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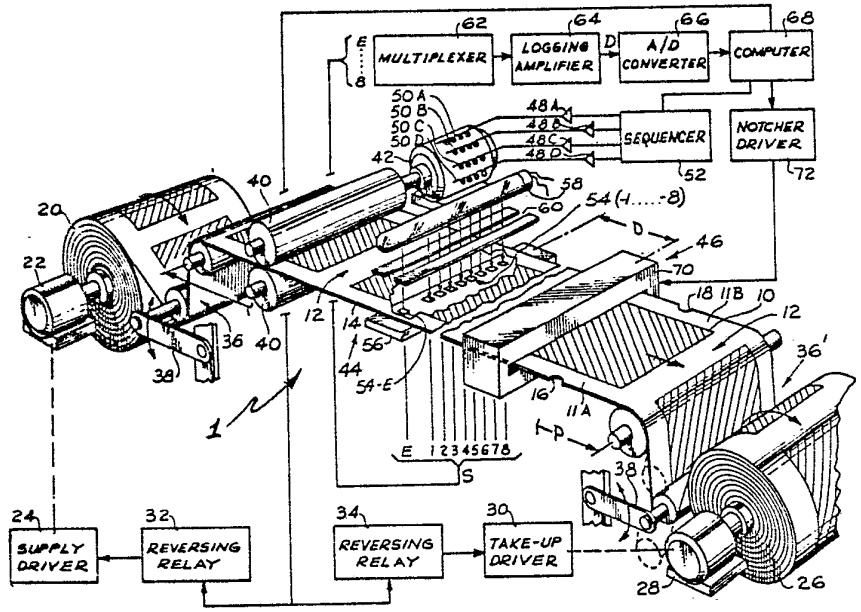
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(54) Title: LOCATING IMAGE AREAS ON A FILMSTRIP



(57) Abstract

A method and apparatus for locating and marking the position of a plurality of image areas on a filmstrip of photographic film. A filmstrip is that film which is normally received after having been exposed in a camera and which is joined end to end with other filmstrips onto a reel for processing by the printer. The filmstrip (14) is moved along in a predetermined path relative to a sensing station (44) and a marking station (46) where such stations are spaced at most a distance equivalent to the length of the filmstrip (14) for the purpose of identifying the location of the image areas (10). The sensing station (44) senses densities of the filmstrip (14) and accumulates signals representative of the densities of the individual image areas (10). Computer means (60) accumulate the density signals for substantially the length of the filmstrip (14) and are coupled with means (80) (84) (86) for generating image position signals indicating the position of selective images relative to their transverse boundaries. Means (72) (86) are actuated for marking the filmstrip (14) in response to the position signals to mark the positions of the located images on the filmstrip for the purpose of locating accurately an image frame at a printing gate, a notching station or a cutting station.

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LOCATING IMAGE AREAS ON A FILMSTRIP

Technical Field

The invention relates to an apparatus for locating and marking the position of a plurality of image frames on a strip of photographic film.

Background Art

It is known that in order for a photofinisher to avoid the manual positioning of image frames in a printer or a film cutter, some form of automatic frame location is necessary to position each image relative to the printing gate or cutting station. One obvious form of automatic frame location utilizes film which has been prenotched by the manufacturer at suitable reference points relative to each image frame. Other types of film, for example, 35mm size film, are unreeled from the cassette mounted in a camera and, when all exposures have been made are reeled back into the same cassette. Prenotching by the manufacturer is unsuitable in this case because the location of the image frame (or area) is not predictable in advance of each exposure. Instead, the position of each image area depends on such factors as the length of film leader initially wound onto the take up mechanism of the camera, and the regularity and distance of each image frame advance in the camera.

Our invention, therefore, is particularly useful when applied to the location of image frames of a filmstrip (not prenotched) and positioning of the located frames adjacent a marking station. The marking station can be a position for stopping the filmstrip whereby the image frame is accurately located at, e.g., a printing gate, a notching station or a cutting station. For purposes of this invention, the filmstrip is that film which

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is normally received after having been exposed in a camera and which is joined end to end with other filmstrips onto a reel for processing by the printer. The filmstrip usually contains image frames (or areas) of from 20 to 40 exposures in the case of 35mm film. The marking of the filmstrip usually by means of a notch thereafter becomes a reference for the photographic printing apparatus with regard to the position of the image frame on each filmstrip as well as the position of border areas between adjacent frames. The notches are useful, in automatically centering the image frame in a printing gate aperture of a photographic printer but more importantly the notch can also be used to direct a film cutter to cut the frame border areas and not cut through an image.

German Offenlegungsschrift 2,705,097 describes an apparatus for the automatic recognition of image areas located in a filmstrip. This automatic recognition of image areas occur between a pair of evaluation sites which are four frames apart. A sensing station is positioned to correspond with one site while the notching station corresponds with the other site. The light source opposite the sensing station emits light upon and through the film to a light receiver positioned adjacent the sensing station. Data which has been obtained with respect to the four frames is collected from the receiver and stored in a group of data collectors. The data in the collectors is organized and processed to estimate the location of the image edges based on a recognition of an observed portion of the filmstrip (a total data accumulation of e.g. four (4) image frames). The estimated image edges are then utilized to form a true image grid determined anew from each four frame section reflecting the actual image length found for the entire filmstrip. The location of the image edges are determined in the

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course of an analysis based on the following two steps:

1. In the first step the system considers the edge combination of the frame closest to the notching station. If both edges of the frame are identified, then they may be compared with a true image grid to check for similarity. If one edge is not clearly recognized, but the other is, then the "true" image grid may be positioned adjacent the recognized edge to determine the position of the unrecognized edge.
2. If step 1 fails because neither edge can be recognized in the area of density near the evaluation site, then the system undertakes a renewed examination of the data by utilizing neighboring images. Three methods are suggested.
   a. If the unrecognized area is located between two recognized image frames within the four frame portion of film, the "true" image grid is used to interpolate the position of frame edges.
   b. If the unrecognized area extends from the sensing station to a recognized frame in a notching station then the "true" image grid is used to estimate the position of the frame edges up to the sensing station, using one edge of the recognized frame as a reference.
   c. If the unrecognized area extends from the notching station to a recognized frame in the sensing station, the "true" image grid is used to estimate the position of

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frame edges up to the notching station, again using one edge of the recognized frame as a reference.

