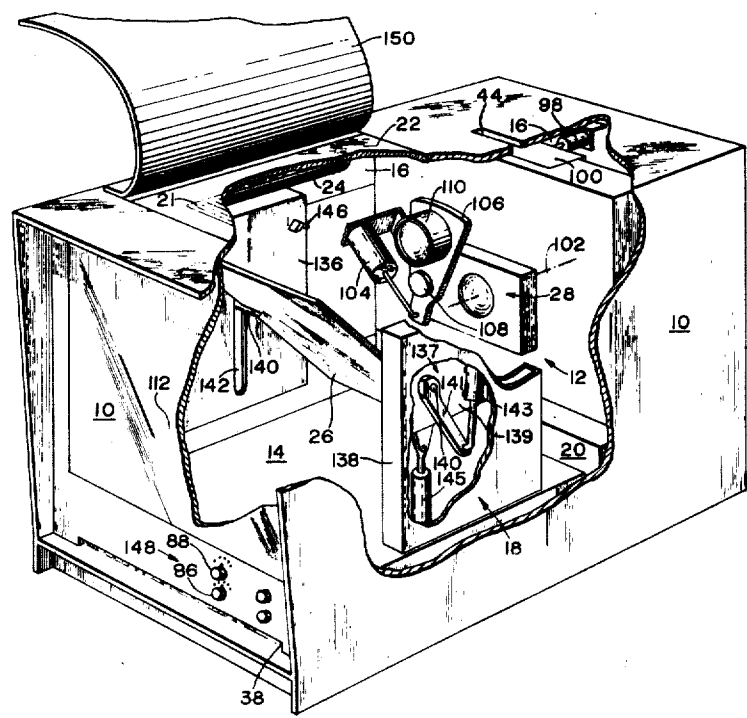


[54]	SYSTEM FOR RECORDING DATA ON MICROFICHE AND FOR VIEWING AND MAKING PRINTS OF THE RECORDED DATA	3,390,620	7/1968	Fairbanks.....	355/3
		3,463,585	8/1969	Levine.....	355/45
		3,509,807	5/1970	Sutton et al.....	355/27 X
[72]	Inventors: Manfred R. Kuehnle , Lexington; Dieter Jochimsen , Winchester, both of Mass.	<i>Primary Examiner</i> —Samuel S. Matthews <i>Assistant Examiner</i> —Richard L. Moses <i>Attorney</i> —Cesari and McKenna			
[73]	Assignee: Audac Corporation , Burlington, Mass.				
[22]	Filed: Sept. 16, 1969				
[21]	Appl. No.: 858,375				
[52]	U.S. Cl.	355/45, 355/5, 355/27, 355/60			
[51]	Int. Cl.	G03b 13/28			
[58]	Field of Search	355/5, 7, 3, 11, 44, 17, 10, 355/18, 27, 45, 66, 54, 64; 353/26, 27			
[56]	References Cited				
	UNITED STATES PATENTS				
	2,435,099 1/1948 Pratt et al.....	355/64			
			11 Claims, 10 Drawing Figures		
[57]	ABSTRACT	A system records graphic data in microimage form on either a temporary, recording medium or a permanent microfiche. Full-size reproductions are made by projecting the recorded microimages onto a photosensitive medium. The reproductions are made via the temporary storage medium when a quick copy of the original data is desired; they are made from the microfiche when the full-size reproductions are to be retrieved from long-term storage. The system can also display the recorded graphic data.			



