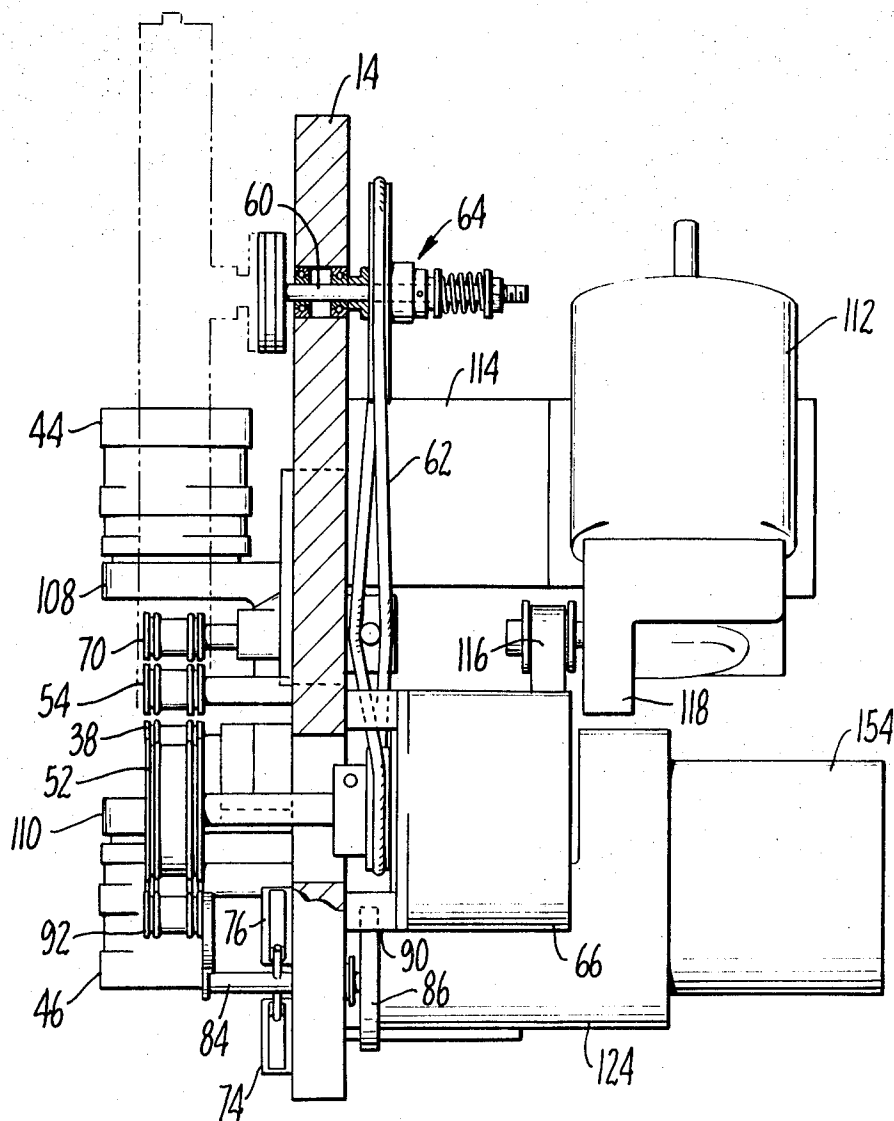
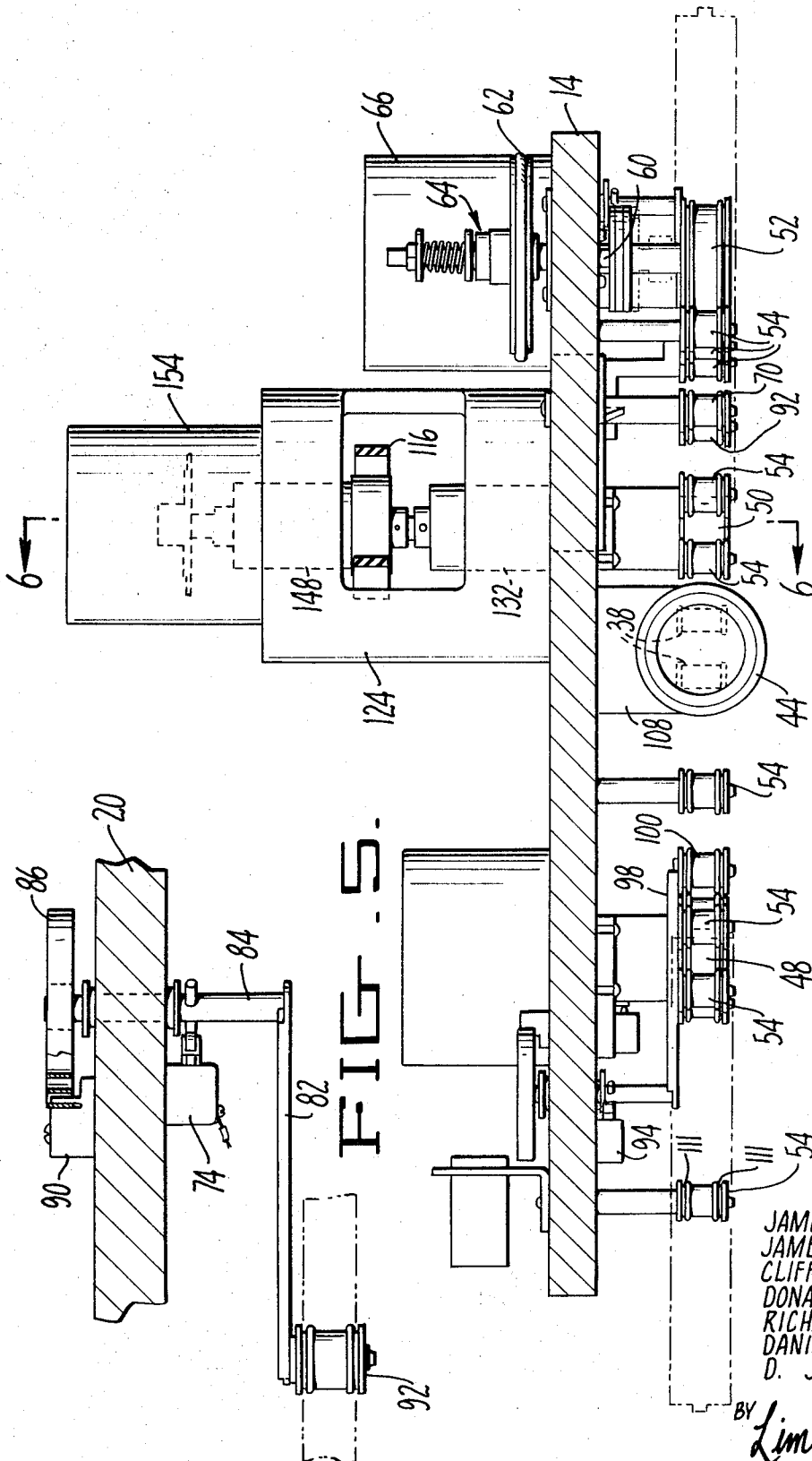


