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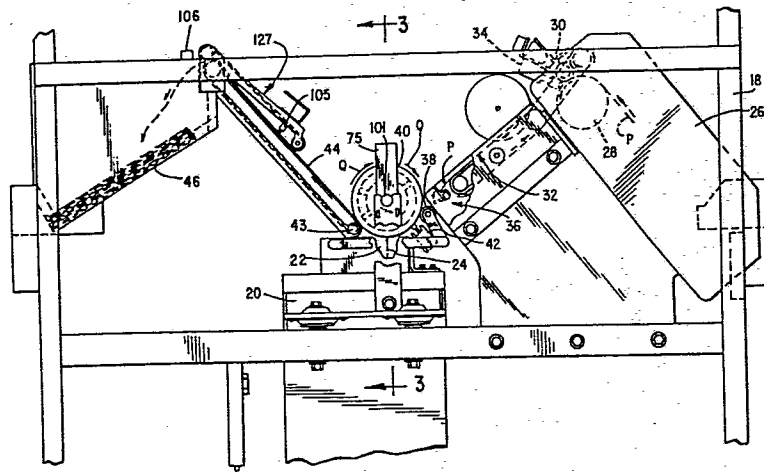
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(54) **Sheet transfer mechanism.**

(57) A sheet transfer mechanism includes a rotating, hollow drum with through apertures in the surface thereof, a negative pressure being drawn on the drum apertures for holding the document against the drum as the document is advanced through a processing zone, and a positive pressure being directed through the apertures for releasing the document from the drum when the document is in an exit zone.

FIG. 1



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SHEET TRANSFER MECHANISM1. Field of the Invention:

This invention relates to a sheet transfer mechanism for conveying a sheet of paper through a scanning station at a high rate of speed in synchronized relationship with scanning apparatus. In particular, the sheet transfer mechanism includes a perforated drum mounted for rotation about a hollow shaft which is divided into a vacuum hold-down chamber and a pressure release chamber.

2. Description of the Prior Art

In document processing machines it is generally

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necessary to scan an original document and project its image into scanning and or processing apparatus. In the past, this has been accomplished either by holding the document stationary while moving the scanning apparatus relative thereto or by placing the document on a movable platen for advancing it past a stationary scanning or viewing window. The present invention is directed to that family of devices for advancing a document past a stationary viewing window. There are many known devices of this type. Most common, of course, is the moving platen on which a sheet document is placed with its face facing the window, the platen and scanning or copying apparatus then being operated in synchronized relationship with one another.

It is also known to secure the document to a drum or cylinder either by clamps or by negative pressure, whereby rotation of the drum about its axis moves the document past the viewing window. For example, it is known to provide a cylinder for holding a single document, end-to-end, for rotating relative to a scanning apparatus, as shown in West German unexamined patent specification OS 25 55 037, filed December 6, 1975 and laid open June 8, 1977. As there shown, a document is held against the periphery of a cylinder by a single clamp which engages the opposite ends of the document and holds them securely in a recessed channel provided in the cylinder. This arrangement is disadvantageous in that it partially blocks the end edges of the original document. Further, the mounting arrangement can also damage the end edges of the document. A cylindrical document holder for

supporting a transparent master is also disclosed in West German unexamined patent specification OS 26 16 137, filed April 13, 1976 and laid open October 20, 1977. As there shown, the light source
5 for illuminating the transparent master is located within the cylinder and projects light through the document during the scanning operation. The means for holding a transparency on the cylinder is not disclosed.

10 All of the above described devices have a common drawback in that each requires either manual loading and unloading or, in the alternative, complicated, synchronised mechanisms for loading and unloading the document. Thus, in many cases either speed or
15 accuracy must be sacrificed in order to hold costs within reasonable limits. Further, the devices partially cover the document during the scanning cycle.

The transfer device of the present invention is intended to overcome the disadvantages of the prior
20 art by providing a simple mechanism which is capable of accurately and efficiently advancing a document past a stationary viewing window at a high rate of speed, within minimum recycle time, without obscuring any portion of the document from view of the scanning
25 apparatus.