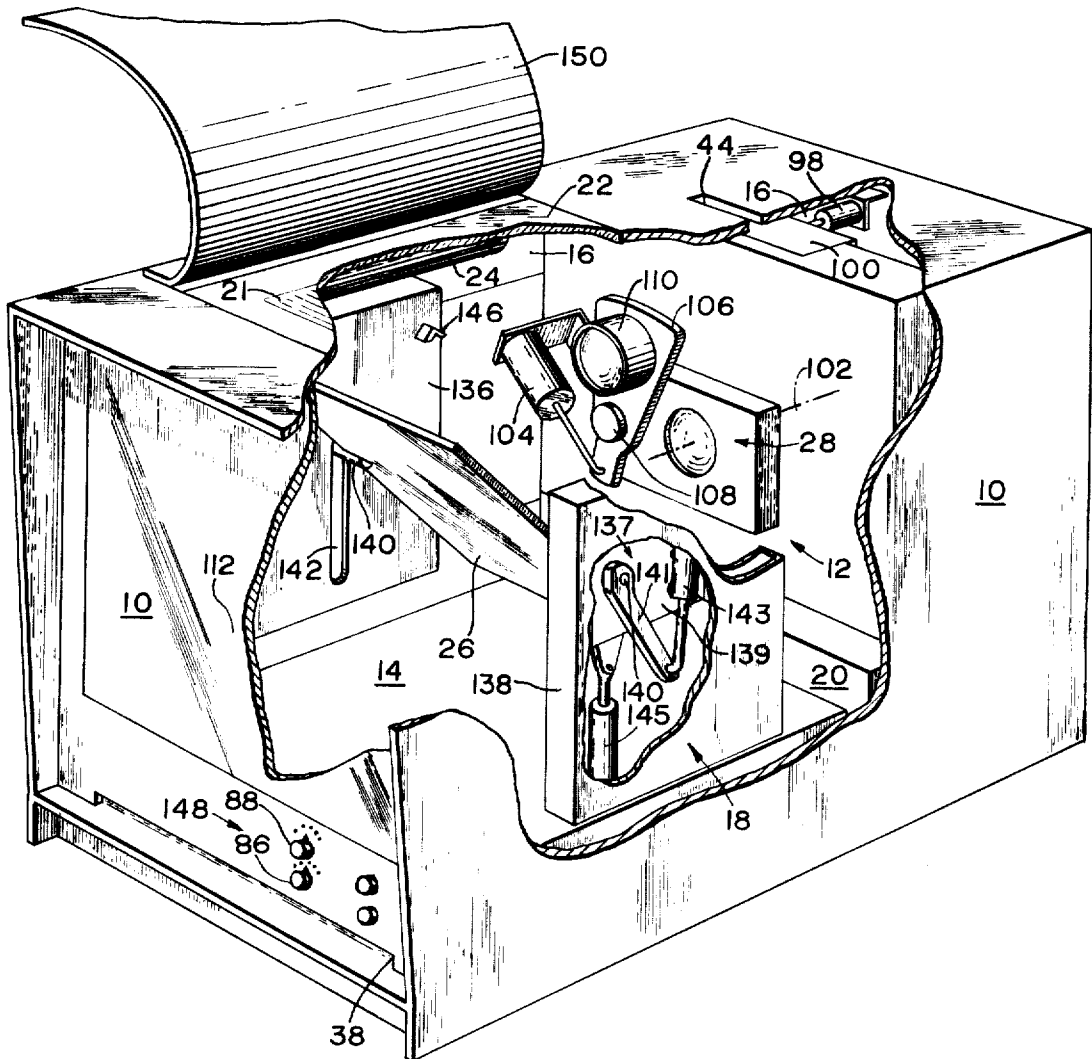


FIG. 1

INVENTORS
MANFRED R. KUEHNLE
DIETER JOCHIMSEN
BY
Blair, Cesari & St. Onge
ATTORNEYS

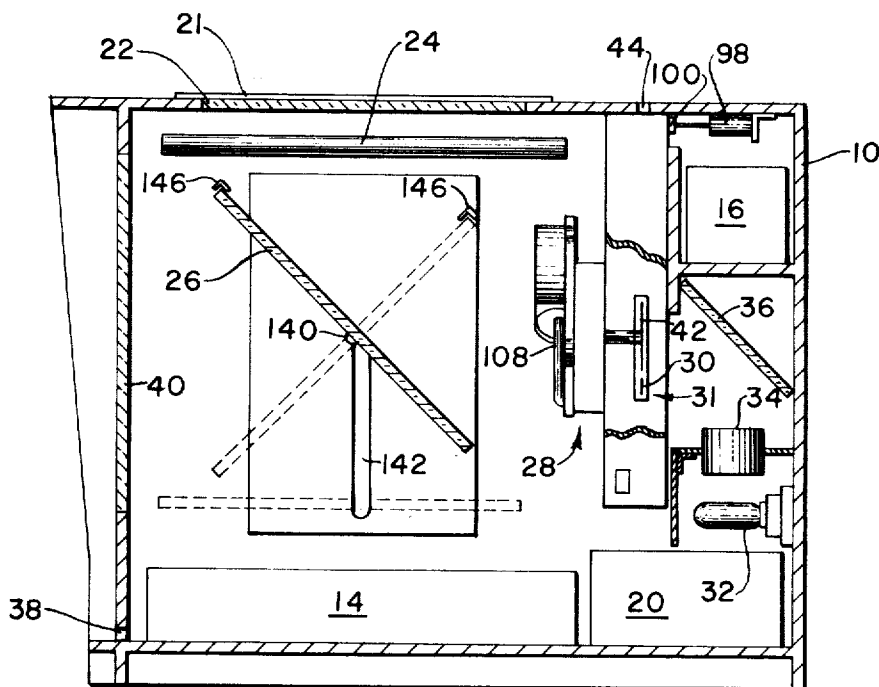


FIG. 2

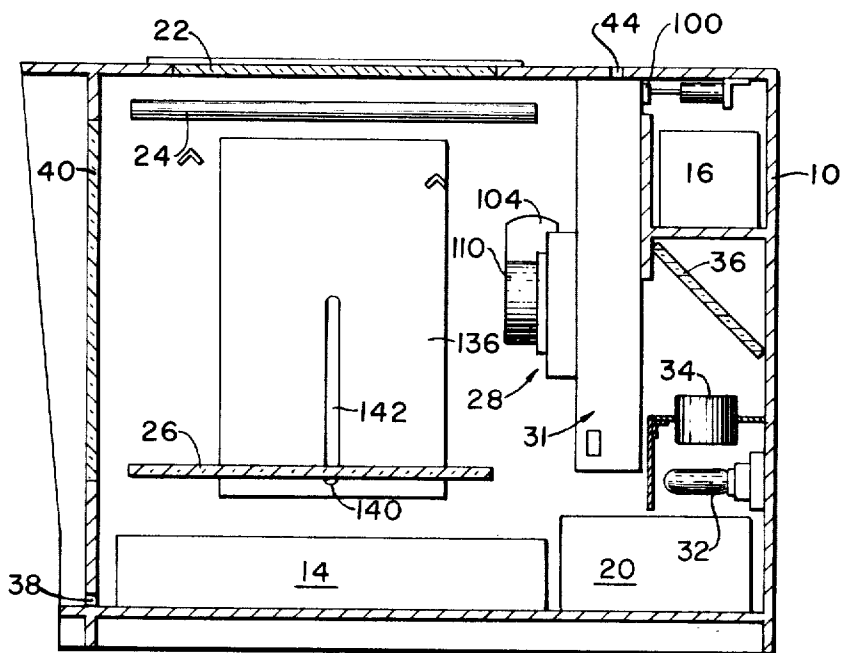


FIG. 3

INVENTORS
MANFRED R. KUEHNLE
DIETER JOCHIMSEN
BY