FIG. 3.

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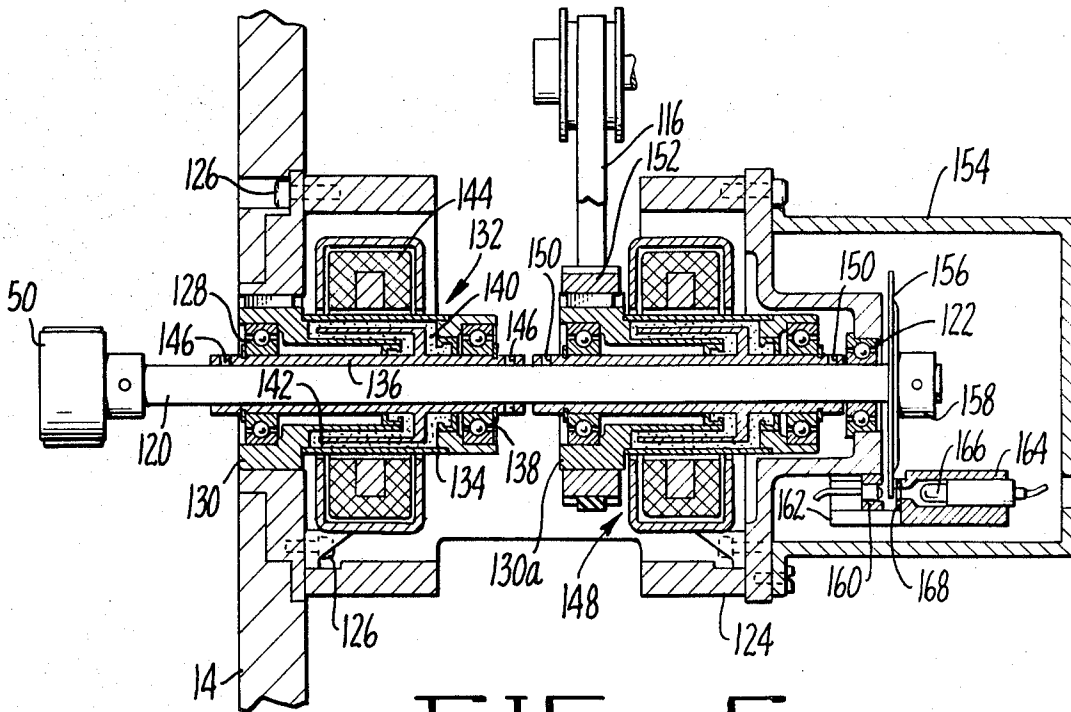


FIG. 6.

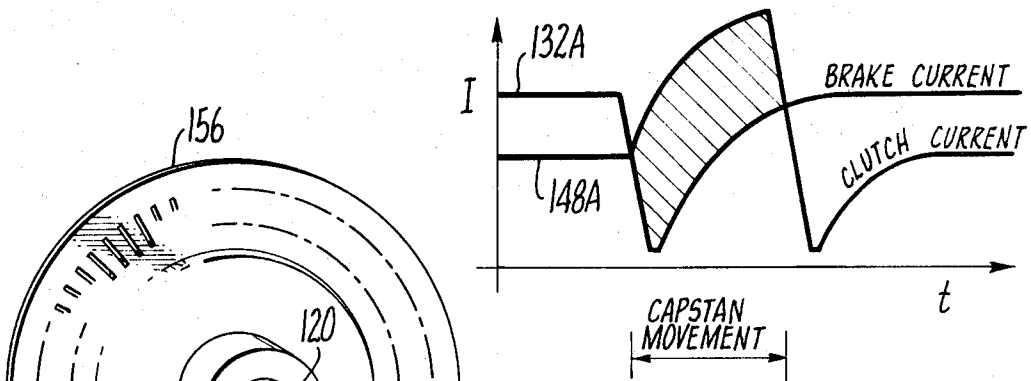


FIG. 8.