SUMMARY OF THE INVENTION

Accordingly the present invention provides an
30 apparatus for engaging a sheet document disposed at an

entry zone, for advancing the document through a processing station and for thereafter releasing the document into an exit zone, the apparatus of the type comprising: a document transport means for engaging
5 the document; means for moving the transport means and the engaged document from the entry zone, through the processing zone and to the exit zone; said document transport means including a plurality of through apertures in communication with the surface of the document, wherein
10 there is included:

a) means for drawing a negative pressure through the apertures when said apertures are in the entry zone and the processing zone for attracting and holding the document against the document transport means as
15 the document is advanced thereby; and

b) means for exhausting a positive pressure outwardly through the apertures when said apertures are in the exit zone for thereby releasing the document from the transport means.

20 The mechanism may hold a portion of a document in precise spatial relationship with scanning apparatus at the processing zone without obstructing any portion of the document from the view of the scanning apparatus. The device is particularly well suited for advancing a
25 sheet of paper past a stationary scanning window at the processing zone at a high rate of speed for use in raster type scanning devices.

Preferably, an original sheet document or a stack of original sheet documents is disposed in a
30 document tray, wherein feed means in communication

with the tray advances the documents, in seriatum, from the tray to a control gate which is disposed in advance of the processing zone scanning apparatus. When a scanning cycle is initiated, the gate is activated, and
5 the sheet document thereat is advanced into and received by the hold down and advancing means of the present invention, whereby the document is advanced past the viewing window in synchronized relationship with the scanning apparatus.

10 In a preferred embodiment this is accomplished by using a perforated, cylindrical drum mounted for rotation about a hollow shaft which is subdivided into two stationary chambers - a vacuum chamber for generating a negative hold-down pressure at the periphery
15 of the drum, and a pressure chamber for generating a positive sheet-release pressure at the drum. As the advanced document is introduced into the vicinity of the drum upon activation of the control gate, leading edge perforations of the rotating drum move into communication
20 with the vacuum chamber, whereby the leading edge of the document is drawn toward the surface of the drum and held thereagainst by the negative pressure. As the drum continues to rotate, it engages and advances the document past the viewing window in synchronized relationship
25 ship with the scanning apparatus. Continued rotation of the drum advances the leading edge of the document into an exit zone, where the leading edge perforations of the drum pass from the vacuum chamber into communication with the pressure chamber. The positive
30 pressure thereat blows the document off the drum and

into exit conveying means, where the document is conveyed from the drum to a receiving station. In order to maintain accurate synchronization of the rotating drum with the exit conveying means, the drive mechanism for rotating the drum is directly linked to the exit conveying mechanism.

It is an aspect of the invention to provide for sheet hold-down means for receiving and advancing a sheet document past a viewing window without engaging any portion of the face of the document, and therefore, without obscuring any portion of the document during a scanning operation.

Other objects and features of the invention will be readily apparent from the attached drawings and the detailed description which follows:-

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front elevation view of a scanning module

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having a sheet transfer mechanism according to the teachings of the present invention.

FIG. 2 is a top elevation view of the module illustrated in Fig. 1.

5 FIG. 3 is a section view taken generally along the line 3-3 of Fig. 1.

FIG. 4 is a section view taken along the line 4-4 of Fig. 3.

10 FIG. 5 is a fragmentary view looking generally in the direction of arrow 5 in Fig. 2.

FIG. 6 is a fragmentary view loooking generally in the direction of arrow 6 of Fig. 2.

FIG. 7 is an elevation view of a drum support shaft in accordance with the teachings of the present invention.

15 FIG. 8 is a view, partially in section, generally corresponding to the view shown in Fig. 7.

FIG. 9 is an end view of the support shaft, looking generally in the direction of arrow 9 in Fig. 8.

20 FIG. 10 is a section view taken along line 10-10 of Fig. 8.

FIG. 11 is an end view of the support shaft looking generally in the direction of arrow 11 in Fig. 8.

25 FIG. 12 is a partial perspective view illustrating in detail the document infeed system of the transfer mechanism shown in Fig. 1.