Blair, Cesari & St. Onge
ATTORNEYS

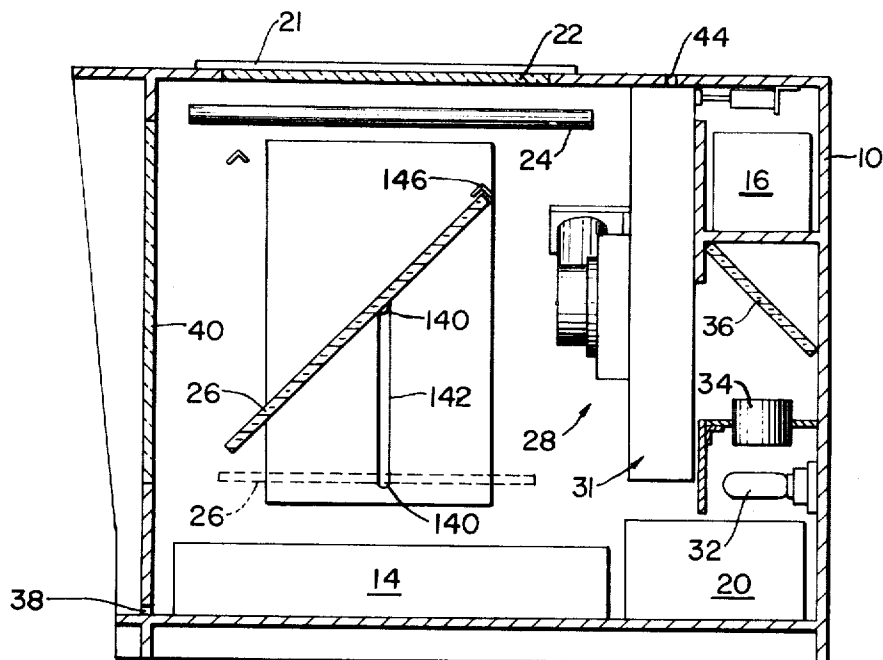


FIG. 4

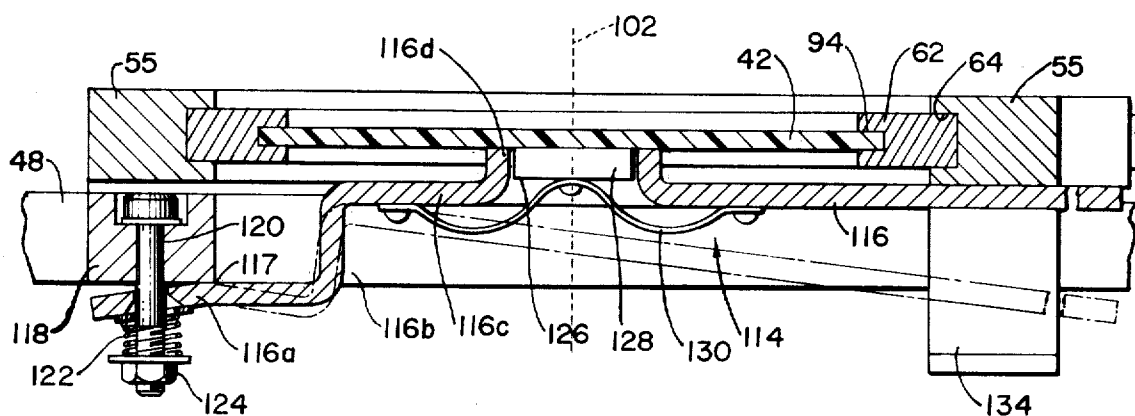


FIG. 5

INVENTORS
MANFRED R. KUEHNLE
DIETER JOCHIMSEN
BY
Blair, Cesari & St. Onge
ATTORNEYS

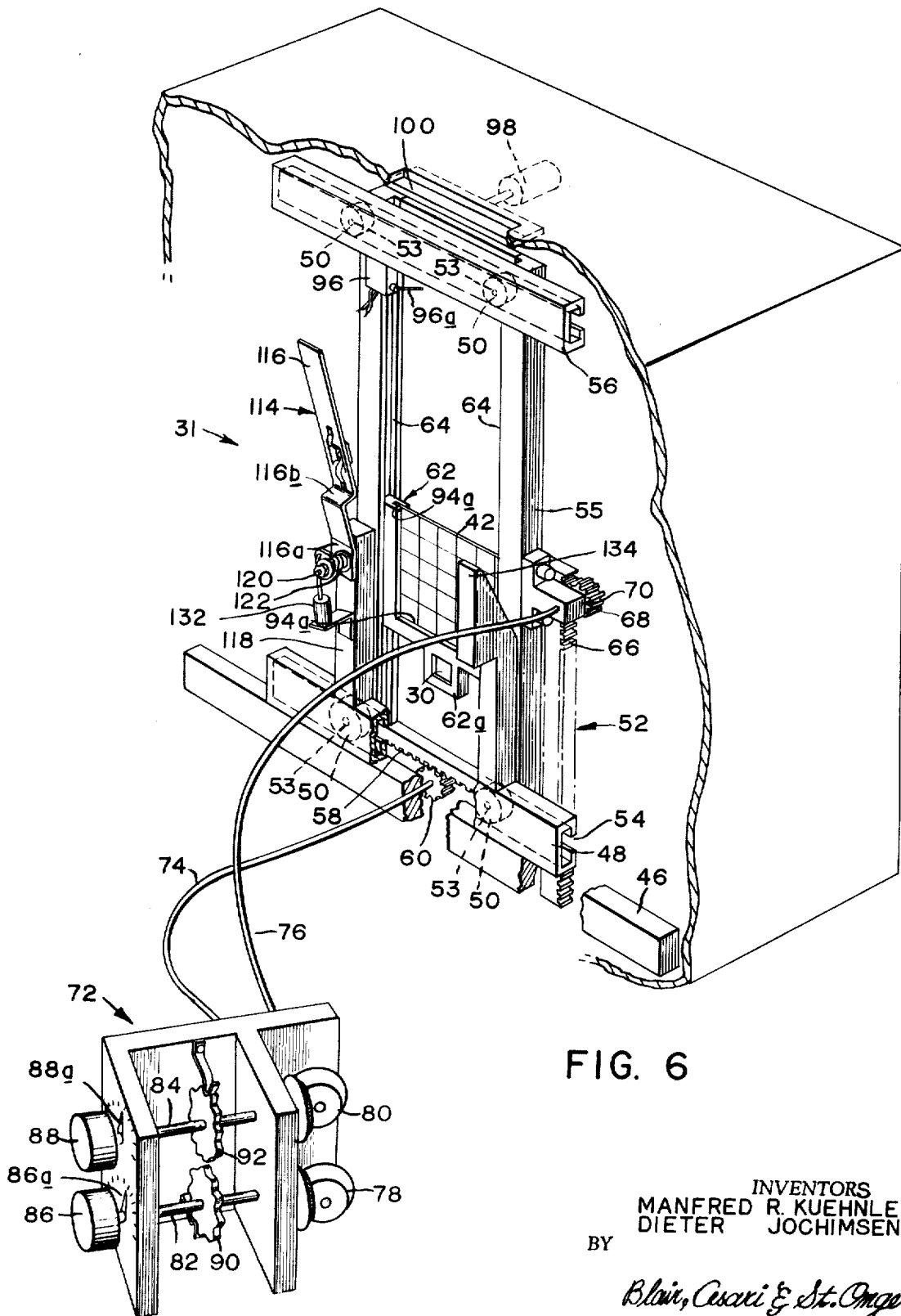
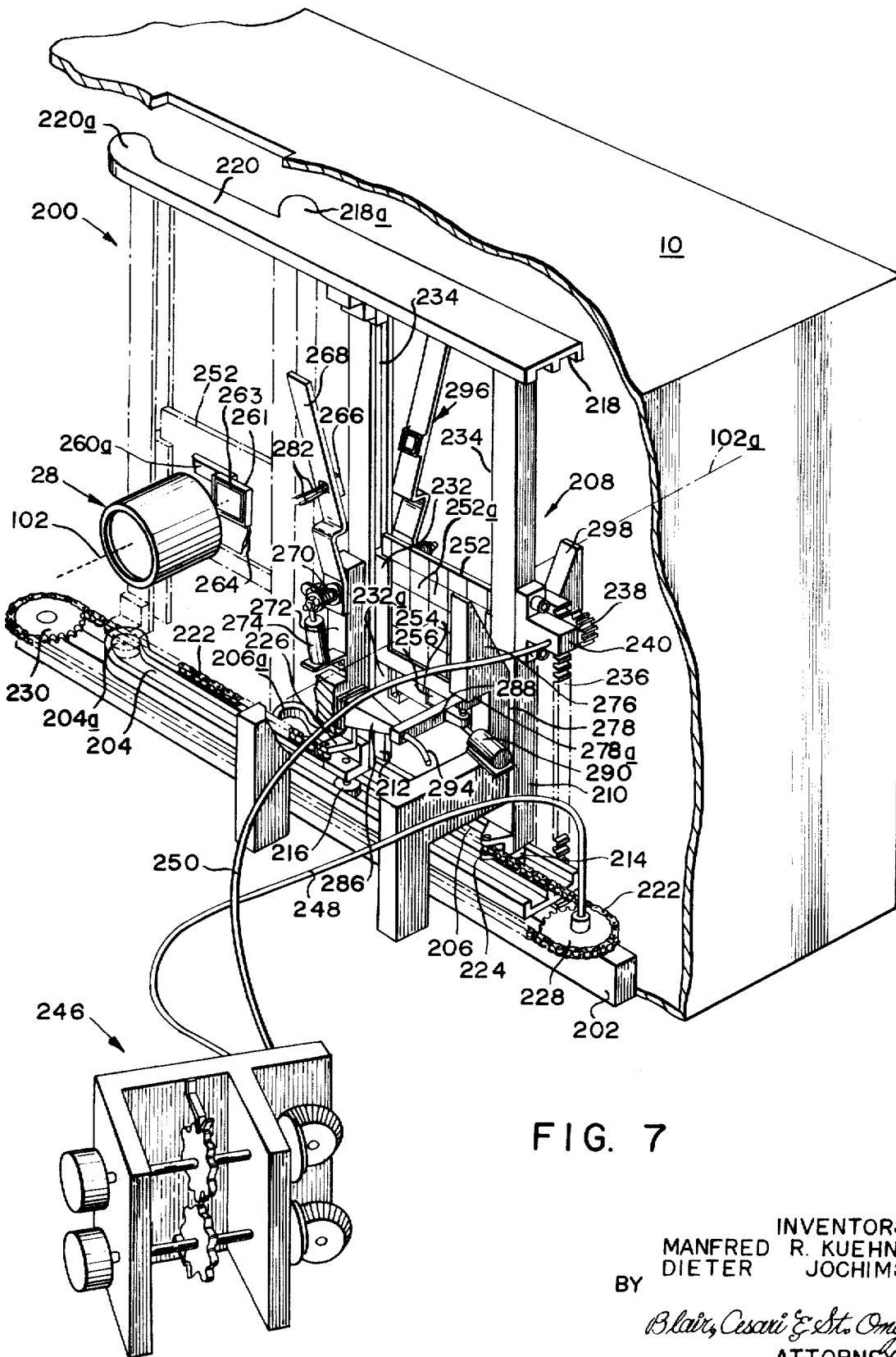