The teaching of German OLS 2,705,097 is limited therefore in that the decision regarding the location of image edges must be based on data gathered between the evaluation sites, which corresponds to only a portion of the filmstrip extending between the sensing station and a notching station. Thus, the apparatus is structurally limited to deciding image edge location based on data taken from a limited portion of the total filmstrip, said portion extending between the limited location of the sensing station and the notching station. Nowhere is it recognized or suggested in German OLS 2,705,097 that one could remove this limitation by an apparatus according to the present invention.

In the devices of the prior art when an uncertainty arises as to where the image edges of the frames are located (as in step 2 above) the problem may only be resolved if a recognized frame or frames is found in the four frame portion of the filmstrip between the sensing station and the notching station. If no edges are recognized in this stretch, then the film must be left unmarked. The resolution of the problem of marking the entire filmstrip is therefore limited by the structure of the apparatus, and particularly by the location of the sensing station relative to the marking station.

The inventors of the present apparatus are the first to recognize the desirability and the advantage of collecting and evaluating data without being physically restrained by the layout of the apparatus. More particularly, they are the first to recognize the advantage of collecting sufficient data such that final image edge determination is postponed until the frame in question is bracketed

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between two recognized frames or between a recognized frame and the end of the filmstrip. In other words the present invention is embodied in an apparatus which is not limited to evaluating data between a recognized frame and either a sensing station or the notching station.

Further it should be appreciated that known techniques for identifying and locating image frames on a filmstrip are most successful in situations where some error can be tolerated. For example, in placing a notch for centering an image frame in a printer, a print based on a wrongly placed notch, while adding to printer waste, can nontheless be detected and discarded at a subsequent inspection station. Then a correctly positioned print can be made. Such "makeovers" undeniably add to photofinisher costs; however, the error is correctable. Much worse are operations, such as film cutting, where tight tolerances must be achieved. Where a wrongly placed print notch can be corrected, a wrongly placed cutter notch leads to a irrevocable damaged customer film, for example, an image cut in half.

Therefore, the known prior art, including German OLS 2,705,097, are structually limited to estimating image edge location based on data taken from a small portion of the filmstrip between the sensing station and the notching station.

Disclosure of the Invention

In accordance with the invention, a filmstrip having a plurality of image areas is moved along in a predetermined path relative to a sensing station and a marking station where such stations are spaced a distance at most equivalent to the length of the filmstrip for the purpose of identifying the location of the image areas. The sensing station senses densities to generate a density signal along at least a portion or a whole of the filmstrip and accummulates said density signals

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for actuating marking means at the marking station.

The apparatus is further characterized by providing means for moving a filmstrip having at least one image area that has nonrecognizable border density adjacent a sensing station for accummulating said density signals until said image area as defined above is bracketed either a) between two identified frames having recognized border densities or b) between such an identified frame and one end of the filmstrip. The apparatus continues such analysis for conditions (a) and (b) above by accumulating density signals for the entire filmstrip if necessary.

In a further embodiment of the invention, the filmstrip is advanced in a first direction along a predetermined path and beyond a marking station which is inactivated at the time. As the filmstrip is being advanced the sensing station senses densities to generate density signals to meet the conditions (a) and (b) to achieve the required data for locating nonrecognizable border density. The filmstrip is then reversed to position the leading identified border density relative to the marking station where the image areas are marked to indicate their location on the filmstrip. This reversing feature permits the sensing station to be located to within one image area distance from the marking station.

In another embodiment of the invention, the means for sensing densities to generate density signals along a portion of the filmstrip is facilitated by forming the filmstrip into a variable-sized loop between the sensing station and the marking station. The size of the loop is varied to accommodate the length of the portion of the filmstrip necessary to meet the conditions for locating nonrecognizable border density.

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Brief Description of the Drawings

A preferred embodiment of the invention will be described with reference to the figures, wherein:

Figure 1 is a schematic view of a preferred embodiment of the invention;

Figure 2 is a diagram illustrating the logical procedure used to generate a table of densities useful in implementing the invention;

Figures 3A, B and C are illustrations of several filmstrips, showing different arrangements of image and border densities and the density tables generated in connection with each arrangement in order to recognize an image area; and

Figures 4A, B and C are schematic diagrams of several embodiments of the invention.

Best Mode For Carrying Out This Invention

Because photographic film handling apparatus and film notchers in general are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with apparatus and method in accordance with the present invention. Elements not specifically shown or described may take various forms well known to those skilled in the art.

Figures 4A and B illustrate schematically embodiments of the invention in which means are provided for placing a notching station 46 a sufficient distance D from a scanning station 44 to accommodate the maximum length of a customer order in the filmstrip 14 of the film size being scanned. Figure 4A depicts the extension of the physical linear separation between the scanning and notching stations 44 and 46 until the distance D_1 equals the length of the greatest customer order (e.g., 36-40 frames). Then all data can be collected and analyzed by a computer before the first frame in the order arrives at the notching

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station 46. Figure 4B shows apparatus having the filmstrip 14 pass through a loop L of controlled length to achieve the needed separation D_2 between the stations. A loop controller 38' responds to the computer to maintain a distance D_2 between stations appropriate for current scanning conditions. The distance D_2 may thus vary, due to the position of the controller from a few frames to the full length of the filmstrip. The filmstrip 14 is allowed to form a loop between the two stations 44 and 46 such that the notching station 46 may be actuated independently of the sensing operation, e.g., the loop may be of variable size. In this case a separate stepping motor may be required to step the filmstrip 14 through the notching station 46 since tension in the filmstrip 14 will be released as the strip passes into the loop.

