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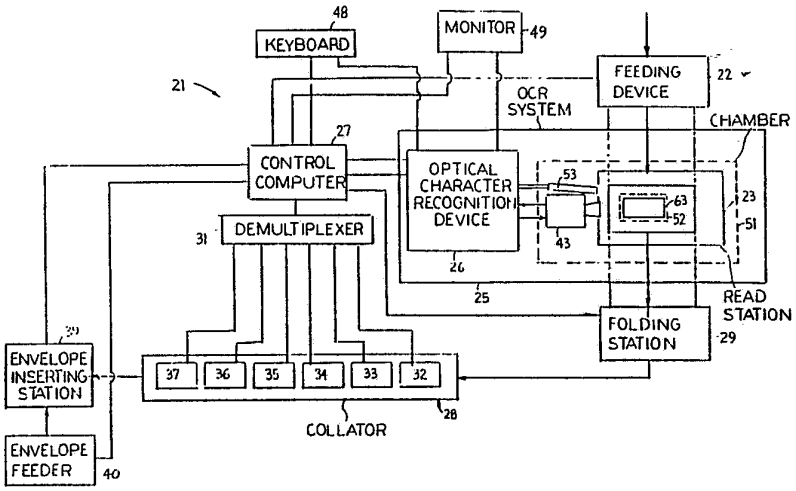

(57) Abstract

An automatic collating apparatus is provided whereby a primary document and selected secondary documents are collated and inserted into a mailing envelope (39). Preferably, the mailing envelope is preprinted with the name and address of the recipient as shown on the primary document. Each primary document bears a recipient name and mailing address and also a secondary document selecting character code. In operation, the character code on each primary document is imaged and interpreted by an optical character recognition means (26), and control signals are then generated which are used to direct a control computer (27) in regulating respective on or off operations for each one of a series of collating stations (28) which can individually combine a different respective secondary document with a primary document passing thereby. The collating apparatus (28) can optionally be equipped with (a) optical character recognition means (26) to verify correct association of a particular primary document with a particular secondary document, and (b) optical character recognition means (26) to sort envelopes.

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SELECTIVE COLLATING AND INSERTING APPARATUS

Field of the Invention

This invention relates to an improved automatic document selective collation and envelope inserting apparatus utilizing optical character recognition means.

Background of the Invention

Various automatic document selective collation and envelope inserting apparatus are known to the prior art. Such an apparatuses can include an optical sensor subassembly that detects a collation code which is imprinted in a name and address field appearing on each of a plurality of serially advanced primary documents, such as, for example, a form letter which has been previously imprinted with the name, address and collation code of an intended recipient.

The collation code, which in the prior art is typically in the form of a mark sense code or a bar code, incorporates machine readable instructions. After optical sensor detection and conversion into electric signals, those instructions direct the selective collation subassembly to associate preselected secondary documents within a preset plurality of secondary documents stored in the selective collator subassembly with each individual primary document. Each so resulting document bundle is then inserted into a mailing envelope that has a window therein through which the name and address of the recipient as shown in the field of the primary document are readable. Usually such an apparatus is also equipped with a cooperating document folding subassembly that is located, for example, before the collation subassembly and after a primary document reading station.

Recipients of mail which has been so processed often object to the presence of a collation code in association with their name and address. In fact, recipients of such mail are believed to often regard the presence of a collation code in association with their name and address when seen through an envelope window as evidence that the contents of the envelope constitute mass mailing advertising material which can be discarded without review. From the standpoint of, for example, financial institutions which make periodic reports to customers, stockholders and employees, this is an undesirable result.

In addition, the use of windowed envelopes is presently commonplace for the mailing of financial statements and the like. Confidential information, such as the account number, balance, etc., may be unwittingly revealed by minor displacement of the document set within the envelope. That information would be more secure if mailed in a non-windowed envelope.

There is a need for an automatic document selective collation and envelope inserting apparatus which does not require the use of a (non-human) machine readable collation code in association with the name and address of the recipient. The present invention is directed to this need.

Brief Summary of the Invention

This invention provides an improved automatic document selective collation and envelope inserting apparatus wherein optical character recognition (OCR) means is employed to image and interpret coded collation information pre-imprinted in the name and address field appearing on each one of a plurality of continuously moving

primary documents being sequentially processed by the apparatus.

The OCR subassembly means includes video camera means, strobe lighting means, interpreting and identification means, synchronizing means and interconnecting means. This subassembly is functionally associated with one station of a multistation continuously operating selective collation and envelope inserting apparatus and provides control signals for the apparatus control computer. Advantageously, the present invention employs a relatively simple OCR means such as is already known to the prior art to read and decode an alphanumeric character code or the like containing collating instructions and, optionally, other instructions.

Advantageously, such functional association of the OCR subassembly is achieved without elaborate restructuring or modifying of prior art selective collation apparatus. Indeed, the apparatus of this invention can employ a computer controller that is responsive to command signals that are infact thereinto from an OCR device as taught herein. Depending upon the structure and the programming, this computer controller may sometimes be the same computer controller that was previously used in the prior art and that was responsive to the prior art mark sense or bar code type codes.

One advantage of the present invention is that no bar code or mark sense code is required to be in association with the recipient name and address in the address field of each primary document. Instead, an alphanumeric character code can be used in association with recipient name and address information. Such an alphanumeric code is believed to satisfy the desire of recipients for their mail to be free from an associated code that is not human readable.

In a preferred embodiment, the OCR subassembly with its incorporated OCR device that is employed in the present invention is used in functional combination with a selective collating and inserting subassembly apparatus which collates selected secondary documents of a series with each primary document using only a code comprised of human readable characters, such as one comprised of alphanumeric characters, which code is imprinted together with the name and address of the recipient in a field area appearing on each respective primary document.

The selective collation and envelope inserting apparatus of this invention employs a primary document read station that is located before the collating subassembly apparatus. At the read station, the character code is read, decoded, and input as an instruction or command signal by the OCR subassembly into the apparatus control computer (or computer controller). The decoded information or command signal constitutes secondary document selective collation instructions for the individual primary document on which such character code appears.

Another advantage of the present invention is that a human readable character code that is also readable by the OCR subassembly is employable. Such a code is believed to be generally preferred by users of selective collation and envelope inserting apparatus. The reason is that such a character code provides for greater ease in achieving accuracy verification by a human collator operator. Thus, in the case of a bar code, for example, a human operator is never absolutely certain by mere visual inspection of a particular bar code that it is correct for a particular document.

The present invention can be practiced with windowed or windowless envelopes. When practiced with

windowless envelopes that are imprinted with name, address and character code, envelope imprinting can be variously accomplished. It is presently preferred, however, to print preliminarily and simultaneously the recipient name, address and code information on each of a primary document and a windowless envelope. Thus, preliminary imprinting is accomplished simultaneously on each of the primary document and the envelope. The resulting order of arrangement of each primary document in a primary document stack or roll then exactly matches the order of arrangement of each envelope in the envelope stack. The respective ordered stacks are then each loaded into their respective food stations in the selective collation and envelope inserting apparatus.

After envelope inserting, the resulting envelopes are preferably automatically sealed. Optionally but preferably, the resulting stuffed and sealed envelopes are also sorted by the collation apparatus at a subsequent sort station according to sorting instructions. The sorting instructions (for example, a zip code or an equivalent postal code if a foreign mailing or address system is involved) are conveniently incorporated into the character code. Such an envelope sorting feature is conveniently accomplished by associating a second video camera means with the OCR means and locating the second camera means at the sort station.

Optionally but preferably, the apparatus of this invention is further adapted to perform a check to make sure that the primary document of each document bundle corresponds with the preimprinted envelope into which it is being inserted as regards recipient name and address information. This checking is accomplished using a comparison system that functions using an OCR means and the

character code associated with the recipient name and address. Such an OCR based comparison system can employ a video camera means that is located at appropriate check station means. If any difference is observed between the character code of the primary document of each document bundle and the character code of the preprinted envelope into which that document bundles being inserted, then programmed corrective action is taken.

In the present apparatus, OCR means is preferably employed which is relatively simple, requires a relatively short time for image making, processing and conversion of digital input into decoded output or command signals, is compatible with existing continuously operating collating systems, and is reliable.

Other and further objects, aims, features, advantages, purposes, arrangements, embodiments, and the like will be apparent to those skilled in the art from the following description taken with the accompanying drawings and the appended claims.

Brief Description of the Drawings

In the drawings:

Fig. 1 is a simplified block diagrammatic view of one embodiment of an apparatus of this invention wherein each one of a plurality of primary documents is continuously serially fed, address-field imaged by an OCR subassembly, folded, selectively collated with secondary documents, and envelope inserted;

Fig. 2 is a diagrammatic view illustrating structural details of one embodiment of a primary document "read" station suitable for use in the apparatus embodiment of Fig. 1;

Fig. 3 is a view similar to Fig. 2 but showing an alternative embodiment of a suitable primary document "read" station for use in the apparatus embodiment of Fig. 1;

Fig. 4 is a simplified flow diagram illustrating software functions for controlling operation of the OCR subassembly used in the Fig. 1 apparatus;

Fig. 5 is a simplified flow diagram illustrating software functions for controlling operation of the apparatus shown in Fig. 1 using output signals from the OCR subassembly that are fed to the control computer in the apparatus of Fig. 1;

Fig. 6 is a simplified fragmentary block diagrammatic view of an embodiment of the apparatus of Fig. 1 which has been optionally but preferably further provided with an OCR means for verification of the identity of the individual recipient name, address and character code as shown on each primary document with the corresponding information shown on a preprinted windowless envelope that is being associated with the primary document;

Fig. 7 is a simplified block diagrammatic view of an embodiment of the apparatus of Fig. 1 which has been optionally but preferably further provided with an OCR means for carrying out sorting of stuffed and preferably sealed envelopes;

Fig. 8 is a simplified diagram of apparatus suitable for preliminary imprinting in a concurrent manner both primary documents and windowless envelopes with identical recipient name, address and character code information;

Fig. 9 is a simplified view of an envelope sorting device adapted for use in the practice of the present invention; and

Figs. 10A.1, 10A.2 and 10B illustrates principle portions of a flow diagram of one embodiment of software for controlling operation of the OCR subassembly and the control computer used in the Fig. 1 apparatus.

Detailed Description

(a) Basic Operation

Referring to the drawings, Fig. 1 shows in block diagrammatic form an embodiment of an OCR-equipped automatic document selective collation and envelope inserting apparatus 21 of this invention.