FIG. 6

INVENTORS
MANFRED R. KUEHNLE
DIETER JOCHIMSEN
BY

Blair, Cecchi & St. Onge
ATTORNEYS



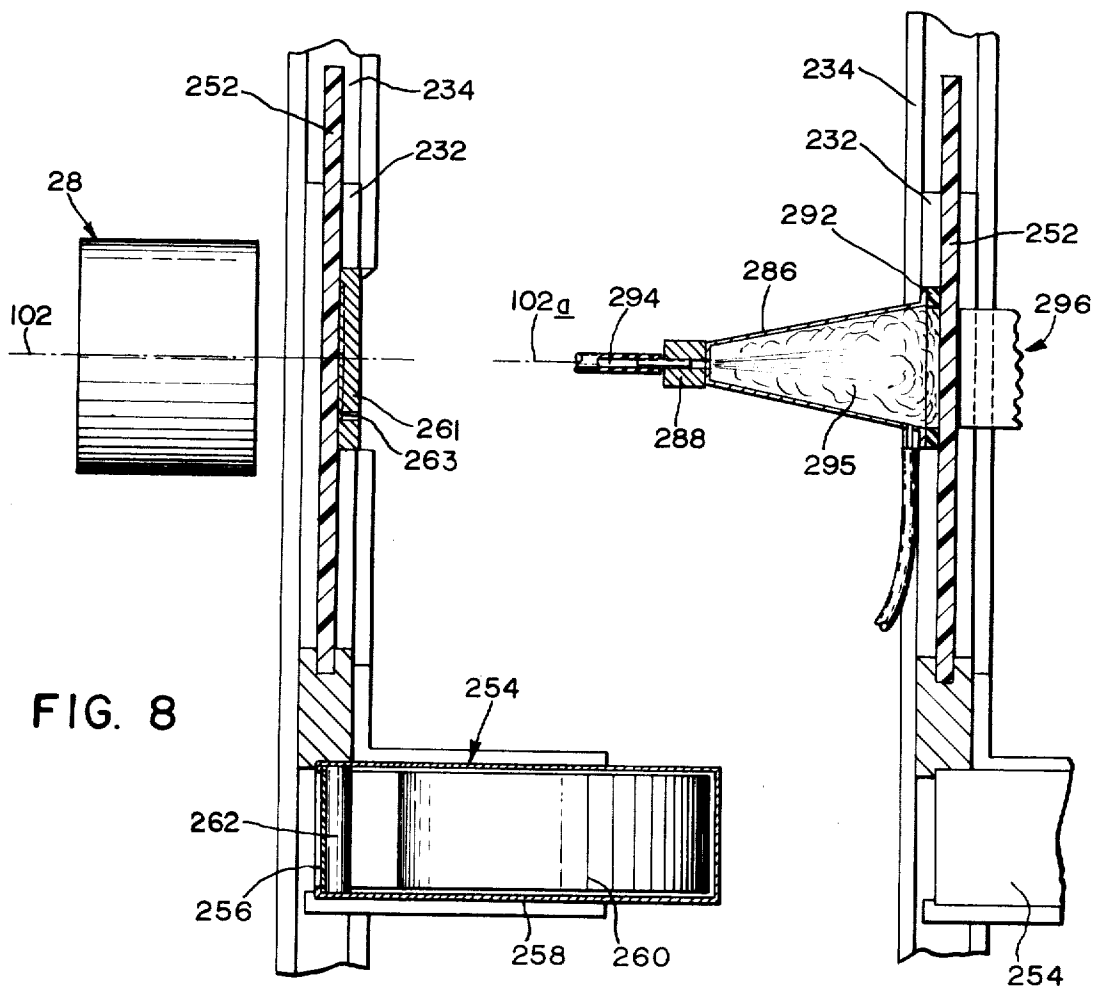


FIG. 8

FIG. 10

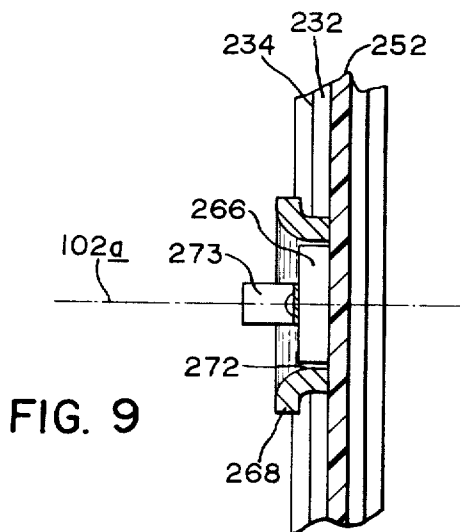


FIG. 9

INVENTORS
MANFRED R. KUEHNLE
DIETER JOCHIMSEN
BY
Blair, Casari & St. Onge
ATTORNEYS

A SYSTEM FOR RECORDING DATA ON MICROFICHE AND FOR VIEWING AND MAKING PRINTS OF THE RECORDED DATA

BACKGROUND OF THE INVENTION

a. Field of the Invention

This invention relates to an information acquisition, and reproduction system. More specifically, it relates to the reproduction of documents and the storage and display of information imprinted on them.

b. Prior Art

The advent of the modern document copier, particularly the electrostatic copier, has worked a veritable revolution in office procedures. Copies are so inexpensive that they are made in many cases where cost was previously a prohibitive factor. At the same time, however, the number of papers to be stored for future reference has increased very rapidly, partly as a result of the low cost of copies. This, in turn, has increased storage costs and in some situations has made it more difficult to retrieve stored information.

An example of these changed conditions is the document that is to be distributed among a number of people. It is now common to prepare an original and then use a document copier to prepare copies for distribution and also for use by the originator of the document. The original document is retained as a master from which further copies can be made at a later time, if necessary.

The storage of these master copies alone is a significant item of cost. The cost of storage can be reduced by recording the document on microfilm, but the full advantage of this technique has generally not been realized, particularly in small offices, because of the cost and inconvenience of preparing the microcopies and the problems involved in retrieving the information stored on them in readily usable form.

BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide a system for the acquisition, storage and reproduction of graphic data.

Another object of the invention is to provide a system which can acquire and retrieve graphic data relatively quickly.

Yet another object of the invention is to produce a system for the acquisition and reproduction of frames of graphic data which permits data to be added to or erased from each data frame from time to time.

Another object is to provide a system of this type which facilitates the storage and reproduction of only high quality graphic data.

A further object of the invention is to provide a system that permits storage of document contents in a relatively small space.

Another object of the invention is to provide a system of the above type that can be contained in a relatively small unit.

Still another object is to provide a system of this type which can display the data stored in it.

A further object of the invention is to provide a document storage and reproduction system that is convenient and relatively easy to operate and is characterized by low operating cost.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention combines the features of modern document copiers and microfilm systems. A single, multiple-function unit provides the operator with several optional modes of operation. These include the full-size reproduction of documents and other graphic data, the recording of documents in micro-image form, display of the recorded micro-images on a screen, and the making of full-size reproductions from the micro-images.

The system operates in all cases by first making a micro-image of the document. If only a full-size reproduction is to be made, i.e. if a permanent record is not desired, the micro-image is formed on an erasable medium or a very inexpensive "one shot" medium. This image is then projected full-size onto a copying medium, such as electrostatic copy paper, after which the reproduction is developed and the temporary medium is erased or removed.

On the other hand, if a permanent micro-image is to be made, an unexposed frame of a photographic microfiche or xerographic microfiche is used in place of the temporary medium, and the image is recorded on the microfiche. Later, if the recorded information is to be retrieved from the microfiche, it may be reproduced full-size by projecting the recorded image onto the copy medium. Alternatively, the micro-image can be projected full size onto a viewing screen contained in the same unit.

The system has a number of important advantages. In the first place, each master copy is stored on a microfiche whose storage space requirements are minimal, and the copying and reproduction unit can easily print out full-size reproductions of the original document from the microfiche.

Moreover, before recording on the microfiche, the operator can check exposure requirements by first making a micro-image on the temporary medium and then viewing a projection of the micro-image. The exposure can then be corrected, if need be, so that the permanent image on the microfiche will have the correct exposure. This is especially important in situations where different types of documents, with different exposure requirements are to be permanently recorded.

Also, as described below, the microfiche can be updated. That is, additional frames can be added into blank frames on the microfiche. This is particularly important in situations where information is developed intermittently over a substantial period of time. Indeed, this is characteristic of most matters handled in offices, manufacturing plants, etc.

Furthermore, if a xerographic microfiche is used for permanent storage, data can even be added to or blocked out of individual data frames on the microfiche or superimposed on existing data in the frames. This is because the xerographic process does not "fix" the images on the microfiche, therefore, the microfiche is always receptive to additional data.

All of these functions of the system are accomplished in a unit that is little larger than units presently used for single functions, e.g. making full-size copies, making reproductions from micro-images, etc., and is comparable in cost. This is accomplished by combining the functions of a number of the system components so that these components are common to two or more of the machine operations. Yet, as will be seen, the unit is fast and easy to use.

Other features of the invention will be more readily understood from the detailed description to follow.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a transparent perspective view, partly broken away, of a document recording and reproduction unit embodying the invention;

FIG. 2 is a simplified vertical section of the reproduction unit as arranged for the recording of a micro-image;

FIG. 3 is a view similar to that of FIG. 2, in which the unit is arranged for the viewing of recorded micro-images;

FIG. 4 is a view similar to that of FIG. 2, in which the unit is arranged for the making of full-size reproductions from micro-images;

FIG. 5 is a horizontal section of the heater used to fix permanent micro-images and erase temporary micro-images;

FIG. 6 is a perspective view of the film positioner used in the reproduction unit;

FIG. 7 is a similar view of another embodiment of the invention which employs a xerographic microfiche from the permanent data storage and a throw-away film and cartridge for temporary data storage, and

FIG. 8 is a sectional view with parts in elevation on a larger scale of a portion of the FIG. 7 unit.