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FIGS. 13 and 14 are additional partial perspectives illustrating, in particular, the operation of the control gate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With particular reference to Figs. 1 and 2, the sheet transfer mechanism of the present invention is shown mounted in a frame 18 with a scanning apparatus 20 having a stationary viewing window located at 22, whereby a scanning mechanism is adapted for scanning the paper along a line orthogonal to the plane of Fig. 1, generally in the vicinity of arrow 24. While any scanning apparatus may be used in conjunction with the invention, there is shown a raster scanning device for scanning advancing documents line-by-line with a primary scanning resolution of 300 lines per inch and a secondary scanning resolution of 300 picture elements (PELS) per inch. In the embodiment shown, it is contemplated that the scanning mechanism is adapted to read five inches of sheet material per second, i.e., the raster scanner mechanism completes 1500 scans per second.

The sheet transfer mechanism of the present invention is uniquely designed to accommodate a scanning mechanism operating at high rates of speed and will accurately convey one or more original sheet documents, in seriatum, past a viewing window in synchronized relationship with the scanning mechanism without obstructing any portion of the document from view. In accordance with the teachings of the present invention, the transfer

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mechanism is adapted for engaging and advancing one or a plurality of original documents, in seriatum, from a storage station remote from the viewing window to an entry zone adjacent the window where, upon initiation of a scanning cycle, a document in the entry zone is advanced into and engaged by vacuum hold down means which advance the document past the window in synchronized relationship with the operation of the scanner. As the document advances past the viewing window, it enters into an exit zone where the negative hold-down pressure is replaced with a positive release pressure for blowing the document into an exit conveyor for transporting the scanned document to a receiving station remote from the viewing window.

As shown in Fig. 1, the storage station 26 comprises a tray which, in well known manner, is adapted for receiving and holding a plurality of original documents P to be fed; in seriatum, from the bottom of a stack, face down, into an infeed device for transporting the documents to the entry zone. With particular reference to Figs. 2 and 12, it will be seen that a cylindrical, hollow drum 28 is mounted for rotation and is disposed in communication with the tray 26. When a sheet document is to be fed from tray 26 into the infeed conveyor, a continuous vacuum is drawn on drum 28 by means 29 (Fig. 12), creating a negative pressure at through apertures 48 provided in the drum. The negative pressure draws the bottom sheet in the tray into engagement with the drum at the apertures 48. A roughened surface 50 is provided on the drum in the vicinity of apertures 48 for

providing a better gripping force for engaging the paper sheet to be advanced. In practice, it has been found that the addition of surface 50 on the drum permits the tray capacity to be as much as two-hundred sheets of twenty pound stock 8-1/2 x 11 inch paper without adversely affecting the performance of the infeed operation. Once the sheet is engaged by the drum, the drum is indexed counterclockwise (as shown in Fig. 1) to advance the leading edge of the sheet P into the nip rolls 30. When the drum is in the forward indexed position, the roughened surface does not touch the document sheet and the friction between the drum and the sheet is reduced. The document is propelled into the infeed conveyor 32 by the nip rolls. A nip switch sensor (not shown) detects the presence of the lead edge of the sheet and signals to a controller (also not shown) to shut off the vacuum at drum 28, in well known manner. When the trail edge of the sheet leaves the nip switch, a signal is sent to the controller to index the drum clockwise to home position where the drum perforations are placed to attract and engage the next sheet in the tray upon command from the controller.

It will be noted that drum 28 includes a pair of circumferential races 29, 29, each adapted for receiving a ring bearing 31. The ring bearings are rotatable relative to the drum and are engaged and driven independently thereof by the driven nip rollers 30 mounted on drive shaft 33. During operation, as the drum 28 is indexed toward the nip rollers 30 and the sheet is advanced onto conveyor 32 by the nip rollers 30, the ring bearings reduce the friction between the paper and the drum.

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A sensor 34 is provided for gauging the thickness of the document sheet being introduced onto conveyor 32. If the document is not within a specified thickness range, the sensor indicates to the controller the presence of a malfunction, such as the simultaneous feeding of two sheets onto the conveyor. In the event of malfunction, the system is shut down and the operator is signalled.