Figure 4C schematically illustrates another embodiment of the invention in which data may be gathered from portions of the filmstrip, including lengths ranging from a few frames to the full length of the customer order. This facility provides for the filmstrip 14 to be advanced in a first direction along a predetermined path and beyond a notching station 46 which is inactivated at the time. As the filmstrip 14 is being advanced, the sensing station 44 senses density signals to accumulate the required data for locating nonrecognizable border density. The filmstrip 14 is then reversed along the film path (P) until the first discerned image area (e.g., frame G in Figure 3B) is again adjacent the notching station 46. Then the notcher is enabled and places a notch 16 adjacent the frame 10. (See Figure 1). The distance D_3 is therefore constant - and preferably a few frames in length - but a full filmstrip 14 can be handled within that distance.

Figure 1 illustrates frame locating apparatus 1 in accordance with the invention for

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sensing photographic density in image areas or frames 10 and frame borders 12 on a processed strip 14 of photographic film and for placing notches 16 and 18 on the edge borders 11 of the film pursuant to analysis of the densities. The filmstrip 14 is typically composed of a number of discrete filmstrips that are attached together, e.g., by splices. Each discrete filmstrip corresponds to a single customer order or strip that is usually exposed in a single camera. Throughout the description, frame or image area will be used interchangeably, depending on whether the emphasis is on definition of image shape (frame) or the densities in the image (image area). A frame border is the non-image area between intervening frames while an edge border is the non-image area between a frame and the edge of the filmstrip. The notches are placed in the edge border 11 for use in later stages of the photofinishing operation. For example, the notch 16 (also referred to as a print notch) is placed in one edge border 11A of the film for later causing a photographic printer (not shown) to center the image area 10 in the aperture of the printer. The notch 18 (also referred to as the cut notch) is placed in the opposite edge border 11B of the filmstrip 14 to subsequently direct a film cutter (not shown) to cut precisely on the frame border 12 without damaging an adjacent frame 10. Typically there would be a print notch adjacent each frame deemed suitable for printing and a cut notch intermittently applied adjacent every third or fourth frame for cutting precisely in the frame border 12.

The filmstrip 14 is unwound from a supply reel 20 operated by a DC supply motor 22 that is driven by a supply motor driver 24. After exiting the frame locating apparatus 1 of Figure 1, the filmstrip 14 is wound upon a take-up reel

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26 operated by a DC take-up motor 28 that is driven by a take-up motor driver 30. Each driver 24 and 30 is disposed to reverse the polarity of the driver current, and thereby reverse the rotary motion of the DC motors 22 and 28, by means of reversing relays 32 and 34, respectively. The filmstrip 14 - upon leaving the supply reel 20 - is directed into a slack loop configuration 36 before reaching the frame locating apparatus 1. Similarly, film leaving the apparatus 1 also passes through a slack loop 36' before winding upon the take-up reel 26. The size of each loop is centered at a predetermined length by conventional loop controllers 38, which are connected to microswitches that trigger whenever the loop deviates from the predetermined length by a given amount.

The frame locating apparatus 1 has a separate drive mechanism comprising a set of film feed rollers 40 connected to a stepping motor 42 for incrementally advancing the filmstrip 14 through a film path including a scanning station 44 and a notching station 46. The stepping motor 42 is of conventional design; for example, a set of motor drivers 48A to D are respectively connected to a set of drive coils 50A-D surrounding the armature of the motor 42. The coils 50 are driven in appropriate sequence as each driver 48 is turned on and off in a predetermined order by the sequencer 52. By controlling the logic in the sequencer 52, rotary motion in opposing directions is provided by the stepping motor 42. In this manner, the normal operation of the motor 42 consists of discrete angular motions of essentially uniform magnitude, thereby imparting uniform incremental advances in either direction (as selected) to the filmstrip 14.

The scanning station 44 includes an array of photosensors 54 mounted on a support 56. Light from a light source 58 is emitted upon a mask having

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a narrow slit 60 disposed transversely of the filmstrip 14 passing underneath. The slit 60 restricts light impinging upon the filmstrip 14 to a narrow, stationary slit-like ribbon extending across the width of the film. When the film is being moved by the film feed rollers 40, the effect is to have the narrow band of light scan the lengthwise dimension of the filmstrip 14. Light transmitting through the film is modulated by photographic density, and the modulated light strikes the photosensors 54. Although a variety of conventional photosensors are useful, a preferred embodiment of the invention employs photodiodes. Other photosensors, such as phototransistors, may be substituted. It will be noted that nine photosensors are illustrated in Figure 1. Eight photosensors 54-1 to 54-8, collect light transmitted through frames 10 and their intervening frame borders 12. One photosensor 54-E collects light transmitted through the edge border area 11 lying between an image frame 10 and the longitudinal edge of the filmstrip 14. If the filmstrip 14 contains edge perforations, the photosensor 54-E is disposed to intermittently overlie the perforations as the film is advanced.

The analog transmission signals S from the photosensors 54 are connected to a multiplexer 62, from which the signals are passed individually through a logging amplifier 64 for conversion into analog density signals D. Each analog density signal corresponding to the analog transmission signals from photosensors 54 is converted into a digital signal by the converter 66. In digital format, the density signals are suitable for processing in a computer 68. Any conventional microcomputer or minicomputer including sufficient memory to store the required data is a suitable computer for this application. The logical process of the computation

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is illustrated in Figure 2 and will be described later in connection with the operation of the image locating apparatus. Still referring to Figure 1, the computer 68 issues control commands to the supply and take-up drivers 24 and 30, and the sequencer 52, for driving the associated DC motors 22 and 28, and the stepping motor 42, in forward or reverse directions. A notcher 70, located at the notching station 46, is driven by a notcher driver 72, also under control of the computer 68. The notcher 70 is of conventional design, for example, a punch-die set either driven directly from a solenoid or from a solenoid-actuated cam.