FIG. 9 is a sectional view with parts in elevation on a larger scale of a portion of the FIG. 7 unit.

FIG. 10 is a sectional view with parts in elevation on a larger scale of a portion of the FIG. 7 unit.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1, a unit embodying the invention has a housing 10 that contains an optical assembly generally indicated at 12, an electrostatic copying assembly 14, an illumination power supply 16, a function-shifting mirror assembly 18 and a control unit 20.

A document 21 to be copied is placed face-down on a window 22 in the top of the housing 10 where it is illuminated by lamps 24 energized by the power supply 16. With the mirror assembly 18 arranged as shown in FIGS. 1 and 2, a mirror 26 reflects the image of the document toward the optical assembly 12 where a lens unit 28 focuses a greatly reduced image on a photosensitive medium, thus exposing the medium.

With reference to FIG. 2, in this invention embodiment, if a full-size copy of the document 21 is to be made, the photosensitive medium is a photochromic plate or film 30 contained in a film positioner 31. The film 30 is sensitive to a narrow band of light characteristic of the lamp 24. For reasons discussed below, this band is preferably in the near ultraviolet region, i.e. actinic light. The film 30 thus exposed and now carrying a micro-image of the document 21, a full-size reproduction can be made by swinging the mirror 26 into the position shown in FIG. 4. A projection lamp 32 is turned on and a collimating lens 34 directs light from the lamp 32 to the film 30 by way of a mirror 36. Lamp 32 emits nonactinic light to which film 30 is insensitive. The film is in the focal plane of the lens unit 28, and the lens unit therefore projects the recorded image toward

the mirror 26, which reflects it downward onto photosensitive paper contained in the copying assembly 14.

The assembly 14 operates according to well-known principles and need not be described in detail. It is sufficient to note that when actuated, it withdraws unexposed paper from a supply contained in it and transports the paper to the proper position beneath the mirror 26. Then, after exposure, the assembly 14 develops and fixes the image on the paper and ejects the finished copy through a slot 38 in the front of the housing 10.

Preferably, the surface of the photosensitive paper in the copying assembly 14 is the same distance from the lens unit 28 (by way of the mirror 26) as the distance from the original document 21 to the lens unit 28 when the image of the document is recorded (FIG. 2). This provides a copy that is exactly the same size as the original and without any adjustment of the lens unit.

Next, assume that the operator wishes to view the image recorded on the photochromic film 30. He merely actuates the mirror assembly 18 so as to move the mirror 26 down to its lower horizontal position as shown in FIG. 3. With the mirror thus out of the way, he can project a full-size replica of the document 21 onto a ground glass screen 40 by turning on the projection lamp 32 as before. This projects the recorded micro-image by means of the lens unit 28 in the same manner as when a full-size copy is to be made. Again, the screen 40 is preferably the same optical distance from the lens unit 28 as the top of the window 22 so that an exact replica can be viewed without adjusting the lens unit. Before the photochromic film is exposed to a new image, the previously recorded image is erased by heating the film in the image area as described below.

With reference to FIG. 2 in this system, if a permanent micro-image of the document is to be recorded, the film positioner 31 is actuated to replace the photochromic film 30 with a photographic microfiche 42. The document is illuminated by the lamps 24 and the image reflected by the mirror 26 is projected onto the microfiche 42 by the lens unit 28. The microfiche image is then fixed by the application of heat. The heat is applied only to the area of the microfiche containing the document image. Consequently only the data in this area is fixed. Therefore, the microfiche may have relatively large unexposed areas together with other areas containing exposed and fixed images.

After that, the microfiche can be withdrawn from the housing 10 through an upper slot 44 for storage elsewhere and a new microfiche can be inserted for recording or retrieval of information thereon.

If the operator desires to view an image on a microfiche, he inserts it through the slot 44 into the film positioner 31 and arranges the mirror 26 as shown in FIG. 3. He then projects the image onto the screen 40 in the manner described above for an image on the photochromic film 30.

Similarly, if the microfiche image is to be reproduced full size, the mirror position shown in FIG. 4 is used and the image is then projected down onto photosensitive paper in the copying assembly 14.

It will be apparent that the main mechanical differences in the system for the various functions

discussed above are the positions of the mirror 26 and the film positioner 31. The mirror positioner determines which one of three functions is to be performed, namely micro-image recording (FIG. 2), micro-image viewing (FIG. 3) or the making of a full-size reproduction (FIG. 4). The position of the film positioner 31 determines whether the photochromic film 31 or the microfiche 42 will be involved.

The film positioner is shown in detail in FIG. 6. It includes a bar 46 that supports a channel member 48. A pair of rollers 50 that fit within the channel member 48 support a carriage, generally indicated at 52, by means of pins 53 extending through a slot 54 in the member 48 and secured in the frame 55 of the carriage. Similarly, at the top of the carriage, a second supporting channel member 56 accommodates another pair of rollers 50 connected to the frame 55 by pins 53.

A rack 58, fitted to the bottom of the frame 55, meshes with a pinion 60 so that rotation of the pinion moves the carriage 52 horizontally, i.e. to the right or left.

A film holder 62 rides in vertical guides 64 in the carriage frame 55. The holder 62 is attached to a vertically oriented rack 66 that meshes with a pinion 68 supported in a bracket 70 mounted on the frame 55. Rotation of the pinion 68 and resulting movement of the rack 66 adjusts the vertical position of the film holder 62.

With further reference to FIG. 6, the position-adjusting pinions 60 and 68 are connected to a front panel position control unit 72 by flexible shafts 74 and 76. At the control unit 72, the shafts 74 and 76 are coupled by way of right angle drives 78 and 80 and shafts 82 and 84 to horizontal and vertical control knobs 86 and 88. Detent assemblies 90 and 92 constrain the shafts 82 and 84 to a set of predetermined positions corresponding to predetermined positions of the film holder 62, as discussed below.

The photochromic film 30, whose size corresponds to a single micro-image frame, is secured in a subframe 62a of the film holder 62. On the other hand, the microfiche 42, which is capable of storing a plurality of micro-image frames, is removably positioned in slots 94a in the side and bottom members 94 of the film holder 62. This permits removal and insertion of microfiches in the following manner.

When the microfiche 42 is to be removed, the vertical positioning knob 88 is rotated to raise the film holder 62. As the film holder approaches the top of the housing 10, it engages the arm 96a of a switch 96. This closes the switch to actuate a solenoid 98 (FIGS. 1 and 6) that withdraws a cover plate 100 from the slot 44. Further upward movement of the film positioner 62 causes the microfiche 42 to project out of the slot 44 so that the microfiche can be withdrawn from the film holder 62.

A new microfiche can then be substituted for the microfiche 42 by inserting it into the film holder 62. The film holder is then moved downward into operating position by rotation of the knob 88. Disengagement of the film holder from the switch arm 96a will then cause the solenoid 98 to release the cover plate 100 which is biased to close the slot 44.

With the foregoing arrangement, the knobs 86 and 88 can be rotated to bring either the photochromic film

30 or any selected image frame 42a of the microfiche into operative position on the optical axis 102 of the lens unit 28 (FIG. 1). The positions defined by the detent assemblies 90 and 92 are the positions of the film holder 62 at which the respective image frames 42a and the photochromic film 30 are on the axis 102, thereby assisting the operator in positioning the photosensitive media. These positions may also be registered on suitable indicia to which knob pointers 86a and 88a point.

The film positioner 31 provides the indexing capability needed to select individual frames on the microfiche for exposure, viewing or full-size copying, as the case may be. However, to facilitate operation of the film positioner, it is also desirable for the operator to have a convenient visual picture of the positions of the various microfiche frames with respect to the optical axis 102. This is accomplished by modifying the lens unit (FIGS. 1 and 3) to project the entire contents of the microfiche onto the viewing screen 40, with the entire microfiche being illuminated.