As the nip rolls propel the sheet onto the infeed conveyor 32, a pair of edge guides 109 guide the sheet to align it for side-to-side registration during scanning. The sheet is then advanced by the endless conveyor 32 to an entry zone defined by the control gate 36. Sensors 107 are provided for detecting proper orientation of the sheet. For example, a document header sheet may be provided as shown and described in the copending application Serial No.: (case No. 79117), entitled: Header Sheet For Document Generator System, and assigned the present assignee.

Upon initiation of a scanning cycle, the control gate 36 is activated, as will be explained herein, and swings from the closed position shown in Fig. 1 to the open, phantom position (also see Fig. 13), whereby the sheet P is advanced by the endless conveyor 32 into nip rolls 38. The drum 40 is in driving contact with the nip rolls and provides the sole driving force therefor in order to establish a synchronized driving relationship of the nip rolls 38 with the drum 40. The sheet P is introduced into contact with the drum 40 and is held thereagainst by negative pressure as the drum rotates in the direction of the arrow Q (Fig. 1) for

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advancing the sheet past the viewing window 22. The raster scan mechanism 20 of the illustrated embodiment scans the sheet document, line-by-line, as the sheet is advanced past the viewing window. In order to properly coordinate the scanning cycle with the rotation of the drum 40, a document lead-edge sensing device 5 42 is provided in communication with drum 40 at the entry zone and in advance of the viewing window 22. As the leading edge of the document moves past the sensing mechanism 42, the mechanism senses the presence of the document and is operable to activate the scanning operation when the lead edge of the document enters the view- 10 ing window.

As the drum 40 rotates, the leading edge of the sheet P passes from the viewing window 22 into an exit zone in communication with a sheet release means whereby the sheet is dis- 15 engaged from the drum and placed on an exit conveyor, by which it is transported to a receiving station 46. In the preferred embodiment, a set of endless belts 44 is disposed in driven communication with the drum 40 at the exit zone. The endless belts are trained over pulleys 43 for defining nip rolls which receive 20 the sheet P and propel it onto the conveyor. The drum 40 engages the belts at the rolls 43 to provide the driving force for conveyor 44 and thus assure that the exit conveyor 44 is operating in synchronized relationship with the drum.

In the preferred embodiment, drum 40 is mounted on a 25 hollow stationary shaft 54 which is subdivided into a vacuum chamber 58 and a pressure chamber 60 by the elongate axial vane or

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divider 56 (see Fig. 4). As shown, the shaft is a cylindrical tube made of a rigid material such as, by way of example, aluminum, with a plurality of radial through apertures 62 in communication with vacuum chamber 58 and a plurality of like apertures 64 in communication with pressure chamber 60. The shaft 54 is mounted in the drum assembly frame 75 in typical manner and sealed by end-caps 77, 79 to provide sealed chambers. A vacuum source is coupled to chamber 58 at port 90, whereas a pressure source is coupled to chamber 60 at port 92 (see Figs. 11 and 13).

The drum 40 is mounted on bearings 94 in typical manner for rotation about the hollow shaft 54. A plurality of vanes 66 extend axially along and project radially from the peripheral surface of the shaft 54. The vanes are in sealing relationship with the inner wall of the drum 40 for defining chambers 68, 70 and 72 in the open space between the hollow shaft 58 and the interior of the drum 40. Typically, the vanes are made of a flexible, low friction material such as, by way of example, nylon 6/6, and are placed in direct, sealing contact with the inner surface of the drum 40. As the drum rotates in the direction illustrated in Fig. 1, the through apertures in the drum 40 are rotated progressively from chamber 68, to chamber 70 and thence, to chamber 72.

The vacuum drawn on chamber 58 generates a negative pressure in chamber 68 and at the apertures in communication therewith, whereas the positive pressure introduced into chamber 60 provides a positive pressure in chamber 70 and at the apertures in communication therewith. Since no apertures are provided in shaft

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58 in communication with chamber 72, this area defines a neutral zone wherein apertures of the drum 40 are not subjected to any pressure differential.