In operation, the supply driver 24 initially energizes the supply motor 22 and the supply loop controller 38 to pay out a length of filmstrip 14 for threading through the apparatus. Once threaded, the operating supply motor 22 continuously advances the filmstrip, thereby releasing tension on the filmstrip 14 so that the stepping motor 42, now energized, may increment the filmstrip 14 along the film path P. The stepping motor 42 is incremented by sequential instructions from the sequencer 52. The sequence of instructions energizes the drivers 48A to D in proper sequence, and therefore the coils 50A to D, so that the feed rollers 40 angularly increment a uniform distance for each instruction. This uniform angular rotation incrementally advances the filmstrip 14 a uniform and predetermined distance, for example, 0.020 inch per increment. The frequency of sequencer instructions is centrally controlled by the computer 68 in concurrence with other operations about to be described.

As the filmstrip 14 passes along the film path P, it travels adjacent the scanning station 44 and through the slit-like ribbon of

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light emanating through the slit 60 from the light source 58. Since the photosensors 54 are positioned to receive this ribbon of light absent the intervening filmstrip 14, they will also record any variation in light caused by transmission through the advancing film. In this manner film densities modulate the analog transmission signal S provided by the group of photosensors 54. As described earlier, eight of the photosensors 54 are lined up relative the filmstrip 14 so as to sense light transmission from both image areas 10 and intervening frame border areas 12 as the film advances adjacent the scanning station 44. One photosensor 54-E continuously senses edge border transmissions, unless interrupted by perforations. The individual transmission signals - now referred to as S_1 to S_8 and S_E - are input on nine separate channels to the multiplexer 62.

The multiplexer 62 sequentially feeds each signal S_1 to S_8 and S_E to the logging amplifier 64, where the transmission signals are transformed into analog density signals D_1 to D_8 and D_E. Each analog density signal is then passed through an analog to digital converter 66 and stored for subsequent processing by the computer 68. The A/D converter 66 and the stepping motor sequencer 52 are actuated at corrresponding frequencies with the result that density data is sampled at a rate corresponding to each increment of the filmstrip 14. Therefore, eight separate image spots and an edge border spot are examined across the width of the film for each incremental movement. As will be seen, each density spot is individually processed and becomes a component in a large array of densities corresponding to each image area 10 and intervening frame border area 12.

Referring now to Figure 2, the intent of the processing is to set up a table or map 80 in

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the computer 68 including a density indicator from each potential image spot and the frame border on the film. The table is arranged so that each column 81 represents density indicators from an increment of film advance, e.g., 0.020 inch. Each row 82 represents intermittent sampling of densities in a longitudinal direction of film advance and at a particular width-wise dimension. In this manner an entire order of customer film may be "mapped" before determining where to place the notch 16 or 18.

Returning now to the density data existing prior to the generation of the table 80, Figure 2 is illustrative of the logical procedure that is employed to process this data. Digital density data from one increment of advance enters a density comparator 83, where each density is compared to a minimum density (D_{min}). The minimum density (D_{min}) used by the comparator 83 is customized for each strip of film. The lowest density seen in the strip up to the scanning station 44 is taken to be the minimum density. This means that early in the scanning of a strip, as illustrated by Figure 3C, the photosensors will be responding to fog densities where the strip has been fully exposed across its entire width. The "minimum" density is therefore initially set at a high level. With each increment of the filmstrip 14 the previous D_{min} is updated if the new densities are lower than the previous D_{min}. Thus as the scanner proceeds into the filmstrip 14, the D_{min} drops further and further until it assumes an average value corresponding to the minimum densities of a given customer's strip of film. This facility is provided by the density update module 87.

Where potential image density (signals D_1 to D_8) exceeds D_{min}, a corresponding bit in a code word provided by a code word generator 84 is

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set to 1; if D_{min} exceeds or equals the input density, the bit is set to 0. This procedure is separately repeated for each of the digital density signals which are derived from the transmissions sensed by photosensors 54-1 to 54-8 such that an 8 bit code word is generated in the code word generator 84 for the given increment of film advance. In practice, it has been found useful to compare each digital density signal to a D_{min} plus a threshold density 85, which may be varied by the operator. The final result for a well-exposed length of filmstrip is illustrated by Figure 3A. There it is seen that zeros correspond to frame border areas 12 and ones correspond to image areas 10 in the filmstrip 14.

Taking first the correctly-exposed filmstrip of Figure 3A, the table corresponding to this strip is analyzed by a processing unit 86 (Figure 2) in the computer 68. Conventional logic routines, such as developed in the course of conventional programming of ordinary decision sequences, are employed to detect the pattern of ones and zeros in the table 80 and to compare this pattern with an expected or standard pattern for a properly exposed filmstrip of the presently scanned format (e.g., 135 size film). Since the standard will coincide with the observed pattern of densities in this particular case, the computer 68 instructs the notcher driver 72 to place a notch in filmstrip 14 at the appropriate moment. Since the timing of the stepping motor 42, and thereby the advance of the filmstrip 14 is controlled by the computer 68 (and all distances on the apparatus are known) the computer 68 is aware of the position of the film at any moment relative to the scanning and notching stations 44 and 46. Thus when the center of an image area is present within the notcher 70, the computer instructs the notcher driver 72 to place a notch 16 on the film, (see Figure 3A.)

Figure 3B illustrates a situation where in

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the course of scanning a customer's order, the image densities begin to fall below D_{min} for several consecutive frames. The table of density values begins to look erratic and rather uninformative (based on the logic routines). More particularly, the border densities of certain frames become nonrecognizable and a decision regarding recognizable image borders cannot be made any longer by reference to a single frame. The succeeding adjacent frames in both directions must therefore be then considered. The computer continues to step the film past the photosensors 54, collecting data regarding additional images, e.g., areas A through G. In this example, areas A through F provide inconclusive data regarding image frame location but area G yields a correct or standard format, as illustrated in Figure 3A. At this point the nonrecognizable border densities of, e.g., frames A through F are bracketed between two recognized or validated frames A' and G. The processing unit 86, based on the position of valid frames A' and G, recognizes the borders depicted by arrows FL as definite frame lines based upon a standard or expected increment determined from known frames A' and G. The processing unit 86 also estimates the phantom lines depicted by arrows FL' as frame lines, using the standard or expected increment. Then the positions of print notches 16 and cut notches 18 are finalized with regard to position. So it is seen that from the image density indicated by solid lines, the frame outline depicted in phantom is in effect "constructed" by the computer.