The apparatus 21 performs in a single operational step sequence or operating cycle sequential functions with (a) a primary document; (b) one or more secondary documents and (c) an envelope. Each individual primary document, such as, for example, a one-page form letter or the like, is preliminarily individually imprinted within a predetermined address field that is located at a predetermined position on each individual respective such primary document of a plurality thereof with (a) the intended recipient's name, (b) that recipient's address, and (c) a character code that is preferably comprised of human readable characters, such as alphanumeric characters or the like. This code is readable by an associated OCR subassembly 25 and this code incorporates or is representative of instructions identifying which individual members of a group of secondary documents are to be combined with each primary document. Each individual primary document (not shown) is serially advanced as a workpiece by conveyor means (not shown in Fig. 1 but see Fig. 2) through the apparatus 21 in a sequential,

continuous, non-stop manner. As it advances, each primary document passes through a series of stationary stations. Each station constitutes a separate location at which a work function of apparatus 21 is executed by one or more subassemblies upon that primary document.

The transport speed of each primary document through apparatus 21 can be varied, but typically is such that about 1,000 to about 10,000 primary documents per operating hour are processed. For such throughput rates, the total residence time or processing time for each primary document in apparatus 21 is typically in the range of about 3.6 to about 0.35 seconds. For such residence times, typical transport speeds for a primary document sheet member are in the range of about 6.05 to about 8.05 feet per second. During such residence times, all processing is carried out on each primary document. In such processing, a primary document is first selectively collated with one or more secondary documents to form a document bundle, and then the document bundle is inserted into an envelope and optionally sealed. Suitable automatic selective collation apparatus with such operating characteristics is known to the prior art. It is presently preferred to employ in the practice of this invention automatic selective collation apparatus which is available commercially from Inscerco Mfg. Inc. of Crestwood, IL under the trademark "Mailcrafters".

At primary document storage and feeding station 22, a primary document (not shown in Fig. 1, but see Fig. 2) at one end of a primary document stack or roll (not shown) is separated and advanced by a sheet feeder or the like (not shown) to a read station 23. The feeding station 22 can either accommodate primary documents in a roll form from which individual primary documents are separated by a cutting blade associated therewith (conventional, not

detailed), or in a stack form comprised of individual primary documents which are fed sequentially by a sheet feeder (conventional, not shown). In read station 23, the character code that is imprinted in a name and address field 63 of each primary document is imaged by a video camera 43 (as described below). Video camera 43 is part of the OCR subassembly or system 25 which includes an optical character recognition (OCR) device 26.

The character code on each primary document that is thus imaged by camera 43 is typically imprinted in line form in adjacent relationship to the recipient name and address information in the name and address field (typically above or below) in the same corresponding position on each primary document. This code incorporates and represents specific identifying data regarding the preselected identity of particular secondary documents that are to be combined (i.e., collated) with each primary document as it passes through collator 28.

The thus formed image of the character code existing on each primary document as made by camera 43 is conveyed into optical character recognition device 26 wherein (as described below) the so imaged code is decoded and converted into output electrical control (i.e. command) signals that are representative of secondary document selective collating information for each primary document. Such control signals are fed from device 26 to a control computer 27 and used by (i.e., interpreted by) control computer 27 to operate selectively the collator 28 as the originating primary document passes therethrough. In collator 28, selected secondary documents among a predetermined plurality thereof are combined with the primary document to produce a document bundle (not shown).

Each resulting document bundle comprised of a primary document and associated one or more selected secondary documents that have thus been collated therewith then advances from collator 28 to an envelope inserting station 39. In station 39, each succeeding document bundle is inserted into a separate envelope (not shown) that is sequentially fed thereto, and the resulting "stuffed" envelope is then preferably sealed in station 39 (for example, as the stuffed envelope leaves station 39). Windowed or windowless envelopes can be used. Preferably, each envelope is windowless and is preprinted with the recipient name, and address and character code exactly as such information appears on the primary document of the document bundle that is inserted thereinto (as is exemplarily described and illustrated herein).

Conveniently and preferably, a primary document folding station 29 (conventional, not detailed) is provided in apparatus 21 between read station 23 and collator 28.

(b) The OCR Subassembly

In OCR subassembly 25, various image forming arrangements such as known to the prior art can be utilized in combination with the OCR device 26 to achieve character code imaging at read station 23. In one preferred arrangement, as shown in Figs. 1 and 2, the imaging is accomplished in station 23 by advancing each primary document 61 (here illustratively a single sheet) on a conveyor 62 through a normally dark imaging chamber or region 51 which accommodates successive passage of the continuously moving individual primary documents 61 therethrough. The video camera 43 is positioned in chamber 51 so as to image a predetermined field area 52 in chamber 51.

During operation of apparatus 21, the camera 43 is continuously maintained in an active "camera-ready" state able to accomplish imaging. Since the chamber 51 is normally dark (i.e., the light level therein is normally below the minimum level at which camera 43 is able to form a distinct image), most of the time during the normal conditions of operation of apparatus 21, no actual imaging by camera 43 occurs.

However, at the exact predetermined time when a particular advancing primary document 61 has been transported to the location shown in chamber 51 where the imprinted address field 63 of each document 61 is aligned and preferably centered within the field area 52 (see, for example, Fig. 1), a strobe light 53 is turned on (or activated) so that the so aligned primary document 61 in field area 52 is momentarily illuminated by strobe light 53. The illumination is timed to occur only for a brief interval of time. The strobe light during its activation has a frequency and an intensity that are sufficient to permit the camera 43 to form and produce an image of the individual primary document character code appearing within the field 63 of each prime document 61 that then resides in the field area 52. The activation time is typically only a fraction of a second in time. For operational tolerance reasons, field area 52 is preferably larger than field area 63.

The "on" or illumination time interval of the strobe light 53 is short enough so that each primary document address field 63 does not appear to the camera 43 to be appreciably moving during this time interval.

Conventional, commercially available video imaging cameras can be employed as video camera 43 in combination with the strobe light 53. A present preference is to employ with strobe light 53 a video camera that is available

commercially under the trade designation "Pulnix" from the Pulnix Company of the United States.

In operating effect, the strobe light 53 functions similarly to a shutter for the camera 43. A strobe light with suitable "on" time illumination capability and light emission characteristics is available commercially from various manufacturers, such as that identified by the trade name "MUS-2200" from the EG&G Electro-Optical Company which strobe light is presently preferred. Such a strobe light is functionally preferably associated with a fiber optic cable, and such a cable is terminally associated with a light emitting structure adapted to illuminate the area of an address field on a primary document. A presently preferred such light emitting structure is a ring (universal) form, such as the ring available as Model MVS-8 from the same company. With such equipment, a light output pulse of less than about 25 microseconds pulse width at all energy setting is achieved at 1/3 of peak energy.

To synchronize the operation of the strobe light 53 with a primary document 61, both as regards to its position on conveyor 62 and as regards the position of its address field 63 within the field area of chamber 51, any convenient means can be employed, including photodetection, microswitch actuation, gamma ray interruption, and the like. One present preference is to employ in association with chamber 51 a fiber optic photoelectric sensor or scanner, such as, for example, a Model FS-17 sensor that is available from the Keyence Corporation of Osaka, Japan.

However, since longitudinal spacings of successive single sheet primary documents 61 on conveyor 62 are substantially constant, one can employ an electrically timed interval between successive strobe light "on" intervals.

For example, in the arrangement shown in Fig. 2, the direction of travel of conveyor 62 is shown by the arrow. To control stroke light 53 actuation, a photon beam emitting device 93 such as a conventional infrared, ultra violet light, or visible light beam-emitting structure, is provided, and a photon sensing device 94 that is sensitive to photon emission of the frequency emitted from device 93 is employed. Spacing between successive primary documents 61 on conveyor 62 is substantially equal. In the spacing region between successive documents 61, no reflection from the surface of conveyor 62 occurs that is sufficient to activate sensing device 94, but when the leading edge of a document 61 intercepts a beam from device 93, sufficient reflection occurs and is sensed by sensing device 94, thereby activating such. This activation triggers the functioning of a time delay circuit. When the delay time has expired, the address field 63 of the lead document 61 has moved into alignment with the field area 52 of read station 23, and, at this point, the strobe light 53 is "fired" or activated form imaging the address field 63.

Camera 43, during the time interval when strobe light 53 is "on" and emitting light as above indicated, images the character code on each primary document 61. This image for each primary document is temporarily stored (i.e., recorded) in a storage unit (not shown but conventional) and then the stored image is scanned and read as a raster producing an analog signal output. Thereafter, the stored image is erased from the storage unit so that the storage unit is available for use again in recording a succeeding image of the address field 63 of a subsequent primary document 61. The image "picture" produced during each exposure can have various sizes, but preferably the size thereof is standardized for all documents in a given series.

A present preference is to employ a picture size that is in the range of about 570 by about 450 pixels.

The analog raster signal is converted to a digital signal, and the resulting digital signals are fed to the OCR device 26. In OCR device 26, the digital signals are conveniently and preferably processed with pattern recognition algorithms which identify or recognize the particular character code. Various pattern recognition algorithms are known to prior art and are believed to be generally suitable and adaptable for use in the practice of this invention. It is presently preferred to employ the pattern recognition algorithms that are available commercially from Intelledex Incorporated of Corwallis, Oregon in association with OCR equipment sold by this concern.

In another image forming arrangement (not shown), imaging of each address field 61 is accomplished using as the video camera 43 one which produces a digital output signal directly, such as a video camera that is available from the Panasonic Company, and such a digital output can be fed directly to the control computer 27.

Another embodiment of an imaging and timing arrangement is shown in Fig. 3. Here, common structural components in the Fig. 2 arrangement are similarly numbered but with the addition of prime marks thereto for purposes of separate identification. Direction of movement of conveyor 62' is shown by the arrow. Spacing between successive primary documents 61 on conveyor 62' is substantially equal. As a primary document 61 is discharged by guidance fingers 97 from a sheet feeder 96 or the like onto conveyor 62', a microswitch 98 is tripped (i.e., closed) as one of the fingers 97 is in its fully extended configuration. The distance between successive documents 61 is correlated with

the position of full extension of such one finger 97 so that when such finger 97 is fully extended, the preceding document 61 has traveled on conveyor 62 to the position where its address field is in field area 52' of camera 43'. Closing of microswitch 98 is sensed by a control device 99 in OCR subassembly system 25 which immediately activates the strobe light 53', thereby initiating imaging. Control device 99 can comprises relay or the like.

The character code used in the address field of a set of primary documents can comprise various numbers of alphanumeric characters; for example, the number of characters in a given character code can range from 1 to about 20 inclusive. Each character in a given code is representative of numerical information. All primary documents in any one collating operation preferably use the same number of characters in the imprinted code, but each primary document can carry, for example, a different character or character arrangement or a different combination of characters for purposes of achieving various predetermined collating instructions in the character code.