5 In the preferred embodiment, a drive motor 78 is mounted on frame 75 for driving, in typical fashion, the drum 40 in rotation about the shaft 54 through the pulley and belt drive 94, 96. The motor is controlled in well-known manner in synchronized relationship with the scanning apparatus 20 (Fig. 1). The frame 75 is hingedly mounted at 93 to the machine frame 18, whereby the entire drum assembly may be pivoted away from viewing window 22 to clear the paper track in the event of malfunction and also for ease of maintenance. As shown, a latch 99 is provided on the frame 18 and is adapted for receiving the projecting post 101 of the end-cap 77. In the embodiment illustrated, a spring detent latch is shown. The latch locks the drum assembly in position during operation, yet permits pivoting of the assembly about hinge 93 to approximately the angle represented by center-line CL, for maintenance and clearing of the paper track. A second latch (not shown) may also be provided for holding the drum in the open position.

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Typically, the leading edge of the advancing document is introduced into the drum at the entry zone defined by gate 36. At this point in rotation, the apertures 52 and 152 of drum 40 are in communication with the vacuum chamber 68 defined by the boundary vanes 66. The negative pressure at apertures 52 and 152 draws the paper toward the drum surface and holds it thereagainst as the drum is rotated in the direction of the arrow. Apertures 52 and

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152 are provided at the leading edge engaging portion of drum 40 and provide increased pressure thereat for engaging the leading edge of the paper. A reduced force is provided by apertures 52 only over the remainder of the drum. As the leading edge of the document reaches the exit zone defined by nip rollers 43, the apertures 52 and 152 pass from the vacuum chamber 68 to the pressure chamber 70 whereby the positive pressure differential blows the document off of the drum and releases it onto the exit conveyor 44. In this manner the drum provides both the hold-down mechanism and the release mechanism for first engaging and advancing the document past the viewing window and then releasing it onto an exit conveyor. This arrangement, of course, minimizes the number of mechanisms which have to be synchronized in order to properly advance a document in synchronization with the scanning apparatus. The vacuum and pressure sources may be continuous, with rotation of the drum providing the shift in operation from a hold-down mode to a release mode. Typically, a negative pressure of five p.s.i.g. has been found sufficient to attract and hold a single sheet of 20 lb. stock paper against the drum as it rotates past the viewing window. A positive pressure of about five or more p.s.i.g. has been found sufficient to blow the paper off of the drum and release it onto the exit conveyor.

Document path detectors 103 and 105 are provided in order to ensure orderly and proper movement of an advancing document P from the infeed tray 26 to the scanning window 22 and from there through exit conveyor 44. A document exit sensor 106 is

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provided in advance of exit tray 46. The sensors 103, 105, and 106 will automatically sense the presence of each document at that point in the paper path and, in the event of malfunction, the operator is signalled and the system is shut down in well known manner.

With particular reference to Figs. 13 and 14, it will be noted that the control gate 36 comprises a pair of abutments 111, 113 mounted on a shaft 115 which is mounted in frame 18 for axial rotation. A lever 117 is provided at one end of shaft 115, and a tension spring 119 is secured thereto for continuously biasing and urging the abutments 111 and 113 into the closed, document intercept position. A solenoid 121 includes actuator piston 123 in communication with lever 117, whereby actuation of the solenoid and movement of the actuator piston pivots lever 117 and opens the abutments. This allows document sheet P to be advanced by conveyor 32 into contact with drum 40. The solenoid is synchronized with rotation of the drum 40 such that the control gate opens to feed the sheet when apertures 52 and 152 of the drum are in position to receive the lead edge of the sheet.

Also shown in Fig. 14 (see also Fig. 1), the upper portion 127 of the exit conveyor is hingedly mounted on supports 129 by shaft 131. This permits pivoting of the upper conveyor portion 127 out of the document path for maintenance and/or for clearance of the document path in the event of malfunction. Thus, the hinged supports 93, 129 for the drum assembly frame 75 and the

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exit conveyor 127, respectively, provide easy access to the entire document path.