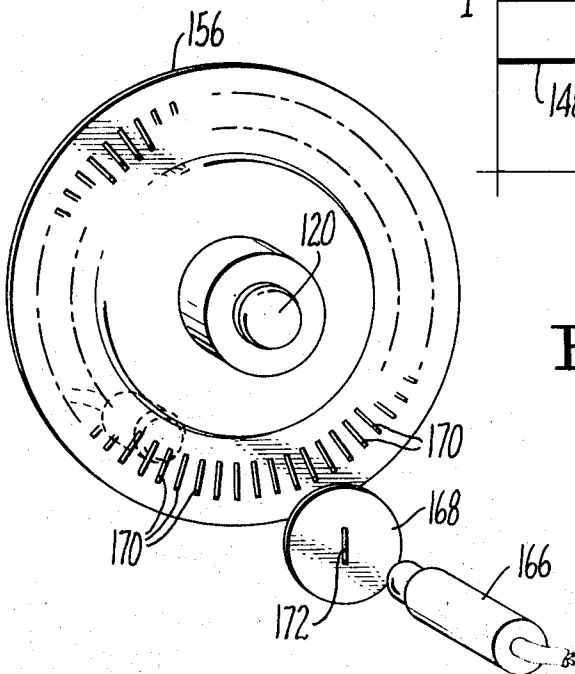


FIG. 7.

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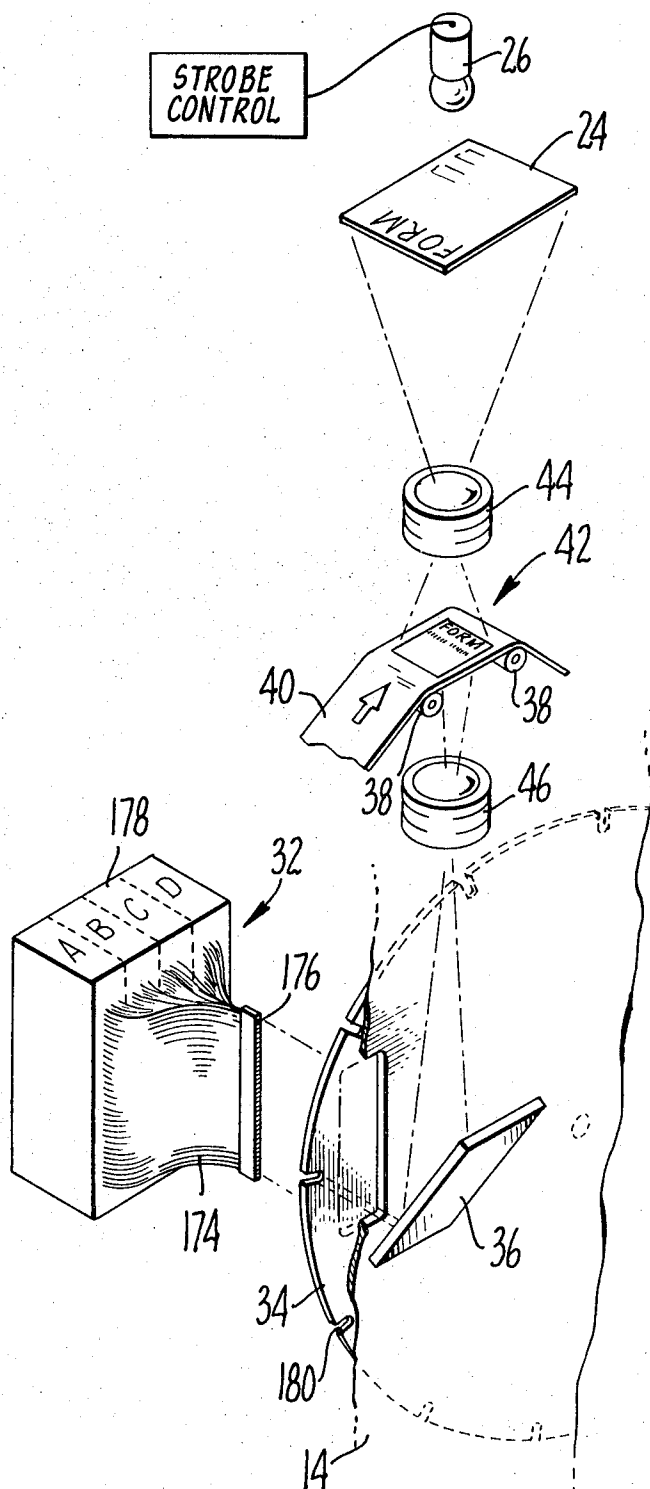


FIG. 9.

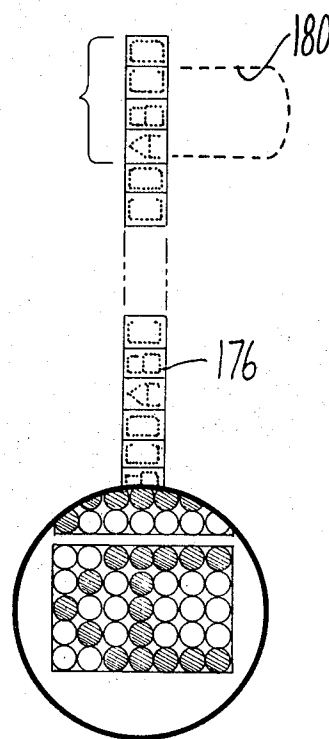


FIG. 10.

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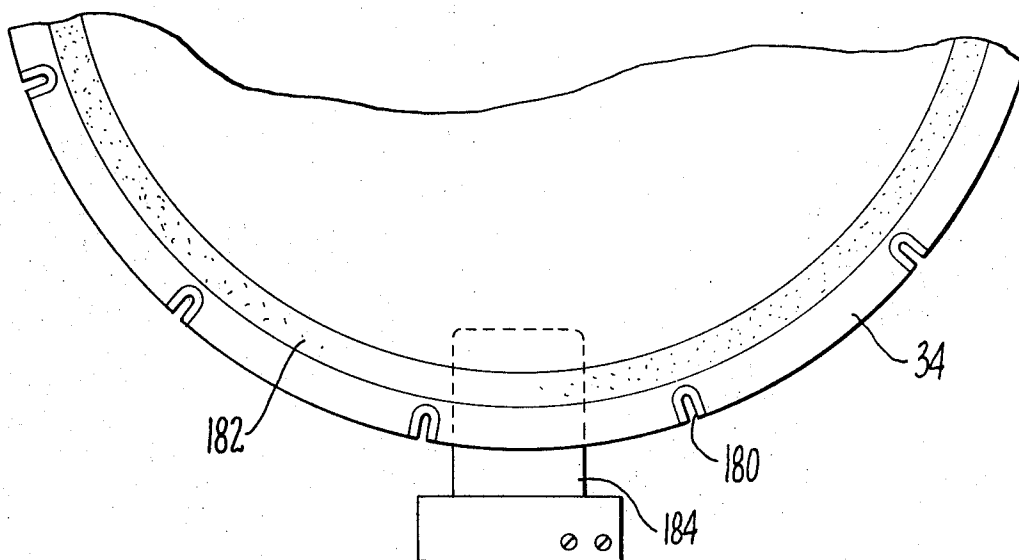


FIG. 11.