In the presently preferred practice, and for illustration, the character code for identifying each document of a series is preferably comprised of four characters and each individual character preferably represents a hexadecimal (16 digit) number. From the numbers identified by the OCR device 26 using the read and recognized character code of each primary document, the collation instructions for each respective primary document are identified by OCR device 26.

The collation instructions thus determined are output preferably as a binary signal set (or command signal) for each primary document from the OCR device 26, and each signal set so output is input into the control computer 27.

When using, for example, the pattern recognition algorithms of Intelledex, one preferably employs an OCR recognition device which is available commercially from Intelledex, such as is sold by this concern under the trade designation "386-P". Other known optical character recognition systems are also believed to be useful.

The total time required for the OCR subassembly 25 to image on address field 63 and then to process that image to the point where a binary signal output code is fed from OCR device 26 to control computer 27 is usually and preferably less than about a few hundred milliseconds. More preferably, this time period can be in the range of about 150 to about 300 microseconds. Preferably, a camera 43 has an image resolution capability of at least about 300 dots per inch and a frame scan time of less than about 30 milliseconds. Character recognition speeds of at least about 1000 characters per second are presently preferred. Thus, command signals are generated and input into the control computer 27 before each individual primary document that has been so imaged reaches the collator 28.

In actual fact, the character recognition speed of OCR device 26 is independent of the camera 43 capture time. However, in terms of overall system throughput, it is important that the camera 43 frame capture time be short, as throughput is a function of such variables as paper positioning time, camera imaging time, camera frame time, character recognition time and decision process time. At a document input (feeder) speed of, for example, about 10,000 primary document sheets per hour, there is achieved a time for complete character code recognition that is believed to be about 400 milliseconds per sheet.

The OCR subassembly 25 is software controlled. Various software programs can be used. In Fig. 4, a

simplified software diagram is shown for the controlled operation of OCR subsystem 25, and in Figs. 10A.1, 10A.2 and 10B a flow diagram of one embodiment of a software program for controlling operation of the OCR subassembly 25 is shown. Since Figs. 4 and 10A.1/10A.2/10B are believed to be self explanatory to one of ordinary skill in the art, no detailed description thereof is given herein.

With conveyor 62 continuously operating, the feeding station 22 is actuated, so that individual primary documents, here illustratively separate sheets 61, are sequentially fed forwardly on conveyor 62 from station 22. As each primary document 61 arrives at read station 23 and reaches the location where the address field 63 thereof is aligned with field area 52, strobe light 53 is actuated and camera 43 images address field 63 and the character code appearing therein. The imaged character code is recorded, read as a raster pattern to produce an analog output signal, and this signal is converted into a digital signal output which is fed to the OCR device 26. In OCR device 26, these signals are interpreted and converted to control or command signals representing the predetermined secondary document collation information for that individual primary document. These command signals are fed to control computer 27 which uses these signals to control secondary document selection and collation in the operating collator 28 for combining secondary document(s) with the primary document as it passes through the collator subassembly 28.

(c) The Collator Subassembly

From the command signals input into the control computer 27 from OCR device 26, the control computer 27 produces control signals directing which individual ones of a predetermined group of collating stations, such as stations 32 through 37 of collator 28, are to be

individually activated so as to discharge, responsively to such control signals, a respective secondary document stored in a stack or the like at each such individual station 32 through 37 into an adjacent association with each particular primary document as that primary document passes each one of such station 32 through 37. A plurality of each of the respective secondary documents is preliminarily loaded as an individual stack into an assigned station in the selective collator 28.

The control electrical signals thus output from control computer 27 can typically comprise a digital serial signal set for each primary document. This signal set is conveniently temporarily held by the control computer 27 until each primary document whose code information was read in station 23 has suitably advanced to the selective collator 28.

After being so imaged in the reading station 23, each primary document advances to the next following station. In apparatus 21, this next station is preferably a folding station 29. Upon arrival in folding station 29, each primary document is folded in a predetermined manner. For example, a letter sheet can be conventionally folded into three portions with two horizontal fold lines, such that the opposite end portions of the thus folded letter sheet overlap in a conventional format.

As those skilled in the art will appreciate, the folding station 29 optionally can be eliminated, but is presently preferred. Alternatively, if desired, a folding station (not shown), can be located beyond the selective collator 28 so that all documents of a given bundle comprised of a primary document and selected collated secondary documents are conveniently folded together.

From folding station 29, if employed, a primary document so imaged advances into the first collating station 32 of the selective collator 28. Collator 28 is here illustratively provided with a sequential series of six collating stations 32 through 37, as indicated above. As a primary document is continuously advanced through these stations, the control computer 27 is conveniently programmed so that, for illustration, a first collating command signal of the signal set for that primary document is forwarded either directly or indirectly (as further described below) to the selective collator 28 and to the first collating station 32 therein. Each command signal of such a set is either a "go" (i.e., collate) or "no go" (i.e., no collate) signal.

A "no go" signal received at first collating station 32 means that no copy of a particular secondary document plurality that is stored for collation in the first collating station 32 is selected for placement with the primary document residing in the first collating station 32. A "go" signal received at first collating station 32 means that one copy of the secondary document plurality that is stored for collation in the first collating station 32 is placed with the primary document residing in the first collating station 32.

The primary document, and, if commanded, a thus associated secondary document, advance from the station 32 to the second collating station 33 of the selective collator 28, and another signal of the signal set for that primary document (which signal is either "go" or "no go") is received at second collating station 33. Depending upon the nature of the second signal of the signal set, as indicated above for the first collating station 32, the second station 33 either does or does not combine with the primary document

in the second station 32 a copy of the particular secondary document plurality that is stored in second collating station 33.

Next, the primary document in second station 33 together with any secondary documents that have been thus combined therewith advance to a third collating station 34 in the selective computer controller 28. Another (third) control signal of the signal set for that primary document (either a "go" or "no go" signal) is used to control whether or not a copy of a third particular secondary document plurality that is stored in third collating station 34 is combined with the primary document.

This process is successively repeated at each of the fourth collating station 35, the fifth collating station 36 and the sixth collating station 37. Of course, a selective collator could have more or less than six stations, if desired. An unused station in any actual collating operation (that is, a collating station charged with no particular secondary document plurality) can merely be given a "no go" signal for each primary document passing therethrough. Conveniently and preferably, if the primary document is folded before entering the selective collator 28, then each of the secondary documents is conveniently and preferably pre-sized to form a document bundle or set that will fit subsequently into the desired mailing envelope. Thus, the secondary documents of each secondary document plurality can each be preliminarily folded before being loaded into selective collator 28.

From the sixth collating station 37, a final resulting document packet or bundle (not shown) as thus assembled by selective collator 28 is forwarded. The bundle which consists of primary and selected secondary documents passes into envelope inserting station 39. As each document

bundle is charged into station 39, an envelope (not shown) is timed to arrive from an envelope feeder 40. Windowed or windowless envelopes can be used. Preferably, windowless envelopes are used, and preferably such have each been serially preprinted with the name and address of the recipient. The recipient arrangement order of these preprinted envelopes is such that it exactly corresponds with the order of recipients appearing in the respective primary documents being serially processed by the selection collator 28. In station 39, each document packet is inserted by inserter fingers or the like (conventional, not shown) into each envelope. The filled envelope is then preferably sealed in station 39 and is discharged from the inserting station 39, thereby completing one complete basic operational cycle of the apparatus 21 for one primary document.

The subassembly apparatus employed at each one of the foregoing operating stations of apparatus 21, except at reading station 23, is conventional and known to the prior art. For example, and as indicated above, suitable such apparatus is utilized in commercially available automatic selective collation and envelope inserting apparatus which is made and sold by the Mailcrafters division of Inscerco Mfg. Inc. of Crestwood, Illinois, the assignee of the present patent application.

The control computer 27 for the collator 28 is preferably conventional in structure and employs a commercially available microprocessor. The computer 27 is software controlled. In Fig. 5., a simplified software diagram is shown for the controlled operation of computer 27 and collator 28, and in Figs. 10A.1/10A.2/10B a flow diagram of one embodiment of a software program for controlling operation of collator 28 and computer 27 is shown. Since

Figs. 5 and 10A.1, 10A.2 and 10B are believed to be self explanatory to one of or dinary skill in the art, no detailed description thereof is given herein.

The interfacial interconnection between control computer 27 and OCR device 26 is conveniently accomplished by data lines (single bit signal lines) and a serial port.

The produced character command signal data thus output from device 26 into the control computer 27 is preferably in the form of a signal set which is directly usable by the control computer 27 to control subsequent actions of the selective collator 28 in selectively collating particular secondary documents with each primary document. These command signals are used by computer 27 for producing control signals for controlling the operation of the collating stations 32, 33, 34, 35, 36 and 37. Computer 27 can use and process these command signals in various ways. For example, computer 27 can have a port C with an 8-bit digital output channel. Multiplexed binary digital control signals output from port C are fed to a demultiplexer 31 which functions to decode the multiplexed binary digital control signals received by it. The decoded signals are then relayed as individual control signals to each of the collating stations 32-37 for operating purposes.

Operator access to control computer 27 and to OCR device 26 is achieved for input, access, control and status information purposes by means of the interconnecting keyboard 48 and monitor 49 through appropriate convenient preferably conventional interfaces (not shown).

(d) Options and Preferences

Preferably and conveniently, in one optional feature, the name and address of each recipient together also with the character code for that recipient are preliminarily simultaneously imprinted on each of a primary

document and a windowless envelope. Such simultaneous imprinting is conveniently accomplished using conventional apparatus. For one example, as shown in Fig. 8, one can simultaneously operate two automatic feed/print/stack devices 48 and 49 using the same recipient data base and a single word processing software system that is loaded into a single so-called personal computer (PC) 50 or the like. One such device processes windowless envelopes, and the other device processes primary documents. Suitable feed/print/stack devices are available commercially, or can be assembled from conventional components, as available from various manufacturers, such as IBM and the like.

The imprinted stack of primary documents is then charged to, and temporarily stored in, the primary document feed station 22, and the imprinted stack of envelopes, in which the individual envelopes are thus arranged in exactly the same order as that in the primary document stack, is then charged to, and temporarily stored in, the envelope storage and feed station 40. Then, as desired, in operation of apparatus 21, after the collating, each collated document bundle of primary and associated secondary document(s) is automatically inserted into an envelope that has the identical recipient information (name, address, character code) imprinted thereon compared to the primary document of each bundle.

Preferably and conveniently, another optional feature of this invention, the apparatus 21 is additionally provided with means having the capacity to check, inspect and verify that each individual document bundle which issues from collator 28 and which is inserted into an envelope that is preimprinted with the recipients name, address and character code at inserting station 39 is imprinted with the identical recipient name, address and character code as

shown on the primary document of that individual document bundle.