While certain elements and features of the invention have been described in detail herein, it will be understood that
5 modifications and alterations may be made without departing from the scope and spirit of the invention as defined by the appended claims.

What is Claimed is:

1. An apparatus for engaging a sheet document disposed at an entry zone, for advancing the document through a processing station and for thereafter releasing the document into an exit zone, the apparatus of the type comprising: a document transport means for engaging the document; means for moving the transport means and the engaged document from the entry zone, through the processing zone and to the exit zone; said document transport means including a plurality of through apertures in communication with the surface of the document; wherein there is included:

a) means for drawing a negative pressure through the apertures when said apertures are in the entry zone and the processing zone for attracting and holding the document against the document transport means as the document is advanced thereby; and

b) means for exhausting a positive pressure outwardly through the apertures when said apertures are in the exit zone for thereby releasing the document from the transport means.

2. The apparatus of Claim 1, wherein:

a) the transport means comprises a hollow drum having a peripheral surface adapted for engaging a surface of the sheet document, the peripheral surface of the drum including said plurality of apertures for communicating the hollow interior of the drum to the peripheral surface; and

b) said means for moving the transport means comprises drive means for rotating the drum in a direction advancing its peripheral surface from the entry zone, through the processing zone and to the exit zone.

3. The apparatus of Claim 2, further comprising means for subdividing the hollow interior of the drum into a vacuum chamber which, via said apertures, is in communication with said entry zone and said processing zone, and a pressure chamber which, via said apertures, is in communication with said exit zone.

4. The apparatus of Claim 3, further comprising means for continuously drawing a negative pressure on said vacuum chamber, and means for continuously introducing a positive pressure in said pressure chamber.

5. The apparatus of Claims 3 or 4, including:

a) a hollow shaft having a peripheral surface including apertures therethrough for communicating the hollow interior of the shaft to its periphery;

b) means for mounting the hollow drum for rotation about the hollow shaft;

c) said subdividing means separating the interior of the hollow shaft into the vacuum chamber and the pressure chamber; and

d) a plurality of sealing means projecting radially outward from the periphery of the shaft into sealing engagement with the drum for further subdividing into the interior of the drum into distinct, isolated sub-chambers, whereby rotation of the drum about the shaft advances the apertures in the drum from sub-chamber to sub-chamber.

6. The apparatus of Claim 5, including three radially spaced sealing means for subdividing the interior of the drum into three distinct sub-chambers, wherein the shaft apertures in communication with the vacuum chamber are disposed in communication with a first of said sub-chambers at the entry zone and the processing zone, wherein the shaft apertures in communication with the pressure chamber are disposed in communication with a second of said sub-chambers at the exit zone and wherein a third of said sub-chambers is not in communication with any of said shaft apertures, thereby creating a neutral zone.

7. The apparatus of any one of Claims 2 to 6, wherein said drum is rotated in one direction for advancing the peripheral apertures therein first through the entry zone, second through the processing zone, third through the exit zone, and then fourth through the neutral zone, the drum further including a greater concentration of apertures in the region of the periphery of the drum which initially enters each zone.

8. The apparatus of any one of Claims 2 to 7 further including:

- a) means for storing a plurality of sheet documents at a position remote from said entry zone;
- b) means for advancing the documents, in seriatum, from the storing means to the entry zone; and
- c) means for receiving the documents released, in seriatum, from the drum at the exit zone.

9. The apparatus of Claim 8, including a gate disposed intermediately of the document storing means and the entry zone, and means for selectively operating said gate to selectively intercept documents being advanced by the advancing means.

10. The apparatus of Claim 9, further including:

- a) means for processing a document as it is advanced by the drum through the processing zone; and
- b) control means for synchronizing the processing means with an advancing document, said control means operable to co-ordinate operation of said gate with said processing means.

11. The apparatus of Claim 10, further including means associated with the control means for sensing the location of an advancing document.

12. The apparatus of any one of Claims 8 to 11, in which said storing means includes:

- a) means for storing the plurality of sheet documents in a stack; and
- b) means for feeding the documents, in seriatum, from the bottom of the stack onto said document advancing means.