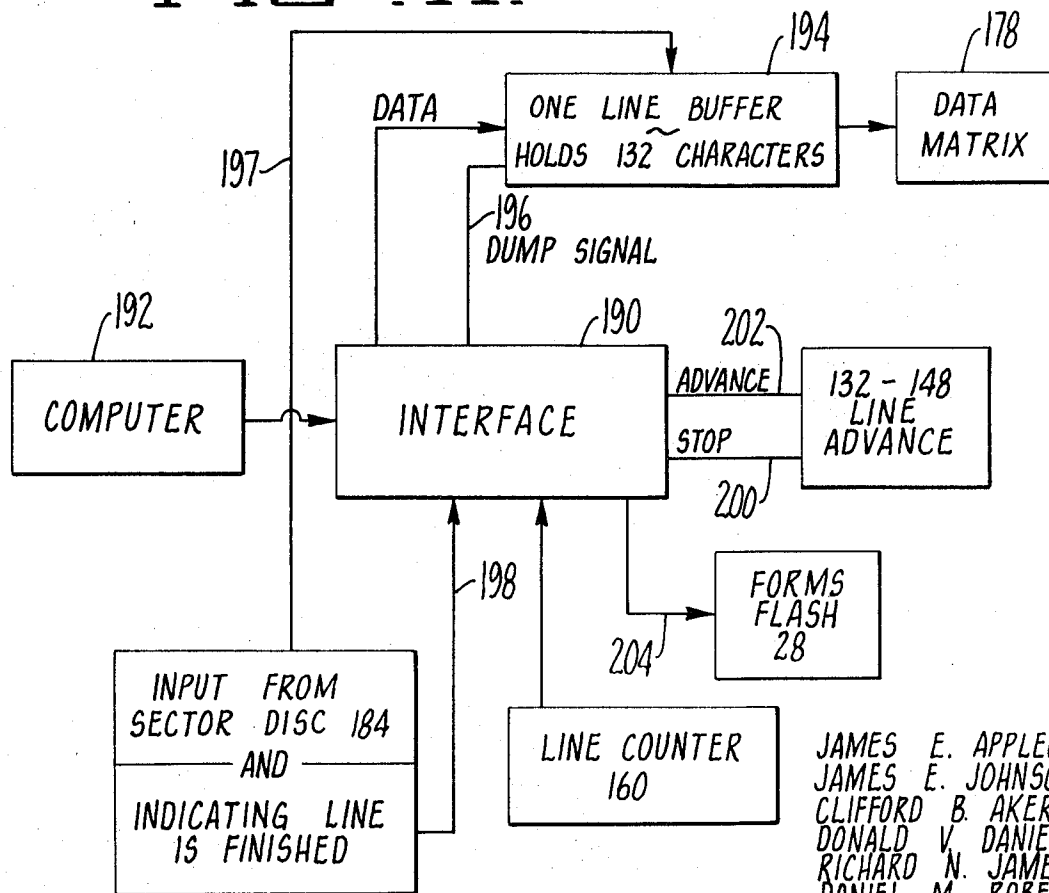


FIG. 12.

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MICROFILM PRINTER

The film transport disclosed employs a new incremental drive capstan for advancing the film on a line by line basis past an exposure station, with a pair of drive capstans employed to transport film to and from the incremental drive capstan from and to, respectively, supply and take-up reels. The incremental drive capstan is started and stopped by electromagnetic brakes in which the starting and stopping times of the capstan are controlled by removal of electrical current from one of the brakes.

A separate lens system is employed for projecting each of the data and form images onto the film to facilitate matching the data to the form.

The film transport is controlled to permit the film to advance a multiple number of data lines between times when the film is stopped at a data line to speed up the printer's response where no data is provided for some lines of the form.

RELATES APPLICATIONS

The microfilm printer of this invention is preferably used with the information display shown in the copending application of Richard N. James, James E. Applequist and Daniel M. Roberts, Ser. No. 841,485, filed July 14, 1969, now U.S. Pat. No. 3,644,922, for "Information Display and Method for Making the Same".

SUMMARY OF INVENTION

A variety of devices are available for recording computer output data for visual examination. Most of these devices print the data on a form with various types of impact printers. These impact printers have speed limitations and all of the other limitations of devices with many moving parts, but they have an additional disadvantage for the computer user. These prints produce output copy in such large bulk that the handling and storage of the output copy is a major problem.

In accordance with this invention, we have produced a computer output printer which prints computer output data on microfilm at a greater rate than the data can be recorded on conventional printers. Additionally, the printer has relatively few moving parts so that long term operation is possible without serious maintenance, and the microfilm records produced by the printer can be handled and stored with ease usually achieved with microfilm records.

The printer of this invention employs several novel concepts by which it can be made and used more efficiently than other arrangements which might be used in microfilm printers. The most important of these novel concepts are (1) the projection of data and form images from opposite sides of the microfilm, and (2) control of film movement to advance the film for each line of data characters imaged on the film.