To accomplish this check, and as shown in Fig. 6, an OCR comparison system 65 is provided. A document bundle check station 66 is interposed between the last collator station 37 of collator 28 and the envelope inserting station 39, and an envelope check station 67 is interposed between envelope storage and feeding station 40 and the envelope inserting station 39. The OCR comparison system 65 is provided with a first video camera 68 that is located at check station 66 and a second video camera 69 that is located at check station 67. Also, each of check stations 66 and 67 is provided with a strobe light 71 and 72. Cameras 68 and 69 are similar in structure and function to camera 43 and strobe lights 71 and 72 are similar in structure and function to strobe light 53. Check stations 66 and 67 each operate in a manner that is similar to that in which read station 23 operates.

System 65 is in effect here illustratively shown as an optional additional component of apparatus 21 into which system 65 has been incorporated as shown in Fig. 6. Components of apparatus 21 which are shown in Fig. 6 are similarly numbered as shown in Fig. 1.

When employing an OCR comparison system 65, each primary document is initially folded in folding station 29 after the imaging at station 23 and positioned in a document bundle of primary and secondary documents prepared by collator 28 so that the primary document address field is on an outside surface of the document bundle. As a document bundle passes through check station 66, it is imaged by the video camera 68, and as a preimprinted envelope passes through check station 67, the pace thereof and the address field thereon is imaged. The respective images are each

processed in the same manner as described above for the images produced by camera 43 at station 23, and the two respective digital signals representative of such images are compared to each other in an OCR device 76 of the OCR comparison system 65 using comparison algorithms. Since only the digital signal produced by an image made at check station 66 is compared to the digital signal produced by an image made at check station 67, the system does not require that each image be analyzed for its own individual content, or character code meaning or instructions, by separate character recognition. A conventional OCR comparison device and conventional comparison algorithms can be and preferably are employed.

If OCR device 76 determines from such a comparison that the respective digital signals are identical, then an output signal from OCR device 76 that is being fed to control computer 27 remains unchanged and operation of apparatus 21 continues normally. If, however, OCR device 76 determines from such a comparison that the respective digital signals are different, then OCR device generates a different output signal which is fed to control computer 27. This different output signal causes computer 27 to respond according to its program. This program preferably either commands apparatus 21 to cease operating at once (as preferred), or commands apparatus 21 to take some other specific response, such as to command station 39 to switch from preprinted windowless fed thereto from envelope feeder 40 to windowed envelopes that are fed to station 39 from a stand by envelope feeder 74 (see Fig. 6). Control computer 27 also programmed to command envelope feeder 40 to stop feeding envelopes and to command envelope feeder 74 to start feeding envelopes.

The OCR device 76 is preferably obtained commercially. Suitable such devices and associated comparison algorithms can be and preferably are obtained, for example, from Intelledex Incorporated of Cornwallis Oregon, such as the device available under the trade designation "386-HR" or the like.

In another optional feature of this invention, sorting of stuffed envelopes is accomplished. When stuffed envelope sorting is desired of either windowless or windowed envelopes, an OCR directed sort system 78 is provided one embodiment of which is illustrated in Fig. 7. System 78 is in effect but illustratively shown as an optional additional component of apparatus 21 into which system 78 has been incorporated as shown in Fig. 6. Corresponding components apparatus 21 appearing in Fig. 7 are similarly numbered as shown in Fig. 1. In system 78, a sort station 44 and an inspect station 56 are placed in apparatus 21 after the envelope inserting station 39 as shown in Fig. 7. The sort station 44 is preceded by the inspect station 56 which is provided with a video camera 46 that is functionally associated with an OCR subassembly 75 and OCR device 76 which are each similar in structure and operation respectively to the OCR subassembly 25 and the OCR device 26. A strobe light 72 that is similar to strobe light 53 in structure and function is also provided and is in functional association with OCR device 76. Video camera 46 is similar to the camera 43. Also, the sort station 44 is provided with a plurality of terminal collection bins, bin deflector means, and bin deflector control means for regulating the particular bin into which each envelope is deposited.

In sort station 44, the stuffed envelopes (not shown) from inserting station 39 undergo sorting or

separation into classes according to some predetermined or desired organization which is included in the character code. For example, organization according to zip code (or similar postal code) is now preferred. In operation, the character code appearing in the recipient name and address field of each envelope from station 39 is imaged in a manner similar to the manner in which camera 43 images primary documents addressed fields and the image is similarly processed in OCR device 76 to the manner in which processing is carried out in OCR device 26. An output signal representative of the character code is determined and temporarily stored and compared to the previously stored corresponding signal of the character code appearing in the recipient name and address field of the immediately preceding envelope (similarly processed). Whenever a zip code difference is detected by such comparison, the sequentially second or just read envelope is deflected in sort station 44 differently by a signal that is fed from OCR device 76 to the sort station 44. The sort station 44 is associated with a series of bins. Thus, an envelope whose sort code is different from a preceding envelope is caused by sort station 44 to move into a different terminal collection bin (not shown in Fig. 7, but see Fig. 9) from that into which the preceding envelope was deposited.

Thus, the zip codes themselves need not be "read" individually, and they need not be converted into specific control signals or the like that are representative of a given zip code. Rather, the image of one character code that incorporates a zip code is simply compared by OCR device 76 to the image of another preceding character code that incorporates a zip code. When a difference is found between the two thus compared character codes, an action signal to accomplish a sorting or separation change for the

envelope involved is generated by OCR device 76 and is used to control the operation of the sort station 44. For reasons of machine control, signals generated by OCR device 76 are preferably fed to control computer 27 which generates control signals for, and feeds such signals to, sort station 44.

The sorting of envelopes by zip codes by apparatus of the invention is desirable because of the associated reductions in subsequent mail processing costs at the local post office. The U.S. Postal Service may offer in the future a reduced postal rate, or a rebate in postage otherwise paid, when a single mailing involving a relatively large number of individually addressed letters or the like is presented to the U.S. Postal Service with the component letters already sorted by zip code. The present system 78 enables one to accomplish zip code sorting of mail in a relatively simple, convenient, reliable, and low cost manner with automatic equipment.

Because of the fact that in system 78 the sorting of envelopes is accomplished comparatively between serially successive preprinted envelopes, it is now preferred to have the primary documents and envelopes not only both preprinted as indicated above, but also to have the primary documents and envelopes preliminarily further arranged into zip code groupings and still further to have only a limited number of different zip codes involved totally in a given operating sequence involving a plurality of preprinted primary documents and windowless envelopes. The number of zip codes is preferably not greater than the number of bins that are individually associated with the chosen sort device at sort station 44.

One embodiment of a simple sort device 80 is illustratively shown in Fig. 9. Device 80 is functionally

associated with the sort station 44. A present convenience and preference is to employ from about 4 to 12 bins in sort device 80, although larger and smaller numbers of bins can be used. It is convenient and now preferred for zip code sorting to be carried out in a progressive manner such that, when all envelopes of a set bearing a given zip code have been processed, another envelope set bearing a different zip code is succeedingly processed and fed to sort station 44, thereby to facilitate collection, sorting and separation of filled envelopes according to their respective zip codes. Particularly when mail for delivery in a large metropolitan area is involved, such a zip code sorting system is very effective.

Preferably, the sort device, such as device 80, is capable of operating at speeds which are fully compatible with the operational speeds that are employed in apparatus 21, as indicated above.

The sort device 80 is provided with a plurality of collection bins 81-84 in a housing 86. Associated with device 80 is a shute 87 which is pivotally mounted at a location 88 that is in spaced, adjacent relationship to the bins 81-84. Shute 87 has an input mouth 89 and an output mouth 89 and an output mouth 91. Cross sectionally, shute 87 has rectangular configuration adopted for passage longitudinally therethrough of single envelopes moving by air support (pneumatically) using a source of flowing air (or gas) provided in, or released internally from sort station 44. During pivotal movements of shute 87 at location 88 adjacent input mouth 88, the output mouth 85 moves through an arcuate path which enables output mouth 89 to associate with the entrance to each of the respective bins 81-84. Thus, an envelope entering shute 87 at input

mouth 88 can be passed therethrough past output mouth 91 into a particular one of the bins 81-84.

To provide shute 87 with pivotal deflection and position setting means so as to align mouth 91 with a predetermined (preselected) one mouth of bins 81-84, one side of shute 87 in the region of output mouth 91 is pivotally connected to the forward end of a push rod 92. The rearward portion of push rod 92 is functionally associated with an actuator 93. The operation of the actuator 93 is controlled by control signals input thereto from control computer 27.

Various structures can be employed for activator 93, as those skilled in the art will appreciate. A present preference is to employ an electromagnetic device which advances or retracts the push rod 93 axially to a predetermined extent responsive to particular control signals input thereinto from computer 87. The distance advanced in response to specific signals is adjusted to align the mouth 91 with a particular predetermined bin 81-84.

In one illustrative and presently preferred arrangement, the sequential imaging of stuffed envelopes is accomplished at the inspect station 56 as shown in Fig. 1 that is located between envelope inserting station 39 and the sort station 44, and the video camera 46 is positioned for envelope imaging at inspect station 56.

In the inspect station 56, the imaging is accomplished in a manner similar to that in which imaging is accomplished in station 23 as described above. Thus, each stuffed envelope is advanced through a normally interiorly darkened imaging chamber comparable to chamber 51, video camera 46 like camera 43 is continuously maintained in a "camera-ready" state or mode, and when each envelope becomes

aligned with a predetermined field area comparable to areas 52, a strobe light 59 is activated to its "on" state and camera 46 forms an image of the address field appearing on the envelope including the character code located therein. Synchronization of strobe light 59 operation with envelope position in station 56 is achieved in the same manner as described above for primary document position in station 23, and the strobe light 59 can be similar in structure to strobe light 53.

The digital signal generated from a first image of an address field on one envelope made by camera 46 is recorded or stored and compared by OCR device 26 to the digital signal generated from a second succeeding image of an address field on a second envelope.

If no difference is found between the successive binary signals thus compared, a no change command signal is output from device 26 to the control computer in sort device at station 44 and the same sort configuration in sort device 44 is maintained.

However, if a difference between successive binary signals is found to exist by the OCR device 26, then the OCR device 26 changes the output control signal being sent by it to the control computer 27 in the sort device at station 44 which causes this control computer to output a position signal to activate 93 so that shute 87 is shifted to a different bin and the proceeding bin is closed along the envelope travel path. Thus, control computer 27 can signal the sorter 80 to close one gate (or one bin) and to open another successive gate (for another bin). Thereby, the desired sorting of envelopes is achieved.