More specifically, when the operator wishes to position the microfiche, he energizes a solenoid 104 (FIG. 1) to swing a lens holder 106 around a pivot 108. This moves a lens 110 down onto the optical axis 102, thereby changing the characteristics of the lens unit 28. As a result, the entire microfiche 42 is projected onto the screen 40 instead of a single frame. The operative position, i.e. optical axis 102, is indicated on the screen 40 by crosshairs 112 or any other suitable indicator. Thus, to select a frame on the microfiche, all the operator has to do is manipulate the knobs 86 and 88 to bring the selected frame into register with the crosshairs 112.

After the selected microfiche frame has been positioned on the optical axis 102, the solenoid 104 is de-energized, thereby swinging the lens 110 out of the way and returning the lens unit 28 to its previous focal length. The operator can then view the selected frame full size, record a micro-image in it if it is a blank frame, or reproduce the contents of the frame full size by means of the copying assembly 14.

FIGS. 5 and 6 depict a heater 114 used to erase images on the photochromic film 30 and fix images on the microfiche 42. The heater 114 includes an arm 116 pivotally secured to a bar 118 mounted on the channel member 48. The arm 116 has a slightly angled end portion 116a that pivots on a bolt 120 extending through the bar 118. A spring 122, compressed between a nut 124 and the end portion 116a, tends to rotate the arm 116 about its contact 117 with the bar 118 so as to bias the main part of the arm 116 away from the frame 55, as best shown in FIG. 6.

The arm 116 also includes a forwardly extending offset portion 116b whose forward end joins a carrier portion 116c. The carrier portion has an aperture 126 that accommodates a heat shoe 128. The shoe 128 is positioned in the aperture 126 with a slight forward bias by a spring 130.

When not in use, the heater 114 is positioned out of the way as shown in FIG. 6. When it is to operate, a solenoid 132 rotates it clockwise (FIG. 6) to bring the arm 116 downwardly into engagement with a cam 134 fastened to the channel member 48. As the arm 116 continues rotation, the cam 134 moves it forward, so that when it reaches the horizontal position, as shown in FIG. 5, the cam has forced the heat shoe 128 against

the microfiche 42 or photochromic film 30, as the case may be.

The shoe 128 is heated by means of electric current passed through suitable leads (not shown) and thus its contact with the microfiche or photochromic film provides the heat necessary for fixing or erasing. Forwardly extending tabs 116d are at the lower temperature of the arm 116 and their contact with the microfiche restricts the heat to a single frame corresponding to the position of the shoe 128.

When the heater 114 is in the horizontal operating position, as shown in FIG. 5, the heat shoe 128 is on the optical axis 102. Thus, if a frame on the microfiche 42 has just been exposed, the shoe 128 will automatically be in a position to apply its heat to that frame. Similarly, if the photochromic film 30 is about to be exposed, the heat shoe will automatically be in position to erase any previous image on the film.

When the fixing or erasing has been completed, the solenoid 132 (FIG. 6) is de-energized to return the heater 114 to its nonoperating position.

With further reference to FIG. 1, the mirror assembly 18 includes, in addition to the mirror 26, a suitable mirror-moving mechanism contained within subhousings 136 and 138. The mirror is mounted directly on a pair of shafts 140 that extend through slots 142 into the interiors of the subhousings 136 and 138.

The mirror assembly 18 can be arranged for completely manual movement of the mirror 26 among the three positions illustrated in FIG. 2, 3 and 4. However, we prefer to use an electromechanical arrangement which, in its simplest form, has a mirror-rotating unit 137 in each of the subhousings 136 and 138 connected to the outer ends of the shafts 140. Each of these rotating units includes a bracket 139 in which the corresponding shaft 140 is journaled. A crank arm 141 is attached to the end of the shaft and one or more solenoids 143 are connected between the crank arm and the bracket to provide rotation of the mirror among its three angular positions. A translation unit includes solenoids 145 arranged to move the mirror 26 and the rotation units attached thereto in the vertical direction between vertical limits defined by the slots 142.

In order to ensure accurate positioning of the mirror 26 when it is used as a reflector, we prefer to include limit stops 146, the mirror being rotated against the stops when in the positions shown in FIGS. 2 and 4.

For several reasons, front surface reflection should be employed at the mirror 26. In the first place, the reflections in FIGS. 2 and 4 are made from opposite surfaces of the mirror with the arrangement shown, although the mirror could quite obviously be manipulated so as to reflect from the same side. Of more importance, if ultraviolet radiation is used to illuminate the document to be copied, there will be much less loss at the mirror 26 with front surface reflection than with back surface reflection.

We have not illustrated the electric circuits for the system. Obviously, a set of front panel control knobs or buttons 148 (FIG. 1) can be used to initiate and control the respective operations, with conventional timers being employed to control the times of exposure. Preferably, however, the system includes circuits that permit the operator to control an entire function by manipulating a minimum number of knobs or buttons, desirably a single one for most functions.

Again, this is a simple matter. Each function can be controlled by a sequencing unit or timer that sequences the system through all the operations associated with that function. For example, if a microfiche is to be exposed, the sequencer will turn on the lamps 24 for a length of time determined by a lamp timer, then after exposure is completed, it will energize the solenoid 132 (FIG. 6) to fix the image in the manner described above. If a temporary image is to be made on the photochromic film 30 (FIGS. 1 and 2), a sequencer associated with that operation will first energize the solenoid 132 to erase the previous image on the film 30 and then it will turn on the lamps 24 to expose the film for an interval determined by a timer associated with the film 30.

Preferably, the two exposure timers for the microfiche and photochromic film are ganged together so that they "track." Thus, when the operator adjusts the exposure interval for the photochromic film, he will automatically make the same adjustment for the microfiche.

The sequencing systems for the exposure of the microfiche and photochromic film should include interlocks to make sure that the right medium is on the optical axis 102 when exposure is made and the heater 114 is operated to fix an image or erase one, as the case may be. This can be accomplished by suitable position-sensing switches associated with the film positioner 31. Additionally, the positioning control unit 72 (FIG. 6) may include a motor drive that forces the film 30 or the microfiche 42 onto the optical axis, depending on which of the sequencers the operator has actuated.

Finally, a system may be provided with an automatic indexing system so that successive frames of the microfiche 42 are shifted onto the optical axis for the recording of successive documents or for the making of a succession of full-size copies of the contents of the respective frames.

The use of the same medium for fixing the microfiche image and erasing the photochromic image substantially simplifies the system. This is therefore an important, though not absolutely necessary, criterion for selection of the two image-recording media. A further constraint results from the fact that the microfiche must be capable of recording successive frames at spaced intervals during which it is removed from the system and stored elsewhere. This means that it should be relatively insensitive to the conditions under which it is stored and, in particular, unexposed areas should not be exposed or fixed by the ambient temperature or light conditions. Finally, the photochromic film and microfiche should be sensitive to the same radiation so that one set of lamps 24 can be used.

With these characteristics in mind, we prefer to use a photographic microfiche and photochromic film that are sensitive primarily to near ultraviolet or actinic light, i.e. on the order of 3600A to 4200A. We have also found that this light gives good color definition and limits reflections to the front face of the film. The microfiche is fixed by exposure to an elevated temperature as described above, and the same arrangement serves to erase the photochromic film. Also, the sensitive paper in the copying assembly 14 should be sensitive to visible wavelengths to which the photochromic film is not sensitive, so that the same projection lamp

32 can be used to project images onto both the screen 40 for viewing and the copying assembly 14 for the production of full-size copies.

A microfiche medium meeting these requirements is Kalvar KDR 17 or SD Warren 1264 film; a photochromic medium is American Cyanamide XD 1 film and a suitable photosensitive paper is OPC marketed by S.D. Warren Paper Company. The OPC paper is particularly good to use here because it is "reversible." That is, one can make positive prints from either positive or negative microfiche images simply by reversing the polarity of the copy paper and the toner used with the paper.

With near ultraviolet light being used for exposure, the window 22 should be enclosed by a cover 150 (FIG. 1); and the cover should be arranged with an interlock switch (not shown) to prevent operation of the lamps 24 unless the cover is closed.