Figure 3C illustrates another situation, where in the course of scanning into the beginning of a customer filmstrip 14, border densities are nonrecognizable until, e.g., a recognized or validated frame E is reached. In this case, image borders are not finally determined until the

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nonrecognizable border densities are bracketed between a recognized frame, e.g., frame E, and one end of customer filmstrip 14. In effect, the maximum amount of density data is gathered before a decision on image edges is made. As in the case of Figure 3B, the processing unit 86 then verifies frame lines FL and estimates frame lines FL', based on a comparison with a standard or expected image frame increment. A converse situation will exist at the other end of the filmstrip 14, where the nonrecognizable borders will not be estimated until they are bracketed between another recognized or valid frame and the other end of the filmstrip.

The filmstrip illustrated by Figure 3C is useful in discussing several other features of the frame locating apparatus in accordance with the invention. A splice S is seen at the beginning of the filmstrip 14. The densities observed when the splice S passes over the photosensors 54 are found to be substantially higher than any photographic densities observed in the film. Consequently the comparator 83 also tests each density against a maximum photographic density. When this density is exceeded during an increment of advance, a bit is set in the code word generator 84 to indicate that a splice is being observed.

Figure 3C also illustrates a situation where a valid frame is not observed until well into the order (e.g., frame E). Since D_{min} has been floating in the meantime, perhaps without relationship to true minimum density in the filmstrip, some of the entries in the memory table 80 may be based on wrongly estimated D_{min}. To alleviate this problem, an average density generator 88 averages all the digital densities from each of a plurality of spots spanning the width of the filmstrip for each increment of film advance. The average is

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also stored as part of the code word by the generator 84. Once an image frame is recognized, based on the continuously updated D_{min}, the computer 68 has the ability to go back and re-examine prior average density for each increment of film advance. Where the average density exceeds the updated, and presumably more accurate, D_{min} the table 80 is modified to indicate the presence of image density; where the average density is below the updated D_{min}, a frame border 12 is indicated. In this way, the average density affords the capability of reconstructing the table, particularly where the D_{min} used in the comparator 83 is found to be initially inaccurate.

Referring now to Figure 1, the notching station 46 is positioned a distance D from the scanning station 44. This spacing may vary but in conventional notching equipment it is normally no more than three or four image frames in length. However, scanning situations will arise, as illustrated in Figures 3B and 3C, where the density quality of the filmstrip deteriorates but it is still possible to precisely recognize an image area with the level of tolerance necessary for automatic film cutting. For example, the strip in Figure 3B was advanced seven frames (A to G) until the valid frame G was recognized and the prior frame positions were reconstructed. However, the initial frames, e.g., A, B and C, would already be beyond the capability of a prior art notching station. Furthermore, in some customer orders it is necessary to scan the entire order, e.g., as many as 36 frames in 135 film, in order to gather enough information to locate the image areas and place the notches.

In accordance with Figure 4C, an apparatus is provided for scanning the filmstrip (14) and then reversing the film movement to back up the filmstrip (14) prior to marking. Referring to

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Figure 1, the reversing movement is controlled by the computer 68, which coordinates the motion of DC motors 22 and 28 and the stepping motor 42. With regard to the DC motors, the reversing relays 32 and 34 are actuated by computer instruction and reverse the polarity of the current with respect to the coils in the motors 22 and 28. This causes the supply reel 20 to take up film and the take-up reel 26 to pay out film. Precise incremental motion is controlled by instructing the sequencer 52 to reverse the actuation of the drivers 48A to 48D. The reverse sequence causes the film feed rollers 40 to step in an opposite angular direction, drawing the filmstrip 14 back through the notcher 70 and under the scanning slit 60 (scan data not being collected at this time). When the initial discerned frame is adjacent the notcher, the computer 68 instructs the notcher driver 72 to drive the notcher 70 and place a notch on the edge of the filmstrip 14. The stepping motor 42 then advances the film in a forward direction for a second time, but this time notching the film in accordance with the retained data in the computer 68.

It will be noted from Figure 1 that two notches are potentially placed in the filmstrip 14. The notch 16 is placed at the edge and centered relative to each image frame 10 such that a printer may key on the notch and automatically center the image frame 10 for printing. The notch 18 is a cut notch and is placed wherever it is desired that a cutter sever the filmstrip 14. For ease of mechanical construction the two notches 16 and 18 are opposite each other. Cut notch 18 is placed a predetermined number of increments from the center of the frame border area 12. The film cutter is then set up to chop the same number of increments from the sensed notch 18, i.e., in the frame

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border 12.

Although both notches 16 and 18 are desirably placed with high reliability, the margin for error in placement of the cut notch 18 is much less than for the print notch 16. Otherwise the film cutter will too frequently sever a portion of the image area 10. It was found that the ability to always bracket nonrecognizable border density between either a) two recognized frames or b) one recognized frame and the end of the filmstrip, before placing any notches assures the high reliability necessary for placement of the cut notch 18. Figure 3B illustrates a situation where the cut notch 18 is not placed at its usual position because of overlapped film frames C and D. From stored information regarding nominal frame length, the computer 68 recognizes that frame line FL at the beginning of frame C is too close to the frame line FL at the end of frame D for there to be a frame border in between. The center of each overlapped frame is estimated, and print notches 16 are provided. However, the cut notch 18, which would normally be adjacent frame C in this example, is omitted and the computer 68 drops the notch signal back to frame B so that a cut notch 18 is subsequently placed adjacent frame B by the notcher 70. Alternatively, the notch can be placed over the next complete frame E. If the computer 68 finds difficulty in locating a suitable position for the cut notch 18, it is programmed to inhibit the notch altogether, thereby causing the filmstrip to be set aside for manual cutting.

While an array of photosensors 54 have been described in connection with the scanning station 44, other types of scanners may be used. For example, a revolving optomechanical scanning drum may use a scanning hole to sweep across the filmstrip to generate the analog transmission signal S. After one

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line of the filmstrip has been scanned, the stepping motor 42 advances the film another increment to bring the next line on the strip into the scanning position. After each advance, the signal S is generated and passed to the A/D converter 66 for further processing by the computer 68.