By increasing the length and complexity of the character code, and also the complexity of the device 26, the device 26 can be arranged to not only sense a difference

between the successive binary signals of succeeding character codes (on envelopes), but also identify the particular character code that is associated with the second or succeeding one of two character codes. The resulting output signal from device 26 can then be used to instruct the control computer on the sort device in sort station 44 as to exactly which bin of the bin plurality is to be activated or opened before the imaged second letter reaches such sort device from the inspect station 56.

Various modifications alterations, changes and improvements in the invention described herein may be made without departing from the spirit and scope thereof.

WHAT IS CLAIMED IS:

1. Apparatus for selectively collating secondary documents with each of a plurality of individual primary documents, each said primary document having imprinted thereon in a field a recipient name and address and also a character code incorporating collation instructions for particular members of a predetermined secondary document group to be selectively collated therewith, said apparatus comprising in combination:

(A) conveyor means for serially and continuously advancing successive ones of a plurality of said primary documents along a processing route;

(B) computer control means for controlling operations of a plurality of work stations positioned along said route, each work station being adapted to perform at least one work function;

(C) a first one of said work stations including means for sequential feeding of each of said primary documents into said serial advancing means;

(D) a second one of said work stations including associated optical character recognition means which comprises:

(a) means to image said character code each said primary document and to convert said image into a digital signal output,

(b) means to recognize from said digital signal output the secondary document collation instructions for said so imaged primary document, and

(c) means to deliver said so recognized instructions as a command signal to said computer control means; and

(E) a succeeding plurality of successive said work stations, each one thereof being actuatable by said computer control means to collate with each one of said primary documents passing thereby a different respective one secondary document so as to produce a document bundle consisting of a primary document and secondary documents that are collated therewith.

2. The apparatus of claim 1 which further includes, after said collating work stations, a further work station having envelope inserting means for stuffing each resulting said bundle into an envelope, said envelope inserting means being associated with envelope feeder means.

3. The apparatus of claim 2 wherein each said envelope is windowless and is preprinted with the same recipient name and address as imprinted on the respective said primary document that is inserted therein.

4. The apparatus of claim 2 which further includes, after said envelope inserting work station, further work station means which includes sorting means for said so stuffed envelopes and optical character recognition means which reads the character code within the address field appearing in association with each envelope and which generates an electrical signal output that directs said sorting means to sort said envelopes according to instructions contained in said character code.

5. The apparatus of claim 2 which further includes

(a) a document bundle check station between said envelope inserting station and the last collating station,

(b) an envelope check station between said envelope feeding means and said envelope inserting station,

(c) means for imaging at each one of said respective check stations the character code appearing in each address field passing through said check station and for generating an output signal representative thereof, and

(d) optical character recognition means for comparing said output signal so generated at each said check station, for producing an output signal when any difference between said so compared output signals is detected and for delivering said output signal to said control computer means.

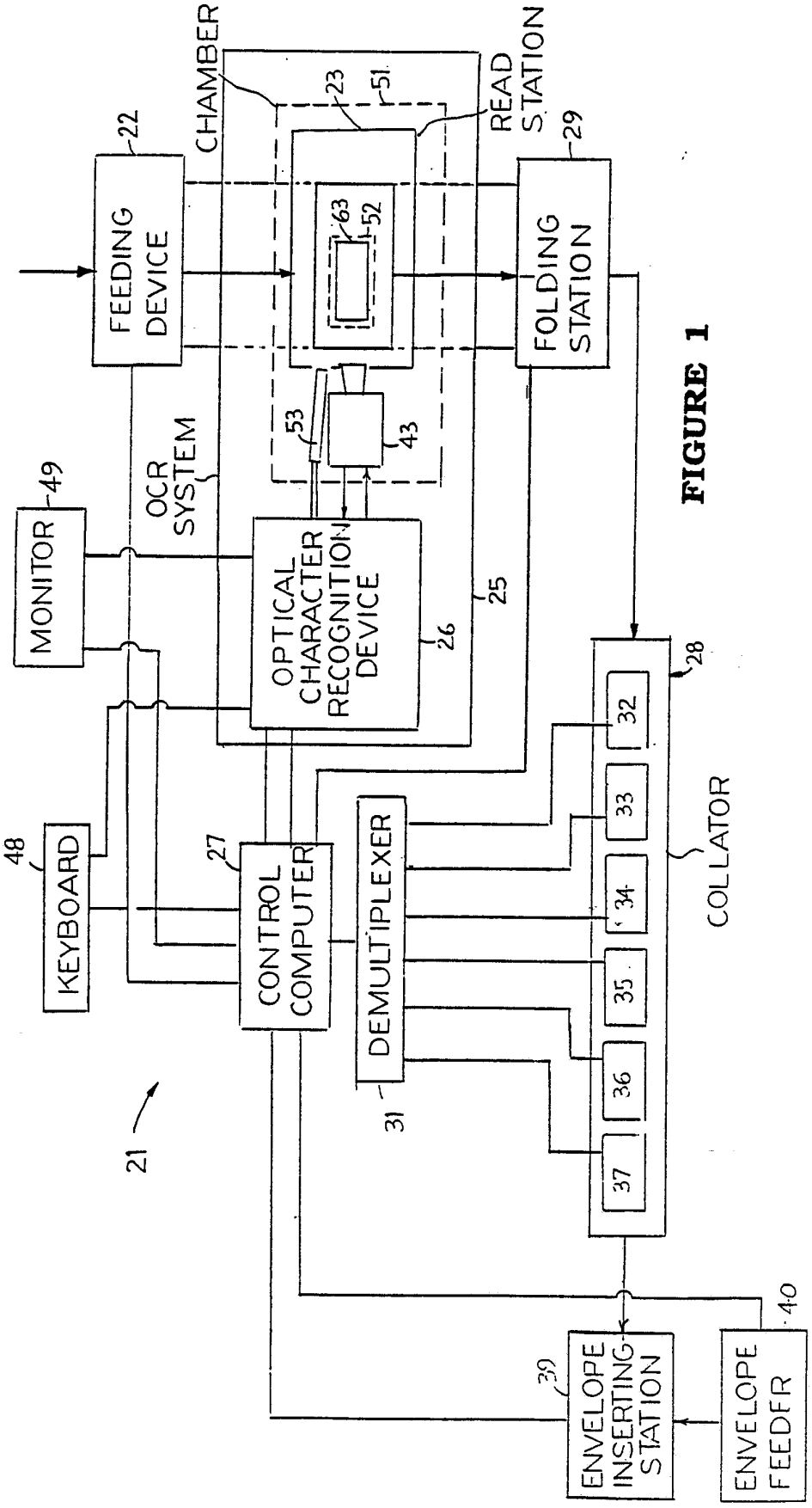

CHAMBER
READ STATION
FEEDING DEVICE
FOLDING STATION
OCR SYSTEM
MONITOR
OPTICAL CHARACTER RECOGNITION DEVICE
KEYBOARD
CONTROL COMPUTER
DEMULTIPLEXER
COLLATOR
ENVELOPE INSERTING STATION
ENVELOPE FEEDER
21
22
23
25
26
27
28
29
31
32
33
34
35
36
37
39
40
43
48
49
51
52
53
63