13. The apparatus of any one of Claims 8 to 12, in which the document receiving means further comprises:

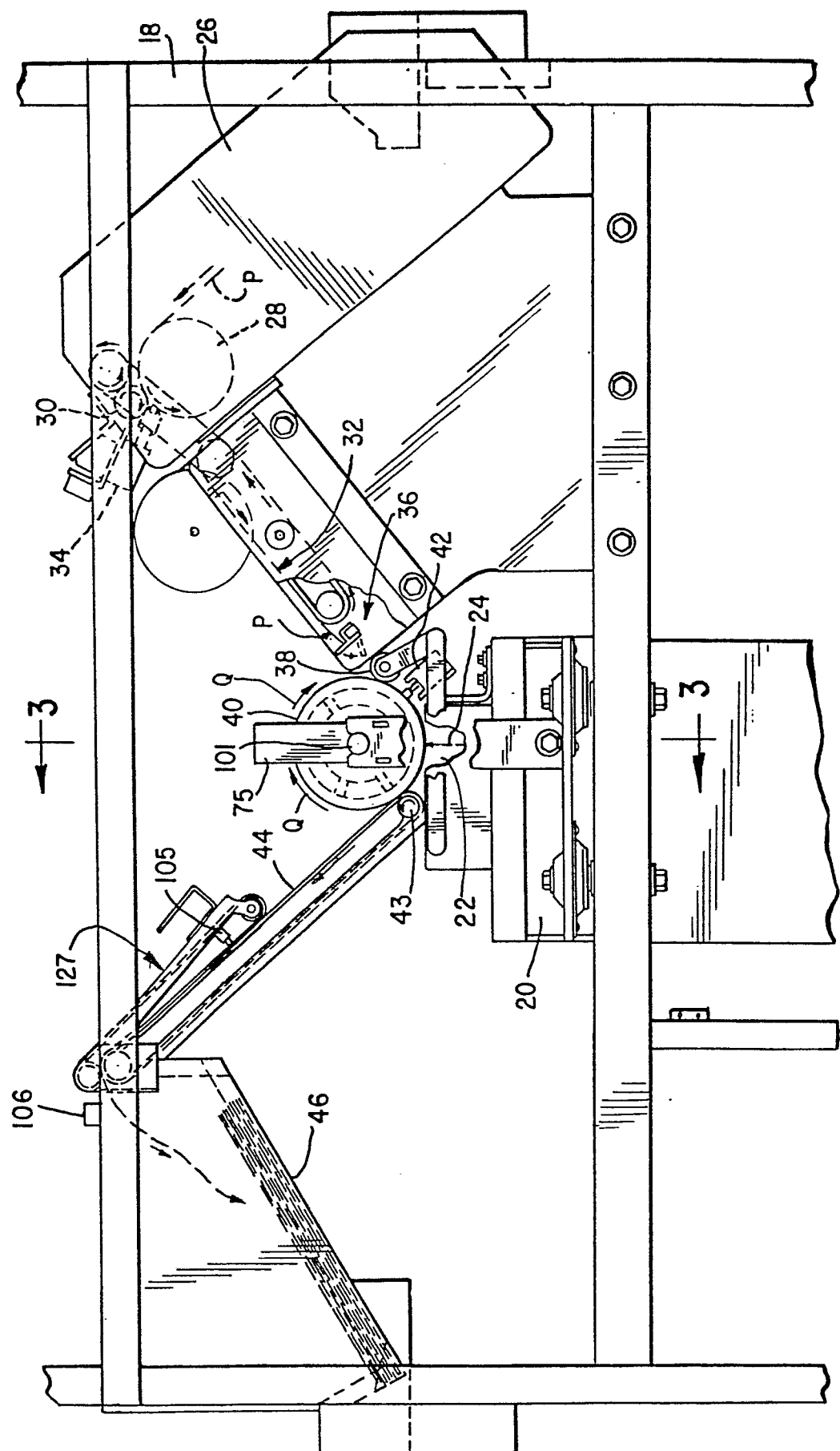
- a) a document storage means remote from said exit zone;
- b) a driven exit conveyor disposed intermediately of the exit zone and the storage means for transporting released sheet documents from the drum to the storage means.