Thus, the printer of this invention employs two independent optical systems for imaging data and a form on the microfilm from opposite sides of the film so that the form generator and the data generator may be located independently and separately imaged on the film. Substantial advantages are thereby obtained in the manufacture and subsequent adjustment of the printer because the form and data displays may be prefabricated, physically located, and subsequently adjusted independently of each other. The projection of

form and data images from opposite sides of the film in accordance with this invention is very advantageous both where the film is advanced on a line-by-line basis in accordance with this invention and also where the film is advanced only once per form image with the data advanced along a stationary film while data is recorded on each form. Thus, the projection of form and data images from opposite sides of the film may be employed in accordance with this invention either with (1) the line-by-line film transport illustrated herein and the single line character generator shown in the above-mentioned James et al. application or, (2) a form-by-form transport which stops the film once for each form image and a multiline character generator such as a cathode ray tube on which all lines of data for one form may be displayed without moving the film.

The line-by-line film transport of this invention has important economic advantages in reducing the cost of equipment used to image data on the microfilm. Thus, the film transport of this invention may be used with a character generator for generating a single line of data at a time such as the character generator shown in the above-mentioned James et al. application or a simple line of NIXIE tubes. Such a single line character generator, with its associated electronic data storage and control circuits is much less expensive than conventional character generators and corresponding control circuits such as a CRT display for displaying on a full page of many lines of data.

In addition to the basic advances in microfilm printers provided by image projection from opposite sides of the film and line-by-line film control, this invention provides several specific improvements in microfilm printers which permit the printers of this invention to be used for recording computer output data efficiently at speeds as high as 10,000 lines of 132 characters per minute and even higher.

Thus, accurate location of individual image lines on the film is obtained with an incremental drive capstan integrally coupled to an apertured disc where the apertures in the disc may be detected optically and are spaced apart by distances proportional to the line spacing of data on the film. Very rapid starting and stopping of the incremental drive capstan is provided by a pair of matched electromagnetic brakes. One brake is connected to operate as a clutch to drive the capstan while the other is connected as a brake to stop it. The response speed of the combination is improved by reducing the current to the clutch to stop the capstan and reducing the current to the brake to start the capstan.

The incremental drive capstan with its apertured disc establishes a minimum advance increment of the film corresponding to the height of one line of data, and the capstan can be stopped after one or any integral multiples of this increment to print data on every line of a form or advance rapidly over lines where no data is to be recorded.

Rapid operation of the incremental drive capstan is provided while insulating this capstan from any substantial inertia in the film supply/take-up system by the use of tension arms in conjunction with take-up and supply capstans. Both the supply and take-up capstans are controlled directly by movement of the tension arms which sense the amount of film near the incremental drive capstan.

The optical system of the printer employs a separate focusing lens system for imaging each of the data line and data form and permitting the line and form to be enlarged or reduced. In enlarging and reducing the form and data images, three physical elements of the printer are controlled with respect to each other, namely (1) the film support which holds the microfilm in an exposure window, (2) the character generator, and (3) the "forms flash" which displays the form. Any one of the three may be stationary at all times with the other two movable to permit enlargement and reduction of both images. In order to hold stationary the data display of the above-mentioned James et al. application, we prefer to move the film support structure and the forms flash. This is preferably accomplished by a single adjusting mechanism to move the form with respect to the film window when the form image is to be enlarged and a single adjusting mechanism to move both the film window and forms flash with respect to the character generator when the data line is to be enlarged.

These and other features and advantages of the invention will be understood from the following description of a computer data microfilm printer constructed in accordance with the principles of this invention. It should be understood that the particular printer shown and described herein is only one of many specific structures which could be used to employ the invention defined by the annexed claims, though the structure illustrated in the drawings and described below is the best mode we contemplate of carrying out our invention.

DRAWINGS;

FIG. 1 is a side elevational view of a microfilm printer constructed in accordance with this invention;

FIG. 2 is a side elevational view on an enlarged scale of the central portion of the apparatus illustrated in FIG. 1;

FIG. 3 is a vertical sectional view taken along the bifurcated plane indicated at 3—3 in FIG. 2;

FIG. 4 is a horizontal sectional view taken along the bifurcated plane indicated at 4—4 in FIG. 2;

FIG. 5 is a sectional view taken along the plane indicated at 5—5 in FIG. 2 and showing the particular apparatus illustrated in FIG. 2 for sensing the quantity of film near the incremental drive capstan;

FIG. 6 is a cross-sectional view taken along the plane indicated at 6—6 in FIG. 4 through the center of the incremental drive capstan;

FIG. 7 is an exploded view in perspective of the perforated sector wheel and associated detection equipment in the incremental drive capstan near the right hand side of FIG. 6;

FIG. 8 is a graph showing the relative electrical currents through the brake and clutch sub-assemblies of the incremental drive capstan of FIG. 6 during a time period when the incremental drive capstan is started and then stopped;

FIG. 9 is an exploded schematic view in perspective of the apparatus of FIGS. 1—8 illustrating the major optical components thereof;

FIG. 10 is an enlarged diagrammatic view of the display end of the character generator illustrated in FIG. 9 and forming the subject matter of the copending application of James et al. mentioned above;

FIG. 11 is an enlarged view of the periphery of the sector wheel employed in the character generator of FIG. 9, and;

FIG. 12 is a schematic diagram of the control circuitry employed for controlling the printer of FIGS. 1—11.

Referring now in detail to the drawings and particularly to FIGS. 1 and 9, the printer illustrated therein includes a main frame 14 which supports a forms flash 16, a character generator 18, and a microfilm transport 20. The forms flash includes a light tight box 22 the front panel of which supports a transparent image of a form 24 which may be illuminated by a xenon lamp 26 strobed by a power source 28. In order to permit enlargement or reduction of an image of the form 24, the forms flash is adjustably mounted for sliding movement on the frame 14 by means of adjustable tracks 30.