If a perforated format, such as 135 film, is being processed by this apparatus, the sensor 54-E may be positioned overlying the path of the moving perforations. The number of perforations can be counted up during forward advance and counted down during reverse advance to assure that the filmstrip 14 is returned to the exact place at which notching was suspended.

The sensor 54-E may further be used to separate fog portions of filmstrip 14 from portions having very dense image areas. In such dense image areas, the border density therebetween may be fogged by extreme over exposure of the image. Since the position of the image areas may therefore be unrecognizable, it is desirable to prevent the cut notch from being made. But if the edge sensor 54-E provides a signal representative of heavy density, this portion of the filmstrip is recognized to be fogged overall and a cut notch may be made.

Size 135 film has been mentioned for illustration only. The apparatus according to the invention is useful with any kind of processed film that does not possess its own frame locating marks (as does for example, size 110 and 126 film). The apparatus is therefore of use with all types of roll film and, particularly, any film that depends on operator and camera variables for image placement. Furthermore, a notch is only exemplary of the type of mark that can be placed on the film by the working station. Optically readable or magnetic marks are examples of other frame location marks that can be used. The marking station may also consist of

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a locating position where at each frame is positioned with precision with regard, e.g., to the printing gate of a photographic printer.

Furthermore, the apparatus according to this invention may be combined with density-responsive equipment for evaluating the quality of the image relative to subsequent operations, such as printing. If there is no discernible image, i.e., blank or fogged, or if the image densities are beyond certain density thresholds indicative of minimally acceptable results, i.e., unprintable negatives, then the computer 68 may be instructed not to place a notch opposite such a frame. This image frame will then be ignored by the printer. Alternatively, a specially located notch may be placed on the film-strip which indicates to the printer - by its location, e.g., relative other notches - that the negative is to be skipped.

While the illustrative filmstrip 14 notched in the disclosed embodiments of the invention is a negative filmstrip from which prints are made, e.g., by keying on the print notch 16, the method and apparatus here disclosed apply with equal force to notching of reversal films. In such case, the print notch 16 is omitted but the cut notch 18 - now placed adjacent each frame 10 - is positioned in accordance with the disclosed embodiments. The cut notch 18 is then keyed upon by apparatus for automatically severing each frame and loading the frames into slide mounts.

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Claims

1. Apparatus for marking a photographic film to indicate the location of individual image areas (10) have recognizable densities and having transverse borders some of which may not be readily recognizable, said apparatus comprising drive means (22) (28) for moving a filmstrip (14) along a predetermined path adjacent to a marking station (46), sensing means (44) located along the predetermined path for sensing densities of the filmstrip (14) accumulating signals representative of the densities of the individual image areas (10), marking station (46) spaced from said sensing means (44), at most equivalent to the length of the filmstrip (14), computer means (68) for accumulating said density signals for substantially the length of the filmstrip (14), means (80) (84) (86) coupled with the computer means (68) for generating image position signals indicative of the position of selective images relative to their transverse boundaries, and actuating means (72) (86) for marking the filmstrip in response to said image position signals to mark the positions of located images on the filmstrip (14).

2. Apparatus as claimed in claim 1 wherein said photographic film includes a plurality of spliced filmstrips (14) each having a plurality of individual image areas (10).

3. Apparatus as claimed in claims 1 or 2 having means (38') positioned between said marking station (46) and sensing means (44) for forming a loop (L) in each filmstrip (14) to include the sensed portion of the filmstrip (14).

4. Apparatus as claimed in any of the claims 1 to 3 having reversible drive means for selectively advancing a filmstrip (14) along a

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predetermined path past a marking station (46) in either of first or second opposite directions:

means (44) for sensing densities of the film as the filmstrip (14) is advanced in the first direction beyond the marking station (46);

means (32, 34) for reversing the drive means to advance the filmstrip (14) in the second direction to position the leading recognizable border density relative to the marking station (46);

means (32, 34) for readvancing the filmstrip (14) in the first direction;

means (70) at the marking station for marking the filmstrip.

5. Apparatus as claimed in claim 4 wherein the marking station (46) is inactivated when the filmstrip 14 is advanced.

6. Apparatus as claimed in any of the claims 1 to 5 in which said sensing means (44) comprises a plurality of photosensors (E-8) spaced transversely across the width of the advancing filmstrip (14) to sense the image and border densities of the advancing film.

7. Apparatus as claimed in claim 6 in which said scanning means detects recognizable densities in incremental portions of the filmstrip and establishes signals representative of the densities in each incremental portion of the filmstrip.

8. A method for marking the location of image areas on a strip of processed photographic filmstrip having at least one image area that has a nonrecognizable border density comprising the steps of:

advancing the filmstrip along a film path;

sensing the density of incremental portions of substantially the full length of the filmstrip and providing signals

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indicative of the incremental densities;

accumulating the density signals from successive incremental portions and determining the location of a plurality of image areas from the accumulated signals; and

marking the location of the image areas as the filmstrip is advanced along the film path.

9. A method as claimed in claim 8 wherein the step of accumulating density signals includes accumulating said density signals until said image area is bracketed either (a) between two identified frames having recognized border densities or (b) between such an identified frame and one end of the filmstrip.

10. A method as claimed in claims 8 or 9. wherein the movement of the filmstrip is reversed to back up the strip after accumulating the density signals; and advancing the filmstrip again along the film path marking the location of the image areas as the film is advanced along the film path.

11. A method as claimed in claim 10 wherein the marking station is inactivated when the filmstrip is advanced in the first direction to a point beyond the marking station.