FIGURE 1

FIGURE 2

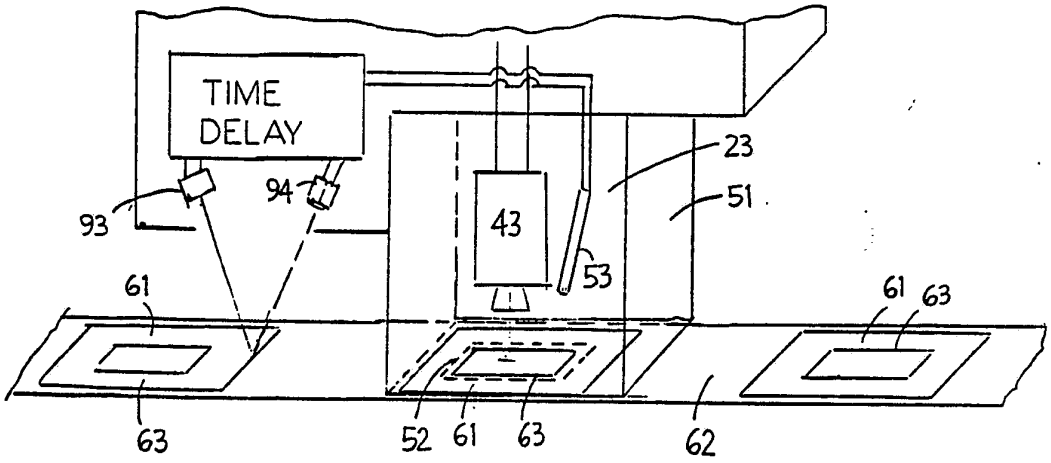


FIGURE 3

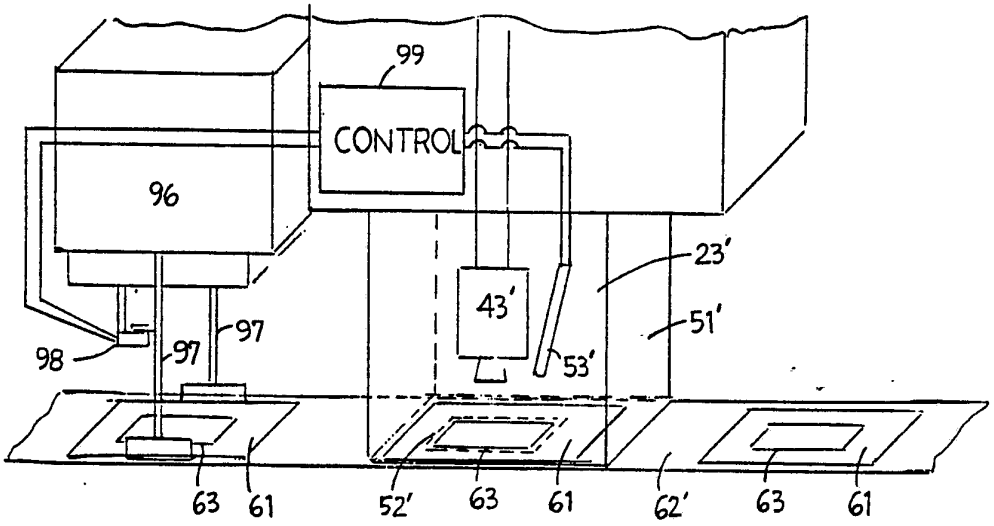


FIGURE 9

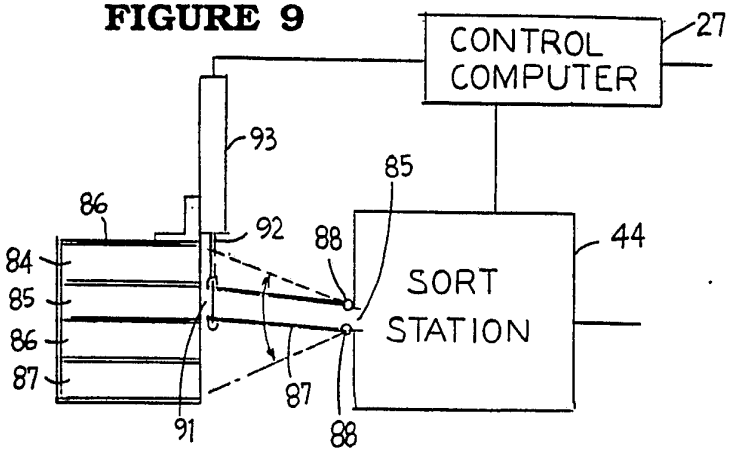


FIGURE 4

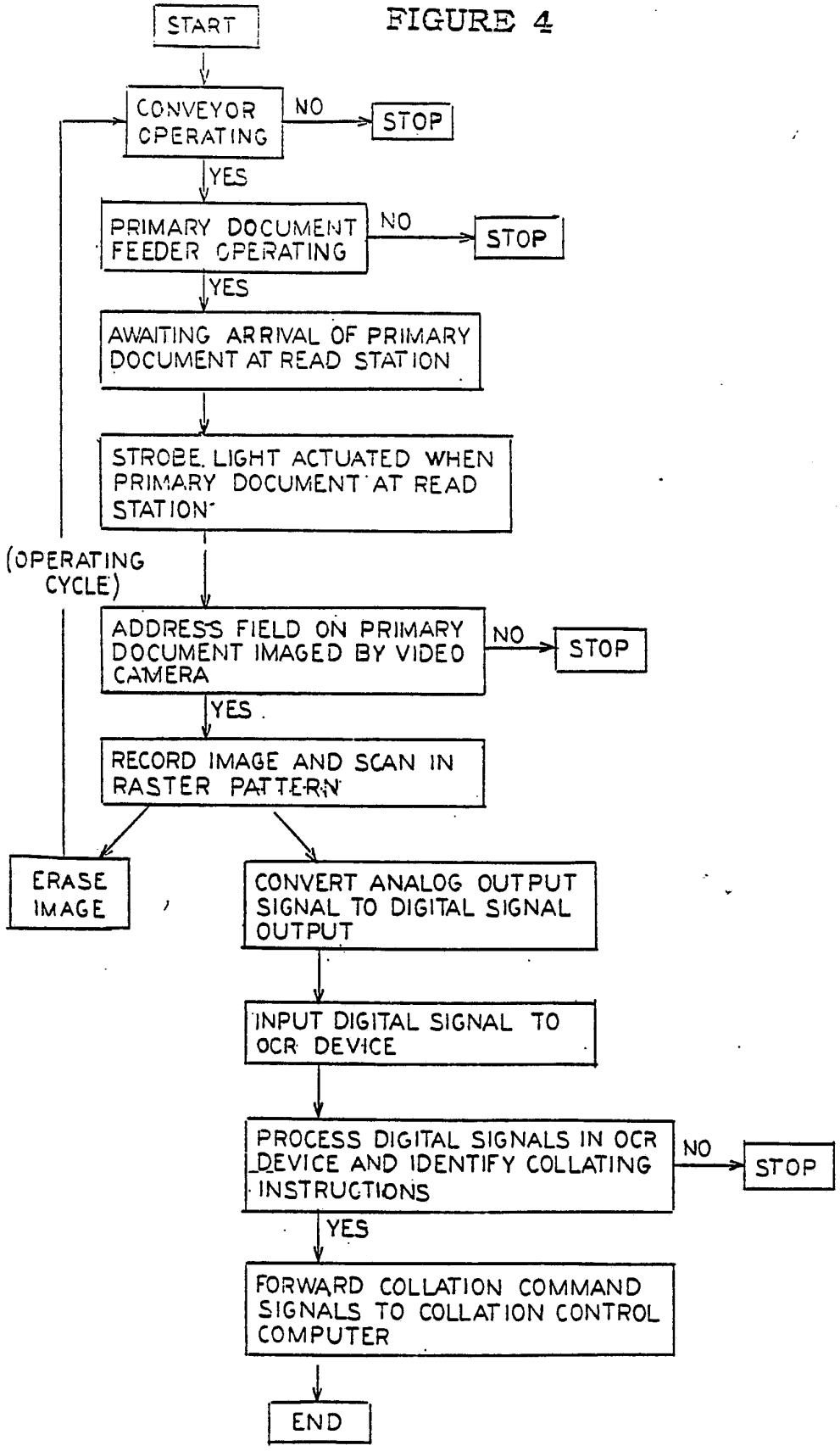

START
CONVEYOR OPERATING
NO
STOP
YES
PRIMARY DOCUMENT FEEDER OPERATING
NO
STOP
YES
AWAITING ARRIVAL OF PRIMARY DOCUMENT AT READ STATION
STROBE LIGHT ACTUATED WHEN PRIMARY DOCUMENT AT READ STATION
(OPERATING CYCLE)
ADDRESS FIELD ON PRIMARY DOCUMENT IMAGED BY VIDEO CAMERA
NO
STOP
YES
RECORD IMAGE AND SCAN IN RASTER PATTERN
ERASE IMAGE
CONVERT ANALOG OUTPUT SIGNAL TO DIGITAL SIGNAL OUTPUT
INPUT DIGITAL SIGNAL TO OCR DEVICE
PROCESS DIGITAL SIGNALS IN OCR DEVICE AND IDENTIFY COLLATING INSTRUCTIONS
NO
STOP
YES
FORWARD COLLATION COMMAND SIGNALS TO COLLATION CONTROL COMPUTER
END

FIGURE 5

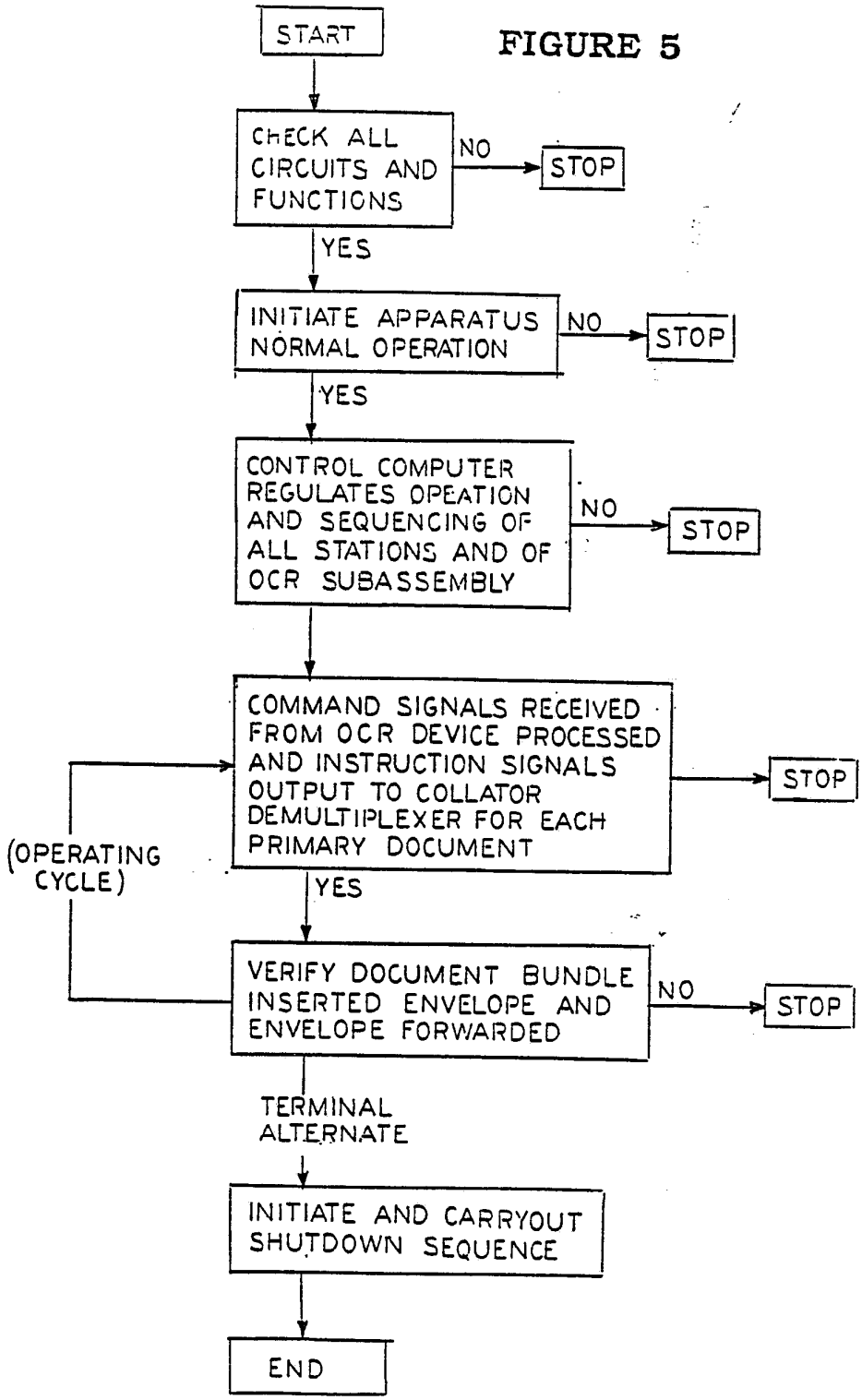

START
CHECK ALL CIRCUITS AND FUNCTIONS
NO
STOP
YES
INITIATE APPARATUS NORMAL OPERATION
NO
STOP
YES
CONTROL COMPUTER REGULATES OPEATION AND SEQUENCING OF ALL STATIONS AND OF OCR SUBASSEMBLY
NO
STOP
COMMAND SIGNALS RECEIVED FROM OCR DEVICE PROCESSED AND INSTRUCTION SIGNALS OUTPUT TO COLLATOR DEMULTIPLEXER FOR EACH PRIMARY DOCUMENT
STOP
(OPERATING CYCLE)
YES
VERIFY DOCUMENT BUNDLE INSERTED ENVELOPE AND ENVELOPE FORWARDED
NO
STOP
TERMINAL ALTERNATE
INITIATE AND CARRYOUT SHUTDOWN SEQUENCE
END