Even though the microfiche is primarily sensitive to ultraviolet light, and even then is insensitive, prolonged subjection to environmental radiation may in some cases expose it to some degree. This can be avoided by enclosing the microfiche in a transparent plastic envelope that filters out the deleterious radiation. A yellow polyimide film such as "Kapton," marketed by DuPont is suitable for this purpose. The microfiche can be manually removed from the envelope before insertion into the slot 44 (FIGS. 1 and 6) and then reinserted into the envelope after withdrawal from the slot. Preferably, however, the microfiche is inserted into the slot 44 while still contained in the envelope and the system is arranged to automatically extract the microfiche from the envelope and later reinsert it. Mechanisms for accomplishing this are currently available and need not be described in detail here.

Generally when it is desired to view the entire microfiche on screen 40 (FIGS. 1 and 3), in order to facilitate selection of an exposure location thereon, it is preferred practice to leave the microfiche in the envelope during the viewing step, so as to further protect the microfiche from radiation. Consequently the image projected on screen 40 may appear somewhat yellowish. However, the images are still clearly visible on the screen. Once the exposure location is selected using the crosshairs 112, the envelope is removed to allow the ultraviolet light to expose the microfiche location thus selected.

Referring now to FIG. 7, another embodiment of the present system employs temporary and permanent storage media which operate on the xerography principle. The major difference between the FIGS. 1 and 7 systems is in the film positioner.

More particularly, the modified film positioner shown generally at 200 in FIG. 7 has a beam 202 which supports a pair of parallel tracks 204 and 206. A carriage indicated generally at 208 has a pair of legs 210 and 212 carrying rollers 214 and 216 which ride on tracks 206 and 204, respectively. Carriage 208 is supported at its top by a pair of similar rollers (not shown) secured to the tops of legs 210 and 212 and riding on a pair of parallel tracks 218 and 220.

Carriage 208 is moved along the tracks by means of a chain 222 secured to ears 224 and 226 extending out from carriage legs 210 and 212, respectively, just above wheels 214 and 216. Chain 222 engages around gears

228 and 230 rotatively mounted at the opposite ends of beam 202 beyond the ends of tracks 204 and 206. Rotation of gear 228 one way or the other moves carriage 208 horizontally, to the right or left in FIG. 7.

A film holder 232 rides in vertical guides 234 in carriage legs 210 and 212. Holder 232 is attached to a vertical rack 236 which meshes with a pinion 238 rotatively mounted in a bracket 40 secured to leg 210. Rotation of pinion 238 moves rack 236 as well as film holder 232 vertically relative to carriage legs 210 and 212.

Still referring to FIG. 7, the hubs of gear 228 and pinion 238 are connected to a front panel control unit 246 by flexible shafts 248 and 250, respectively. Unit 246 is identical to unit 72 in FIG. 6. By manipulating the control knobs therein, film holder 232 can be moved horizontally to the right or to the left, as well as vertically relative to the lens unit 28 and its axis 102.

A xerographic microfiche 252, to be described in more detail later, which is capable of storing a plurality of micro-image frames 252a is removably positioned in film holder 232. Microfiche 252 is inserted and removed from the film holder in exactly the same way as microfiche 42 in the FIG. 6 system. However, it need not be stored in an envelope to protect it from environmental radiation.

Film holder 232 also includes a subframe 232a which holds a conventional film cassette 254 containing a film frame window 256. As best seen in FIG. 8, cassette 254 contains a spool 258 carrying a length of xerographic microfilm 260. Film 260 is threaded around a spindle 262, past the window 256 and is wound around a second spindle and takeup spool (not shown) in the cassette. Film 260 is advanced frame-by-frame, either by hand or automatically, as desired. Suitable advancing means are presently available and will not be described in detail here.

Turning again to FIG. 7, film positioning unit 208 has two operative stations. At one station, the exposing station, unit 208 is positioned at the left-hand ends of tracks 204, 206, 218 and 220, as shown in dotted lines in FIG. 7, so that the microfiche 252 (or cassette 254) is positioned between the lens unit 28 and a transparent glass platen 261 supported by a bracket 260a. Tracks 204, 206, 218 and 220 have end segments 204a, 206a, 218a and 220a, respectively, which curve in toward the plane containing the platen 261. Thus, as the film positioner nears its leftward limit of travel, it is displaced toward platen 261 so that the microfiche 252 is pressed against the platen. Preferably, platen 261 has a transparent metallic coating (not shown) which is maintained at ground potential.

Also, platen 261 includes a peripheral groove 263 facing the microfiche which is connected by way of a hose 264 to a negative pressure source so that a vacuum can be drawn in the groove which pulls the microfiche 252 flat against the platen. These steps are taken to assure that the microfiche is perfectly flat against the platen because the lens unit 28 has a relatively short focal length so that irregularities in the microfiche tend to degrade the image impressed thereon.

Thus, by manipulating the knobs on control unit 246, the operator can position a selected microfiche frame 252a on the lens axis 102, either to expose it or to project an image already on the frame, as described above

in connection with FIGS. 1-6. Alternatively, the cassette window 256 can be positioned on axis 102 so that a frame of xerographic film therein can be exposed or projected through in the same way.

At the other operative station of film positioner 208, the processing station, the positioner is located at the extreme right-hand end of tracks 204, 206, 218 and 220, as shown in solid lines in FIG. 7. Here, the remaining steps in the xerographic process are carried out.

More particularly, a corona charge unit 266 is arranged to apply an electric charge to the microfiche 252 (or film 260). The unit 266 is carried by an arm 268 connected by a pivot 270 to a stationary frame member 272. Arm 268 is similar to arm 116 in FIG. 6 and will not be described in detail here. As best seen in FIG. 9, unit 266 is simply a metal block which is supported in a window 272 in arm 268 by a leaf spring 273 which biases the block toward the film so that good contact is made with the film.

When not in use, the unit 266 is positioned out of the way, as shown in FIG. 7. When it is to operate, a solenoid 274 similar to solenoid 132 in FIG. 6 rotates arm 268 clockwise as shown in FIG. 7 to bring the arm down into engagement with a cam 276 forming part of a stationary frame member 278. As arm 268 moves downwardly, cam 276 moves it toward the film, i.e. into the plane of the drawing, so that when the arm reaches its horizontal position as shown in FIG. 7, the unit 266 is pressed against microfiche 252 or against the window 256 in cassette 254, as the case may be.

Current is applied to the unit 266 by means of leads 282 connected to a suitable power source (not shown). When the unit 266 is energized, an electric field is developed between the unit 266 and a suitable grounding electrode (not shown) behind the microfiche which imposes an electric charge on a portion of the microfiche (or film). In practice, the area of the unit 266 is approximately the same as the area of one frame 252a of the microfiche (or one film frame), so that only this area receives the electric charge as described above.

Still referring to FIG. 7, liquid toner is applied as part of the xerographic process to microfiche 252 by means of a funnel-shaped applicator 286 connected to one end of an arm 288, whose other end is pivotally connected to an offset portion 278a of stationary frame member 278 directly below cam 276. When not in use, applicator 286 is swung away from film holder 232 as shown in FIG. 7. When it is desired to apply the toner, a solenoid 290 connected between frame member 278 and arm 288 swings applicator 286 toward the film holder 232 so that its open end engages against the microfiche 252 as shown in FIG. 10. A gasket 292 at the end of applicator 286 provides a seal between the applicator and the microfiche and encloses an area corresponding to one frame. A hose 294 connected to the back of the applicator leads to a source of liquid toner. When the applicator is in place as shown in FIG. 10, toner 295 is fed into the applicator and is distributed over the surface of the microfiche frame 252a enclosed by gasket 292.

Also, by moving the film positioner 208, applicator 286 can also be swung against cassette 254 with the opening in the applicator registering with the cassette window 256 so that toner can be sprayed onto the surface of the film frame in the window.