The character generator includes a fiber optic matrix 32 (FIG. 9) shutter wheel 34 and 45° reflecting mirror 36 all as explained in greater detail in the above-mentioned copending application of James et al. with the character generator 32 and form 24 mounted in optical paths on opposite sides of the film transport 20. As explained in greater detail hereinafter, the film transport 20 includes a pair of guides 38 (FIG. 9) which support a strip of microfilm 40 in a flat exposure window 42 where images of the form 24 and data from the character generator 32 are focused from opposite sides of the microfilm. Focusing is accomplished by a pair of Nikor 50mm *f* 1.2 lenses 44 and 46. The film guides 38 are adjustably mounted for movement toward and away from the character generator 32 so that the line of characters may be enlarged or reduced as explained above.

THE FILM TRANSPORT

With reference to FIGS. 1 and 2, the apparatus transporting the microfilm 40 past the exposure window 42 includes a supply capstan 48, an incremental drive capstan 50, shown in greater detail in FIG. 6, a take-up capstan 52, and a plurality of roller guides 54. The microfilm 40 passes to the film transport from a supply roll in a supply roll magazine 56 and passes from the film transport to a take-up roll in a take-up roll magazine 58.

The film roll in the take-up magazine 58 is wound by rotation of a shaft 60 (FIG. 3) which is driven by a belt 62 through a slip clutch 64 which is in turn driven by a motor 66. The motor 66 is mounted coaxially of and drives the take-up capstan 52, and the motor 66 is preferably a motor sold by the Superior Electric Company under the trademark "SLOSYN" Motor Model No. SS50-1007. A similar motor is mounted coaxially of and drives the supply capstan 48.

A bracket 68 is mounted on the frame 20 and supports a tension roller 70 held under tension by a tension spring 72 over which the film 40 is entrained along the path indicated in FIGS. 1 and 2 so that the spring 72 maintains the film under tension around the periphery of take-up capstan 52 so that any rotation of capstan 52 advances the film to the take-up magazine 58. The operation of the motor 66 is controlled by a pair of limit switches 74 and 76 with these switches connected to the motor control circuit so that the motor 66 is started when the switch 76 is closed, and the motor 66

is stopped when the switch 74 is closed. The switches 74 and 76 are closed by engagement with a pair of pins 78 and 80 on a dancer arm 82 which is pivotally mounted to the frame of the machine on axle 84 and resiliently urged by a clock spring 86 (FIG. 5) toward the phantom outline position 88 shown in FIG. 2. The outside end of clock spring 86 is attached to a tie down bracket 90 mounted on frame 20. The inner free end of the dancer arm 82 carries a film guide roller 92 to sense the quantity of film between the incremental drive capstan 50 and the take-up capstan 52 and simultaneously maintain the film under tension at both of those capstans. It will be apparent that the dancer arm 82 and its associated switches 74 and 76 operate to maintain within predetermined limits the amount of film between the incremental drive capstan 50 and the take-up capstan 52. When this amount of film increases to the point that the pin 80 closes limit switch 76, the take-up motor 66 is operated to drive the take-up capstan 52 and simultaneously wind up film in the take-up magazine 58 until pin 78 closes switch 74 when the take-up capstan drive motor 66 is stopped.

A similar pair of limit switches 94 and 96 are controlled by the movement of a dancer arm 98 carrying a film guide roller 100 with the switches 94 and 96 connected to the motor which drives the supply capstan 48 to maintain within predetermined limits the quantity of film between the supply capstan 48 and the incremental drive capstan 50.

A gear 102 is gear driven from the shaft of the motor on supply capstan 48, and a microswitch 103 is mounted adjacent to the gear 102 in such a position that the switch 103 closes for each tooth of the gear 102. The output of the switch 103 may be connected to a suitable footage counter by which the total footage of film passing through the printer may be monitored.

The supply and take-up film magazines 56 and 58 are mounted in suitable brackets 104 and 106 on the frame 20, and the focusing lenses 44 and 46 employed to enlarge or reduce the data and form images are mounted on brackets 108 and 110.

It will be noted in FIGS. 3 and 4 that the film guide 54 and the surfaces of the supply and take-up capstans 48 and 52 are provided with peripheral ridges 111 as indicated on the left-most roller 54 in FIG. 4 by which full face contact between the rollers and the microfilm is eliminated. A drive motor 112 is mounted on the back of frame 14 on a bracket 114 and drives a drive belt 116 through a gear box 118. The belt 116 is employed to drive the incremental drive capstan 50 as explained in greater detail below.

INCREMENTAL DRIVE CAPSTAN

As best seen in FIG. 6, the drive mechanism for the incremental drive capstan 60 includes a shaft 120 rotatably mounted by means of a bearing 122 in a rigid housing 124 which is attached to the frame 14 by screws 126. The other end of shaft 120 is rotatably mounted in a bearing 128 which is supported inside of a sleeve 130 which is rigidly attached to the frame 14. The sleeve 130 forms part of a brake assembly 132 which is sold by the Power Equipment Division of Lear Siegler Industries under the trademark "FASTEP" magnetic particle clutch Model 97015-012.

This brake 132 includes a casing 134 rigidly attached to the sleeve 130 and a central sleeve 136 which is rotatably attached to the frame 134 by bearings 128 and 138. A chamber 140 is provided between the casing 134 and sleeve 136, and a cylindrical blade 142 rigidly attached to the sleeve 136 extends into the center of this chamber adjacent to sleeve 130 and casing 134. The remainder of the chamber 140 is filled with ferromagnetic particles which, in the absence of a magnetic field are in a fluid state. An electromagnetic coil 144 surrounds the chamber 140, and upon the application of electric current to the coil 144, the ferromagnetic particles in chamber 140 solidify to rigidly connect the sleeve 130 to the sleeve 136. The sleeve 136 is keyed to shaft 120 by set screws in apertures 146 so that the application of an electrical current to the coil 144 applies a brake between the shaft 120 and the frame 14.