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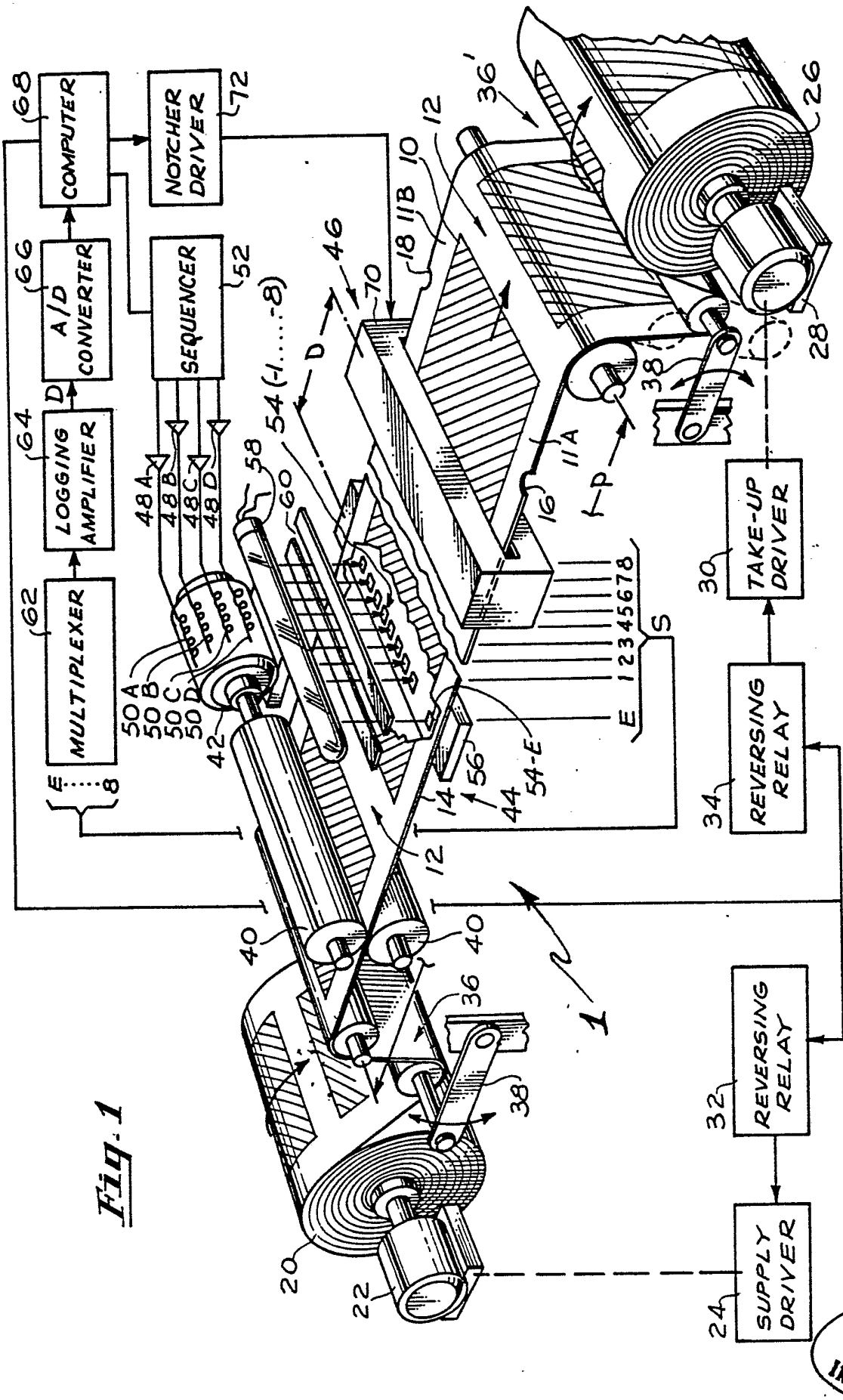