FIGURE 6

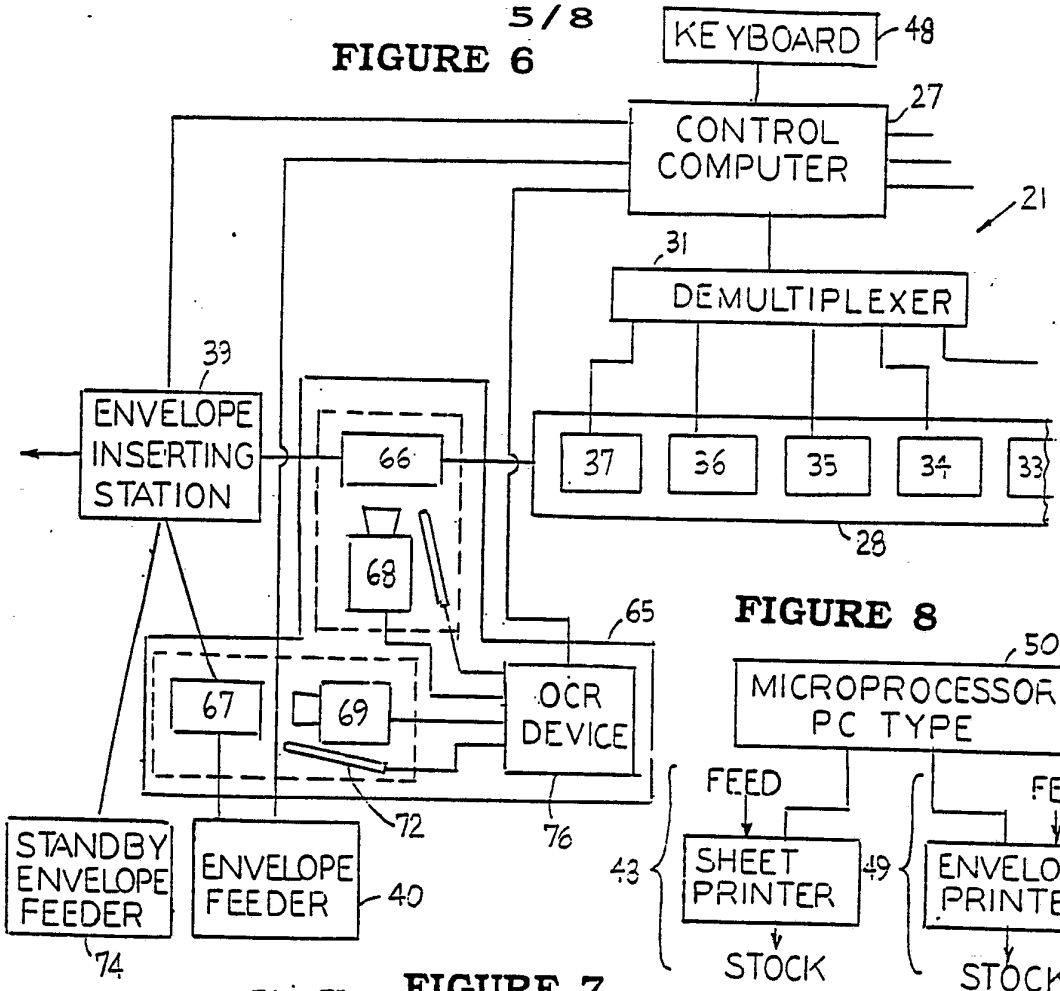
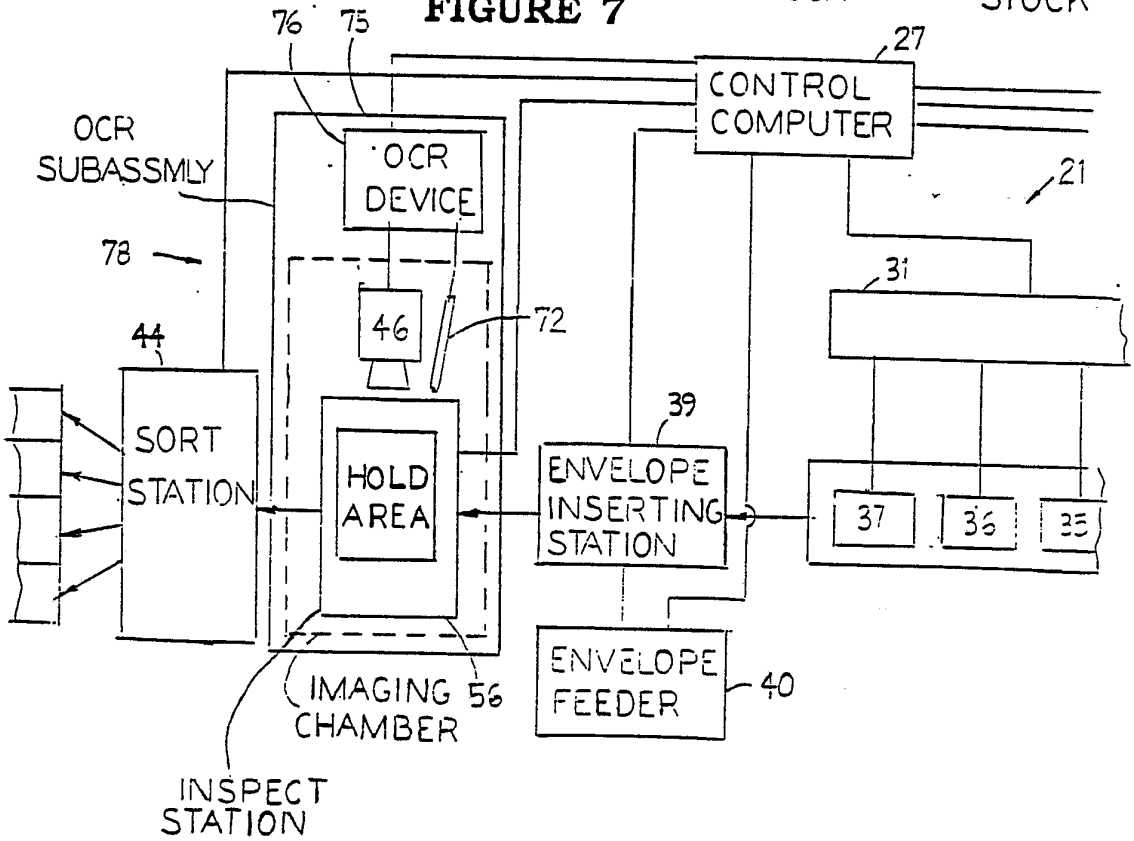


FIGURE 8

FIGURE 7



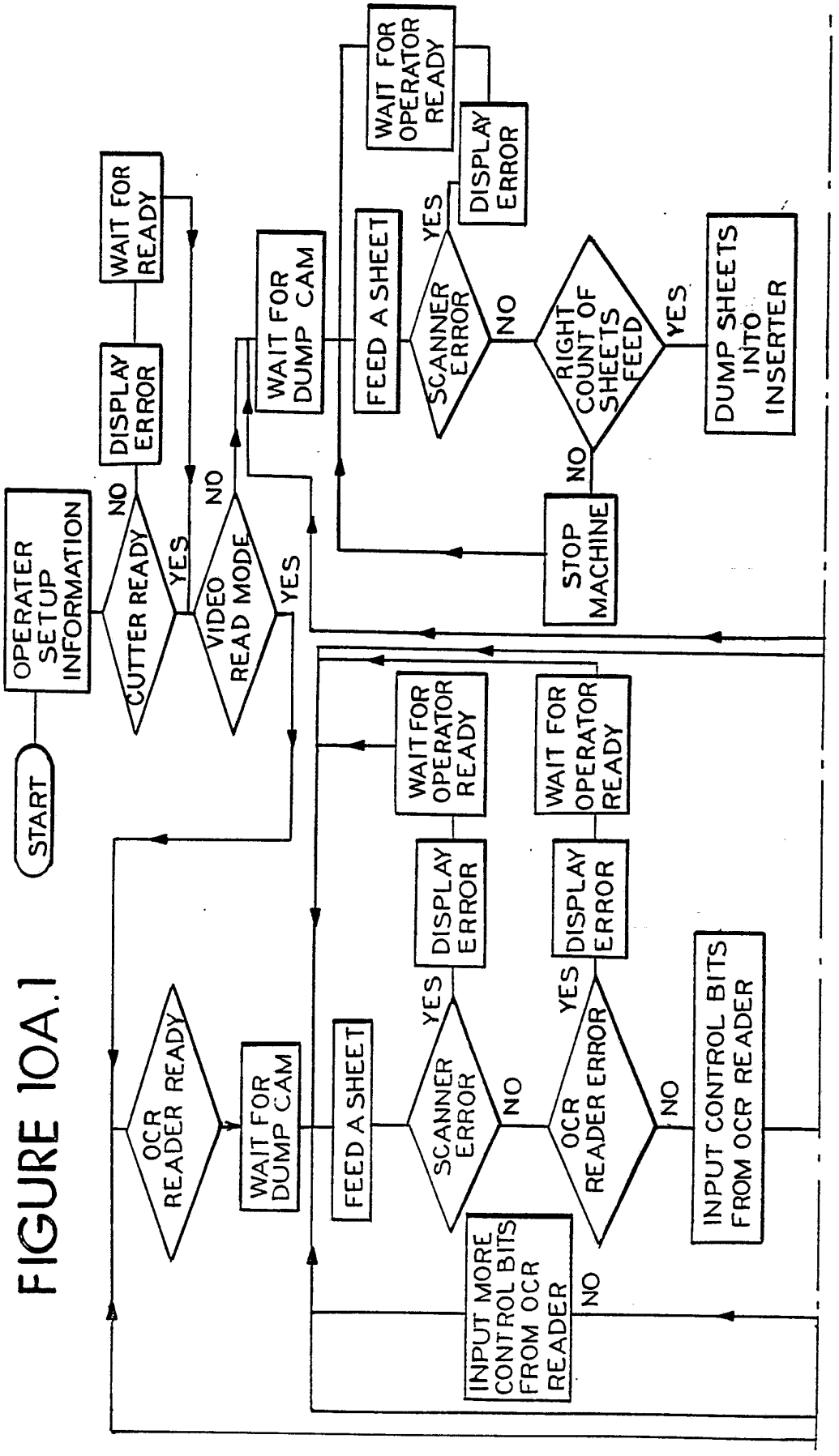

START
OPERATER SETUP INFORMATION
CUTTER READY
NO
YES
DISPLAY ERROR
WAIT FOR READY
VIDEO READ MODE
NO
YES
WAIT FOR DUMP CAM
FEED A SHEET
SCANNER ERROR
YES
NO
DISPLAY ERROR
WAIT FOR OPERATOR READY
RIGHT COUNT OF SHEETS FEED
NO
YES
STOP MACHINE
DUMP SHEETS INTO INSERTER
OCR READER READY
WAIT FOR DUMP CAM
FEED A SHEET
SCANNER ERROR
YES
NO
DISPLAY ERROR
WAIT FOR OPERATOR READY
OCR READER ERROR
YES
NO
DISPLAY ERROR
WAIT FOR OPERATOR READY
INPUT CONTROL BITS FROM OCR READER
INPUT MORE CONTROL BITS FROM OCR READER
NO