A second identical "FASTEP" clutch 148 is mounted with its center sleeve keyed to the shaft 120 by a set screw in aperture 150, and the outer sleeve 130a of the clutch 148 carries a pulley 152 over which the belt 116 is entrained. The application of electrical current to the coil of clutch assembly 148 establishes a rigid connection between the drive belt 116 and shaft 120 so that incremental drive capstan 50 is driven by motor 112.

Referring to FIG. 8, the current through the coil of brake assembly 132 is indicated by the line 132a, and the current through the coil of clutch assembly 148 is indicated by the line 148a during the period when the incremental drive capstan 50 is started and then stopped to advance the film a distance equal to the line spacing for one line of data to be recorded on the film. It will be noted that the current 132a is initially set at a high value so that the brake 132 is effective in maintaining the capstan 50 stopped. At this time, the current in the clutch 142 is not zero, however, so that time lag in bringing the magnetic particles in the clutch into alignment is avoided. The initial current in the clutch assembly 148 is maintained at a sufficiently high value that the magnetic particles in the clutch are substantially aligned, but the clutch exerts a driving force on the shaft 120 which is lower than the braking force applied by the brake 132. At the time that movement of the capstan 50 is to be started, the current to the coil of brake assembly 132 is shut off which permits the current in the coil to decay on a very steep substantially linear curve, and as soon as the current in the brake coil crosses the curve for the current in the clutch coil, the clutch is exerting a greater driving force on the shaft 120 than the braking force applied by the brake so that the shaft 120 starts to rotate driving the film. The capstan 150 continues to advance, and during this period the current to the coil of the brake assembly 132 is increased to its original level, but the clutch continues to override the brake and drive the shaft 120 since the current in clutch assembly 148 exceeds the current in brake assembly 132. During the period that the brake current is increased, however, partial realignment of the magnetic material in the brake is established so that the brake is ready to take over its braking function as soon as the current to the clutch is reduced. When the capstan 50 is then to be stopped, the current to the coil of the clutch 148 is interrupted

so that the current in that coil decays along a steep substantially linear curve, and as soon as the current in the clutch coil falls below the current in the brake coil, the brake assembly 132 takes over and stops the capstan.

A light tight housing cap 154 is mounted on the rearward end of housing 124 and encloses an apertured disc 156 which is rigidly mounted on the end of shaft 120 by a mounting cap 158. A light detector 160 is mounted on a bracket 162 inside the cap 154 adjacent to the apertured periphery of disc 156, and a hollow body 164 is mounted in the cap 154 on the opposite side of the disc 156 from the light detector 160. A light source 166 is mounted inside the body 164, and a small apertured disc 168 is mounted on the end of the body 164 adjacent to the disc 156. As illustrated in FIG. 7, the apertured disc 156 contains 512 equally spaced slots or apertures 170 around its periphery, and the disc 168 carries a single slot 172 so that the photodetector 160 will receive 512 pulses per revolution of the shaft 120. The output of the photodetector 160 which forms a line counter for the film transport is connected to the printer control circuitry to indicate the position of the film along the transport and permit the control circuitry to stop the film by decreasing clutch current when a line of data is to be recorded at a particular data line location along the length of the film.

THE DATA DISPLAY

With reference to FIGS. 9-11, and as explained in greater detail in the above-mentioned copending application of James et al., the data display includes a matrix of optical fibers 174 with each fiber having one end arranged in a character display line 176 which is illustrated in greater detail in FIG. 10 and its other end connected to a bank of light emitting diodes 178. The data line 176 includes 132 groups of fibers each group of which is made from 35 fibers arranged in a 5×7 matrix so that any selected number or other character may be displayed by each group of fibers by illuminating light emitting diodes for a selected combination of the 35 fibers in that group.

The 132 groups of fibers are arranged in 33 sets of four groups each with corresponding fibers in each set connected to the same light emitting diode in light emitting diode bank 178 so that every fourth character in the character line 176 is the same at any instant. The apertured shutter wheel 34 has apertures 180 in its periphery which sweep across the character line 176 with each aperture having a width corresponding to the width of three of the 35 fiber groups. In this way, the number of light emitting diodes employed for illuminating the fibers is substantially reduced, and the diodes illuminating one group of fibers may be switched from a condition displaying one character to a condition displaying a second character in the time interval when all of the 33 fiber optic groups which are connected in parallel are obscured by the shutter disc 34.

As explained in the James et al. application, the shutter wheel 34 may be provided with a recorded track 182 which may be read by a suitable transducer 184 to provide input to printer control circuitry indicating the particular characters in the character lines 176 which are exposed at each instant of time. The shutter wheel 34 is driven by a suitable motor and drive belt 186 and 188 in FIG. 1.

With reference to FIG. 12, the control circuits employed for operating the printer include an interface 190 which accepts data from a computer 192 indicating data which is to be printed. The data received from the computer is transmitted to a one line buffer 194 which stores the information for what characters are to be displayed at the 132 positions of the character line, the sector disc 184 provides means for generating the signal on line 196 to start the buffer 194 discharging its stored data by illuminating the proper light emitting diodes in diode matrix 178 in synchronization with signals on line 197 from the transducer 184 which indicates the position of exposed groups of optical fibers on the data display line 176.

The transducer 184 provides outputs not only to indicate the position of a slot in the shutter wheel along the length of the data line 176 but also a signal indicating the end of the operation of printing one line of data, that is when one of the slots 180 in the shutter wheel has passed the data line 176 and a second slot 180 in the shutter wheel is about to start passing the data line 176. This signal indicating that a line is finished is transmitted to the interface on line 198 and is provided through a suitable gate in the interface to the line advance mechanism 132-148 to advance the microfilm one line before a new line of data is displayed on the data matrix 176. As indicated above, the interface may provide, when so instructed by the computer, to permit the line advance mechanism 132-148 to advance an integral number of line spacings of the microfilm to insert data at selected ones but not all of the lines on the form in which case the film stop signal on line 200 to decrease the clutch current for clutch 148 is delayed after the film start signal on line 202 which reduces the current to the coil of brake 132.