Fig. 1

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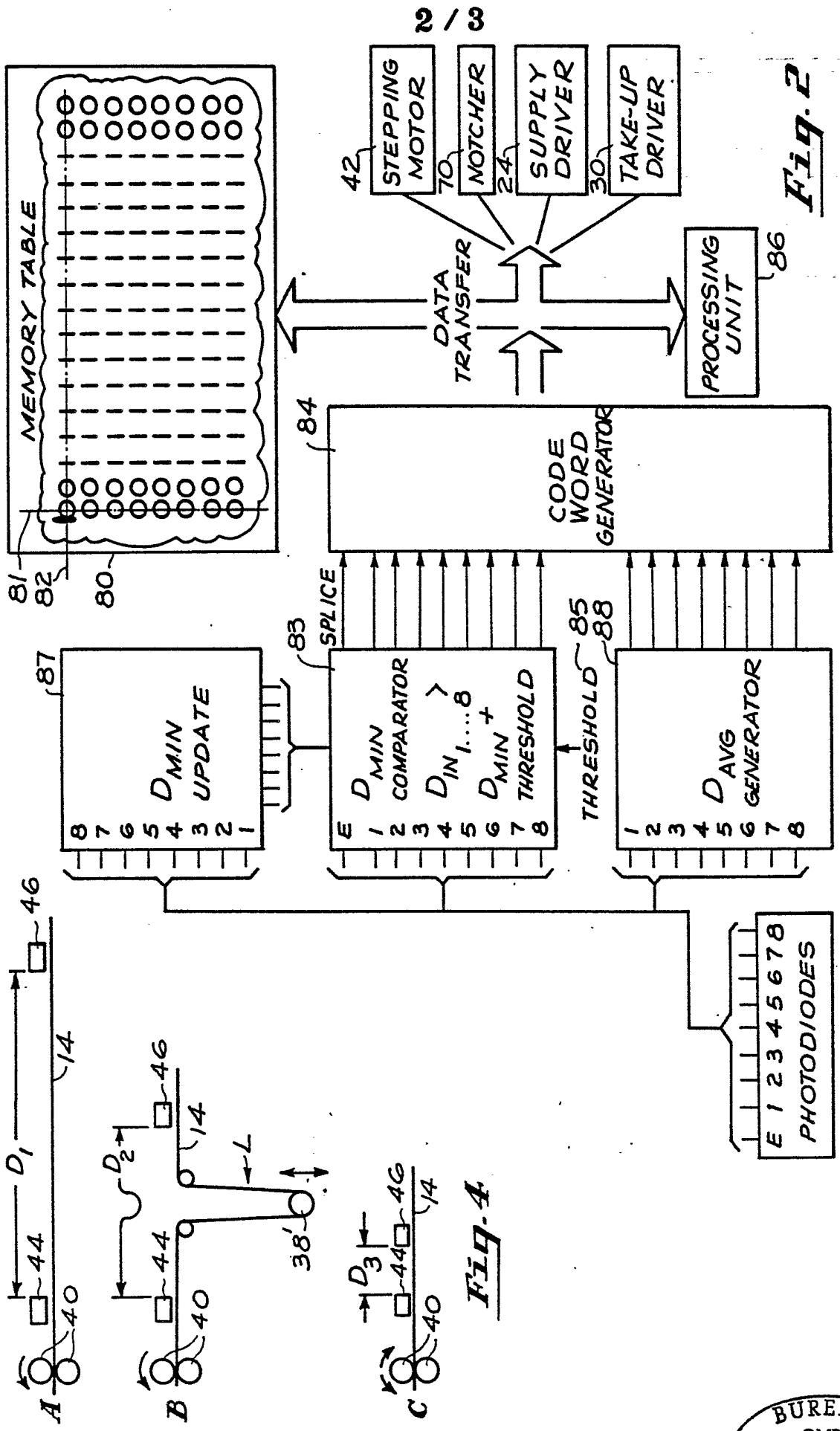
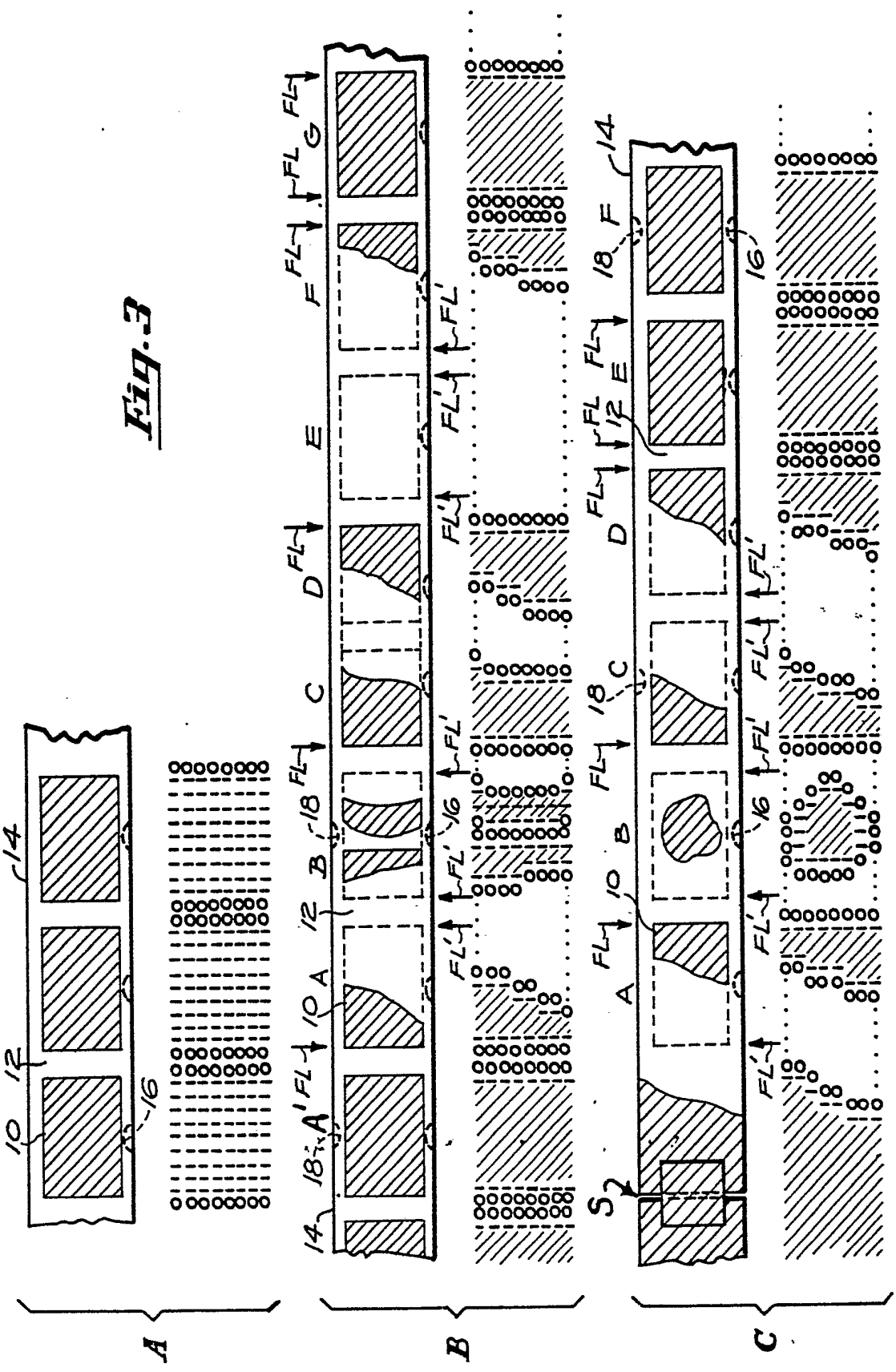


Fig. 2

Fig. 4

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Fig. 3



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INTERNATIONAL SEARCH REPORT

International Application No PCT/US79/00711

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL. G01N 21/30; G03B 27/52
U.S. CL. 355/41; 250/559

WO 80/00613

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	355/28,29,41,68,77,112 250/559,561,570,560 83/208,209,364,365,371

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	DE, A, 2705007, Published 10 August 1978,	1-11
X,E	US, A, 4167678, Published 11 September 1979,	1-11
X	US, A, 3699349, Published 17 October 1972	3
A	US, A, 3435243, Published 25 March 1969,	1,8
A	US, A, 3721495, Published 20 March 1973,	1,8
A	US, A, 3867030, Published 18 February 1975,	1,8
A	US, A, 3402651, Published 24 September 1968,	1,8

* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
17 December 1979	17 JAN 1980
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	J. Brady