Referring again to FIG. 7, a heater 296 is used to evaporate the liquid toner from the microfiche 252 (or film 260) in order to speed up the process. Heater 296 is identical to heater 114 (FIG. 6), except that it is located on the opposite side of film positioner 208 so that the heater can engage the rear surface of the microfiche. Heater 296 is swung down to a horizontal position so that it is pressed by a cam 298 against the microfiche 252 at the same time applicator 286 is swung against the front of the microfiche as shown in FIG. 10. Heater 296 is energized as soon as the spray of toner issuing from the applicator ceases. Alternatively, a heated air stream may be used for this purpose.

When the operator wishes to permanently record information on the xerographic microfiche 252, he manipulates the knobs on control unit 246 to position an empty microfiche frame 252a so that its center coincides with axis 102a as shown in solid lines in FIG. 7. Axis 102a is a lateral translation of lens unit axis 102. In other words, when the microfiche frame 252a is centered on axis 102a, it will automatically center on the lens axis 102 when film positioner 208 is moved to the exposing station. The unit 266 is then swung down to its horizontal position and is energized to impress an electric charge on the centered frame 252a.

Following this, charge unit 266 is retracted and the film positioner 208 is shifted leftward to the exposing station as shown in dotted lines in FIG. 7. At this station, the same microfiche frame 252a is aligned with axis 102 and pressed firmly against platen 260 by drawing a vacuum in the platen groove 262. Next, with mirror 26 (FIG. 2) in the proper position, the microfiche frame is exposed. Those portions of the microfiche frame 252a struck by light from lens unit 28 lose their electric charge; the remaining portions of the microfiche retain a charge.

Film positioner 208 is then returned to the processing station. Next, solenoid 290 is actuated to position the toner applicator 286 against the exposed microfiche frame 252a on axis 102a. At the same time, the heater 296 is brought down into engagement with the back of the microfiche frame. Toner is applied to the microfiche frame and adheres only to those areas still carrying an electric charge. Then the heater is energized to fuse the toner adhering to the microfiche frame so that a permanent positive image is recorded on the microfiche.

Microfiche 252 can then be removed and stored until needed. Alternatively, by properly positioning mirror 26, and moving positioner 208 to the exposing station and adjusting film holder 232 relative to lens axis 102, selected images on microfiche 252 can be projected into the copying unit 14 to provide full-size copies of the micro-image recorded on the microfiche 252 as shown in FIG. 4. or, if desired, the images can be projected onto display screen 40 as shown in FIG. 3.

It will be understood also that, following the same procedures, data can be recorded on film 260 in cassette 254 and retrieved when needed.

The sequencing of the various elements of the FIG. 7 system is accomplished in the same way described above in connection with the FIGS. 1-6 apparatus. Also, it may include an automatic indexing system so that successive frames of microfiche 252 are shifted onto axes 102 or 102a for the recording of successive documents, or for the making of a succession of full-

size copies of the contents of the respective frames or for displaying their contents.

The FIG. 7 embodiment of this system is particularly advantaged because the permanent and temporary storage media are the same material, for example, a micro-xerographic organic photoconductive film such as that marketed by the Matsushita Electric Company.

This film is exposed by near ultraviolet light and once the toner has been fused onto the film to permanently record the document image, the film is not affected materially by white light. Therefore, when the system is used to display a recorded document, a white light may be employed to project a bright image onto screen 40 (FIG. 3).

Utilization of a xerographic microfiche 252 yields an advantage in that information can be added to each frame of the microfiche. This is because the xerographic film is not fixed after an image is recorded on it. Therefore, new data may be superimposed on old data in each frame, or a given frame may be completely blacked out by exposing the frame a second time with an opaque mask on the platen 22 so that toner is fused over the entire frame.

The xerographic film has an added advantage in that it is relatively inexpensive to make. Therefore, it can be used in cassette 254 as a one-shot temporary storage medium. Even though each cassette 254 is used only once, the cost of the film 260 therein is sufficiently low that the system's operating costs are still maintained within reasonable limits.

From the foregoing, it will be apparent that we have provided a novel multiple-function machine for copying, storing and retrieving the contents of documents, with a complexity and cost that are not much greater than one would expect to find in a device performing only one of those functions. The system, which can be operated by relatively unskilled personnel, facilitates storage of information in micro-image form, thereby greatly decreasing the volume of stored documents. At the same time, retrieval of the stored information is a simple matter and, if desired, the retrieval can take the form of full-sized copies of the original documents.

The use of the incrementally exposed microfiche format permits one to store related items of information in the closely adjacent physical locations even though they are not recorded in sequence. This is analogous to the present system of filing items relating to different subject matters in different files, with each file containing items relating to the same subject matter. It thereby facilitates sorting of the stored information and, in this respect, it should be distinguished from systems in which the arrangement of stored material is determined by the order in which it is recorded.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A system for recording data on microfiche and for viewing and making prints of the recorded data comprising

A. a lens system with an axis,

B. means for holding a microfiche and positioning it relative to the lens system axis,

C. light transmitting platen for supporting a document,

D. first light means arranged for illuminating a document on the platen,

E. means for directing an image of the illuminated document in one direction along the lens system axis so that a latent micro-image of the document is imaged on the microfiche,

F. means for reducing the latent micro-image to visible form,

G. copying means,

H. second light means positioned on the opposite side of the microfiche holding means from the lens system so that when the second light means is illuminated, said micro-image recorded on the microfiche in the holding and positioning means is projected in the opposite direction along the lens system axis, and

I. means for directing the projected micro-image so that it is received and copied by the copying means.

2. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 1 and further including

A. a screen, and

B. means for moving the means for directing the micro-image so that the projected visible micro-image on the microfiche is displayed on the screen.

3. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 2 and further including a lens movable into a position so that its axis coincides with the lens system axis, said lens shortening the focal length between the lens system and the screen so that an image on the microfiche is projected onto the screen.

4. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 1

A. wherein said microfiche is exposed by near ultraviolet light and the image thereon is fixed by heat, and

B. means for selectively applying heat to the exposed portion of the microfiche so as to fix the micro-image thereon.

5. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 1 wherein the holding and positioning means includes means for supporting a temporary storage medium, said positioning means being movable so as to place the temporary storage medium on the lens system axis so that the image of a document on the platen is recorded on the temporary storage medium, said image being removable from the system after it has served its purpose.

6. A system for recording data on microfiche and for viewing and making prints of the recorded data according to claim 5 wherein the temporary medium is a film which is

A. exposed by near ultraviolet light, and

B. erased by the application of heat.

7. A system for recording data on microfiche and for viewing and making prints of the recorded data comprising

A. a surface for supporting a document,

B. means for illuminating the surface,

15

- C. a lens system,
- D. means for reflecting the image of the document on the surface in one direction along the lens axis,
- E. means for holding a light transmitting storage medium and positioning it on the lens axis on the opposite side of the lens from the reflecting means so that the image of the document is recorded on the storage medium,
- F. a second light positioned behind the storage medium and the positioning means,
- G. copying means, and
- H. means for moving the reflecting means so that when the second light illuminates the storage medium, the image of the data thereon is projected in the opposite direction along the lens axis to and copied by the copying means.
- 8. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 7 and further including
 - A. a display screen, and
 - B. means for moving the reflecting means so that when the second light illuminates the storage medium in the positioning means, the image of the data thereon is displayed on the screen.
- 9. A system for recording data on microfiche and for

16

- viewing and making prints of the recorded data as defined in claim 7 wherein said positioning means
 - A. supports and positions a permanent storage medium and a temporary storage medium, and
 - B. is adjustable so that either storage medium may be positioned on the lens axis to receive the image of a document on the transparent surface.
- 10. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 9 wherein
 - A. the permanent storage medium is a photographic microfiche which is exposed by near ultraviolet light and fixed by heat, and
 - B. the temporary storage medium is a photochromic film which is exposed by near ultraviolet light and erased by the application of heat.
- 11. A system for recording data on microfiche and for viewing and making prints of the recorded data as defined in claim 10 and further including heating means movable into engagement with a portion of the storage medium on the lens axis so as to fix the image thereon if it is a permanent storage medium and to erase the image thereon if it is a temporary storage medium.

* * * * *

30

35

40

45

50

55

60

65