The interface 190 receives the signals from film line counter 160 to maintain a register of the particular line on a form at which the image of the character line 176 is aligned, there being a large number of data lines per form, and when the line register in the interface 190 indicates that the full area of the form is located in the window area 42 of the microfilm transport, the interface supplies a signal on line 204 to form flash 28 so that the xenon lamp 26 is flashed to provide an image of the form 24 on the microfilm. The particular point in the line counter register at which the forms flash is operated is determined by the physical alignment of the optic systems for the forms flash and data display, and while the forms flash may be operated near the beginning or end of the period when data is entered on the form, the forms flash is preferably operated when the data display is printing data at about midpoint of the form.

WHAT IS CLAIMED IS:

1. A computer output microfilm printer comprising:
 - a. transport means for moving a photosensitive film along a transport path,
 - b. first optical means for establishing a first optical path for transmitting images onto film in said transport path from one side of said transport path,
 - c. second optical means for establishing a second optical path for transmitting images onto the film in said transport path in the same area of said path as the image from said first optical means from the other side of said transport path,

- d. display means for displaying a form in said first optical path at a location spaced away from said film to be imaged on said film by said first optical means,
 - e. a character generator for displaying controlled characters in said second optical path at a location to be imaged on said film by said second optical means,
 - f. means in said second optical means and said character generator for establishing an image of a plurality of selected characters along a line in said transport path with said line extending perpendicular to the direction of film movement in said transport path,
 - g. means in said first optical means and said display means for establishing an image of said form in said transport path with said image of said form having a width measured parallel to said direction of film movement which is many times greater than the width of said line of characters measured parallel to said direction,
 - h. incremental drive means in said transport means for moving said film along its length by a predetermined distance approximately equal to said width of said line of characters and stopping said film after said film has travelled said predetermined distance,
 - i. means for supporting supply and take-up rolls of photographic film,
 - j. a supply capstan for driving film along said path from said supply roll,
 - k. a take-up capstan for driving film along said path to said take-up roll,
 - l. an incremental drive capstan between said supply capstan and said take-up capstan for advancing film along said path in short predetermined increments of film length and stopping said film after the film has travelled said increments,
 - m. film loop sensing means between said supply capstan and said incremental drive capstan and connected to said supply capstan for controlling the amount of film between said supply capstan and said incremental drive capstan, and
 - n. film loop sensing means between said incremental drive capstan and said take-up capstan and connected to said take-up capstan for controlling the amount of film between said incremental drive capstan and said take-up capstan.
2. The printer of claim 1 in which said incremental drive capstan comprises:
- a. an elongated drive shaft having a generally cylindrical film engaging surface thereon
 - b. a frame rotatably supporting said shaft
 - c. drive means on said frame for rotating said shaft
 - d. a clutch interconnecting said drive means and said shaft
 - e. an electrically controlled brake interconnecting said shaft and said frame
 - f. an apertured disc mounted on said shaft and having a plurality of apertures therein distributed along a circular path around said shaft with the distance between said apertures proportional to said predetermined increment of film length, and g - means mounted on said frame for sensing the apertures in said disc.
3. The printer of claim 2 in which:

- a. said clutch comprises driving and driven members mounted adjacent to each other, a fluid mixture of ferromagnetic particles between said driving and driven members for connecting said members together, and an electromagnetic coil adjacent to said driving and driven members for generating a magnetic field to solidify said fluid mixture with said driving member connected to said drive means and with said driven member connected to said shaft,
 - b. said brake comprises driving and driven members mounted adjacent to each other, a fluid mixture of ferromagnetic particles between said driving and driven members for connecting said members together, and an electromagnetic coil adjacent to said driving and driven members for generating a magnetic field to solidify said fluid mixture with said driving member connected to said shaft and with said driven member connected to said frame, and
 - c. control means are connected to said clutch and brake for starting and stopping said shaft by reducing the current to the coil of said brake to start said shaft and reducing the current to the coil of said clutch to stop said shaft.
4. The printer of claim 1 in which each of said film loop sensing means comprises:
- a. an arm pivotally mounted adjacent to said transport path and having a film engaging wheel on its outer end
 - b. resilient support means connected to said arm for pivoting said arm in a direction to move said wheel away from said transport path, and
 - c. first and second limit switches positioned to be engaged by said arm at different pivotal positions of said arm and connected to said capstan for starting and stopping said capstan.
5. A computer output microfilm printer comprising:
- a. transport means for moving a photosensitive film along a transport path
 - b. first optical means for establishing a first optical path for transmitting images onto film in said transport path from one side of said transport path,
 - c. second optical means for establishing a second optical path for transmitting images onto the film in said transport path in the same area of said path as the image from said first optical means from the other side of said transport path,
 - d. display means for displaying a form in said first optical path at a location spaced away from said film to be imaged on said film by said first optical means,
 - e. a character generator for displaying controlled characters in said second optical path at a location to be imaged on said film by said second optical means,
 - f. means in said second optical means and said character generator for establishing an image of a plurality of selected characters along a line in said transport path with line extending perpendicular to the direction of film movement in said path,
 - g. means in said first optical means and said display means for establishing an image of said form in said transport path with said image of said form having a width measured parallel to said direction of film movement which is many times greater

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than the width of said line of characters measured parallel to said direction,
h. incremental drive means in said transport means for moving said film along its length by a predetermined distance approximately equal to said width of said line of characters and stopping said film after said film has travelled said predetermined

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distance, and
i. means included in said incremental drive means for continuously advancing said film an integral multiple of said predetermined distance before stopping said film.

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