FIGURE 10A.1

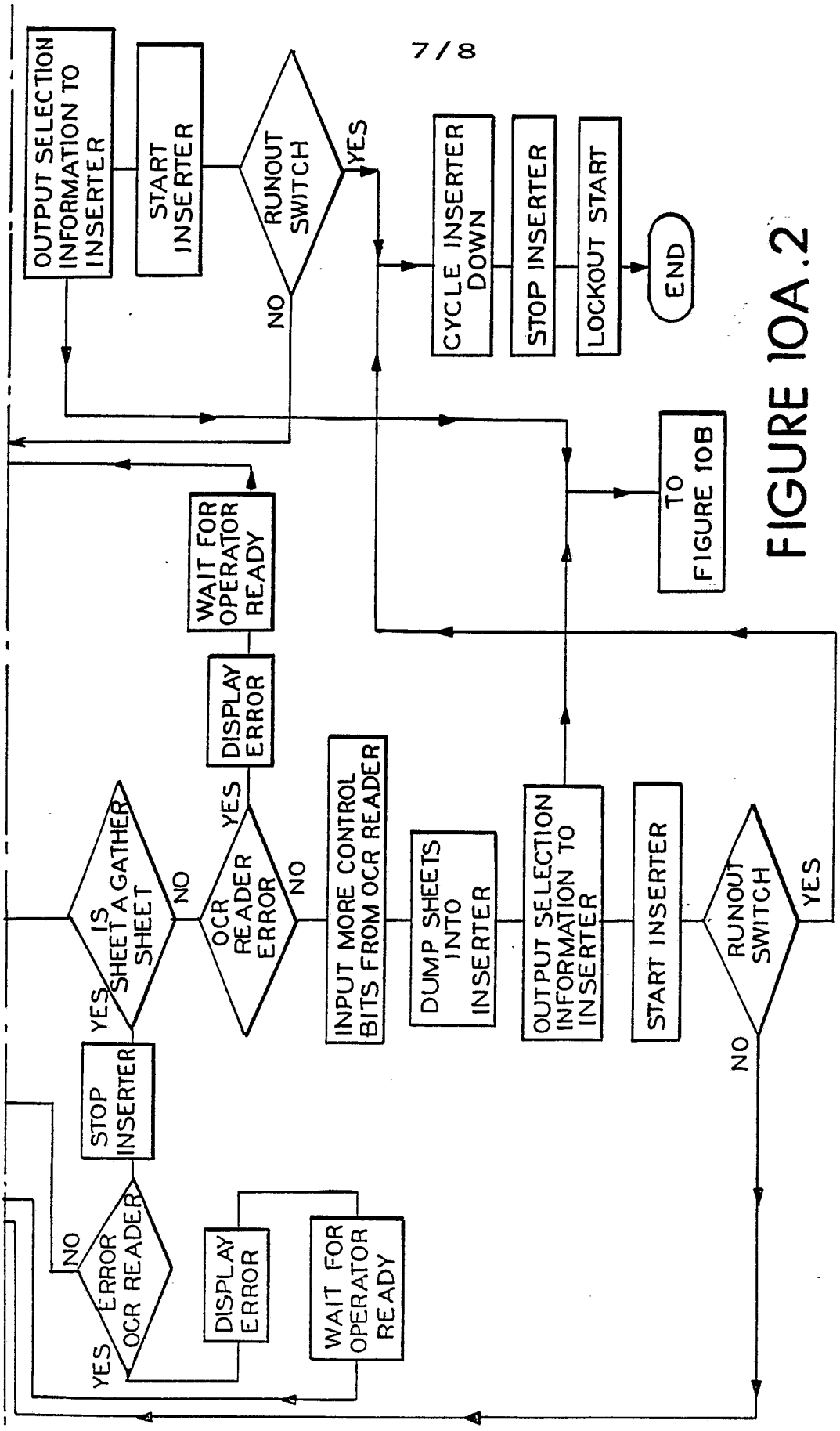

OUTPUT SELECTION INFORMATION TO INSERTER
START INSERTER
RUNOUT SWITCH
YES
NO
CYCLE INSERTER DOWN
STOP INSERTER
LOCKOUT START
END
TO FIGURE 10B
WAIT FOR OPERATOR READY
DISPLAY ERROR
IS SHEET A GATHER SHEET
YES
NO
OCR READER ERROR
YES
NO
INPUT MORE CONTROL BITS FROM OCR READER
DUMP SHEETS INTO INSERTER
OUTPUT SELECTION INFORMATION TO INSERTER
START INSERTER
RUNOUT SWITCH
YES
NO
STOP INSERTER
ERROR OCR READER
NO
YES
DISPLAY ERROR
WAIT FOR OPERATOR READY

FIGURE 10A.2

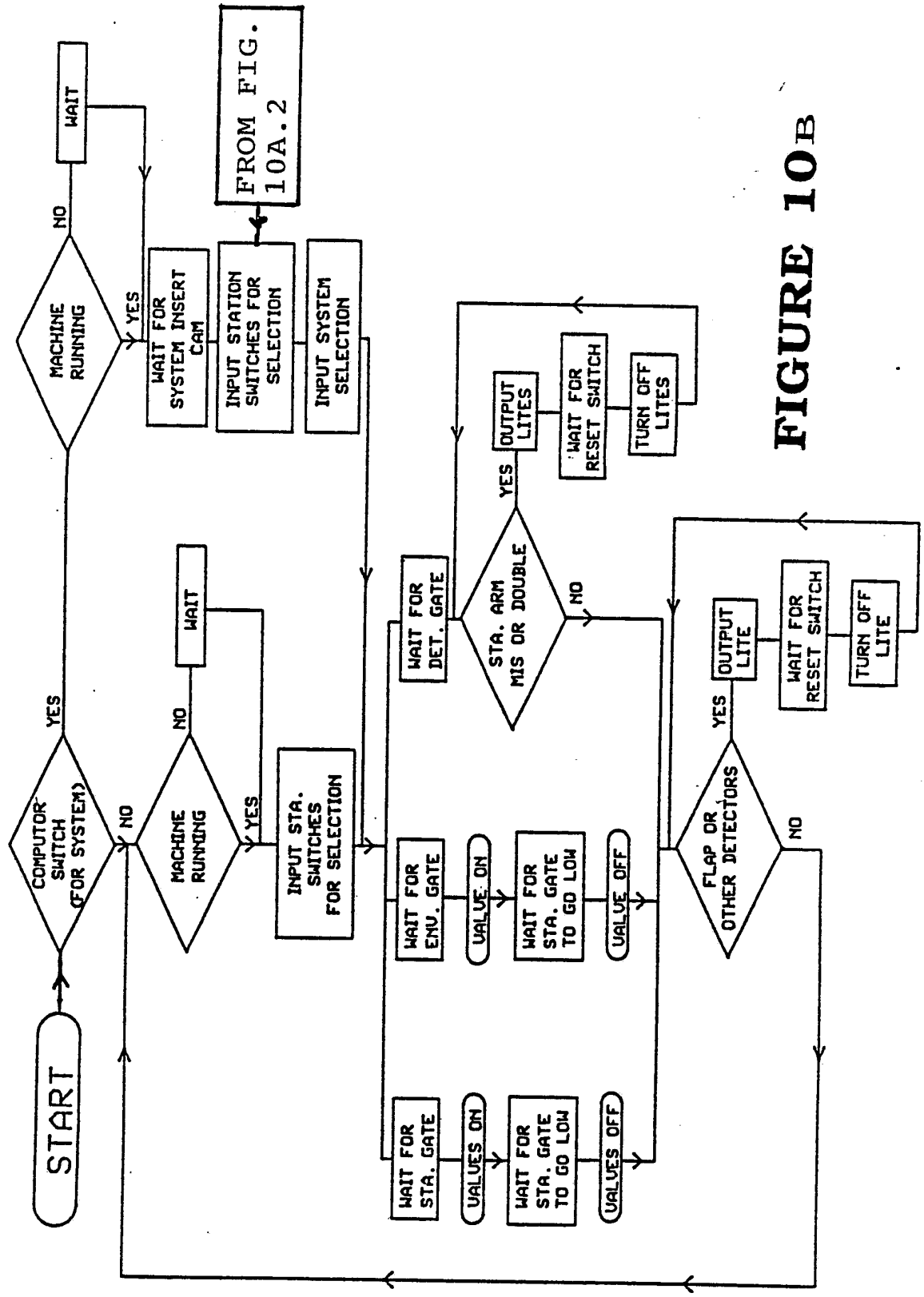

START
COMPUTOR SWITCH (FOR SYSTEM)
YES
NO
MACHINE RUNNING
YES
NO
WAIT
INPUT STA. SWITCHES FOR SELECTION
WAIT FOR ENV. GATE
VALVE ON
WAIT FOR STA. GATE TO GO LOW
VALVE OFF
WAIT FOR STA. GATE
VALVES ON
WAIT FOR STA. GATE TO GO LOW
VALVES OFF
MACHINE RUNNING
YES
NO
WAIT
WAIT FOR SYSTEM INSERT CAM
INPUT STATION SWITCHES FOR SELECTION
INPUT SYSTEM SELECTION
FROM FIG. 10A.2
WAIT FOR DET. GATE
STA. ARM MIS OR DOUBLE
YES
NO
OUTPUT LITES
WAIT FOR RESET SWITCH
TURN OFF LITES
FLAP OR OTHER DETECTORS
YES
NO
OUTPUT LITE
WAIT FOR RESET SWITCH
TURN OFF LITE

FIGURE 10B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/02294

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G06K 9/00; G06F 15/20
US CL :382/61

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 382/1,7,48; 235/383,462; 209/584; 395/148,478

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US,A, 5,034,985 (Keough) 23 July 1991. See the entire document.	1-3 4-5
Y	US,A, 5,025,475 (Okabe) 18 June 1991. See figure 2A and column 2, lines 22-41.	4-5
A	US,A, 4,862,386 (Axelrod et al.) 29 August 1989. See figure 3 and column 1, line 5- column 3, line 9.	1-5
A	US,A, 4,800,505 (Axelrod et al.) 24 January 1989. See figure 1 and column 3, line 64- column 5, line 61.	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published 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
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search 11 MAY 1993	Date of mailing of the international search report 30 JUN 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer for YON J. COUSO NGUYEN NGOC-HO INTERNATIONAL DIVISION Telephone No. (703) 305-4779

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