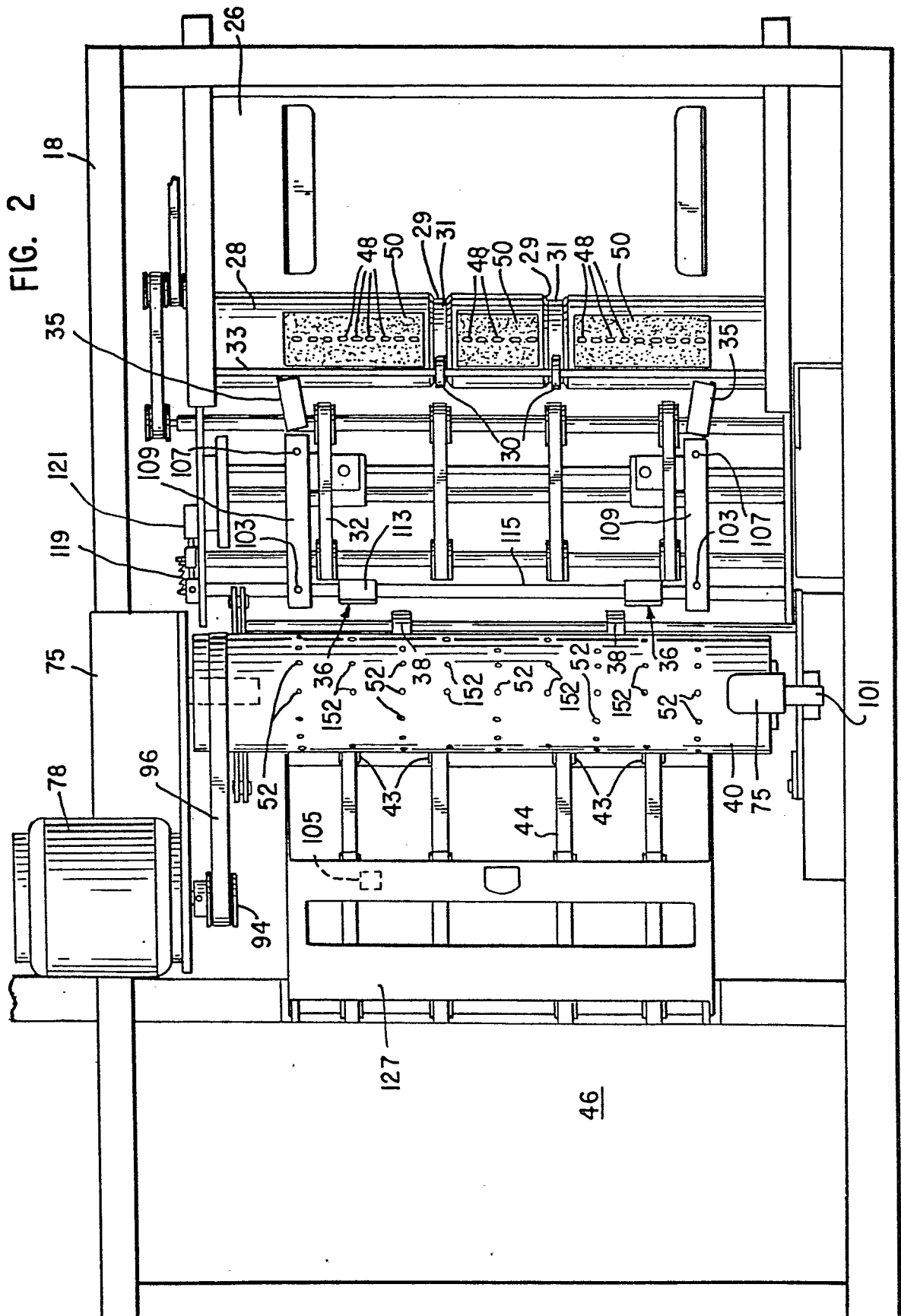
14. The apparatus of Claim 13, including common drive means for said drum and said exit conveyor.

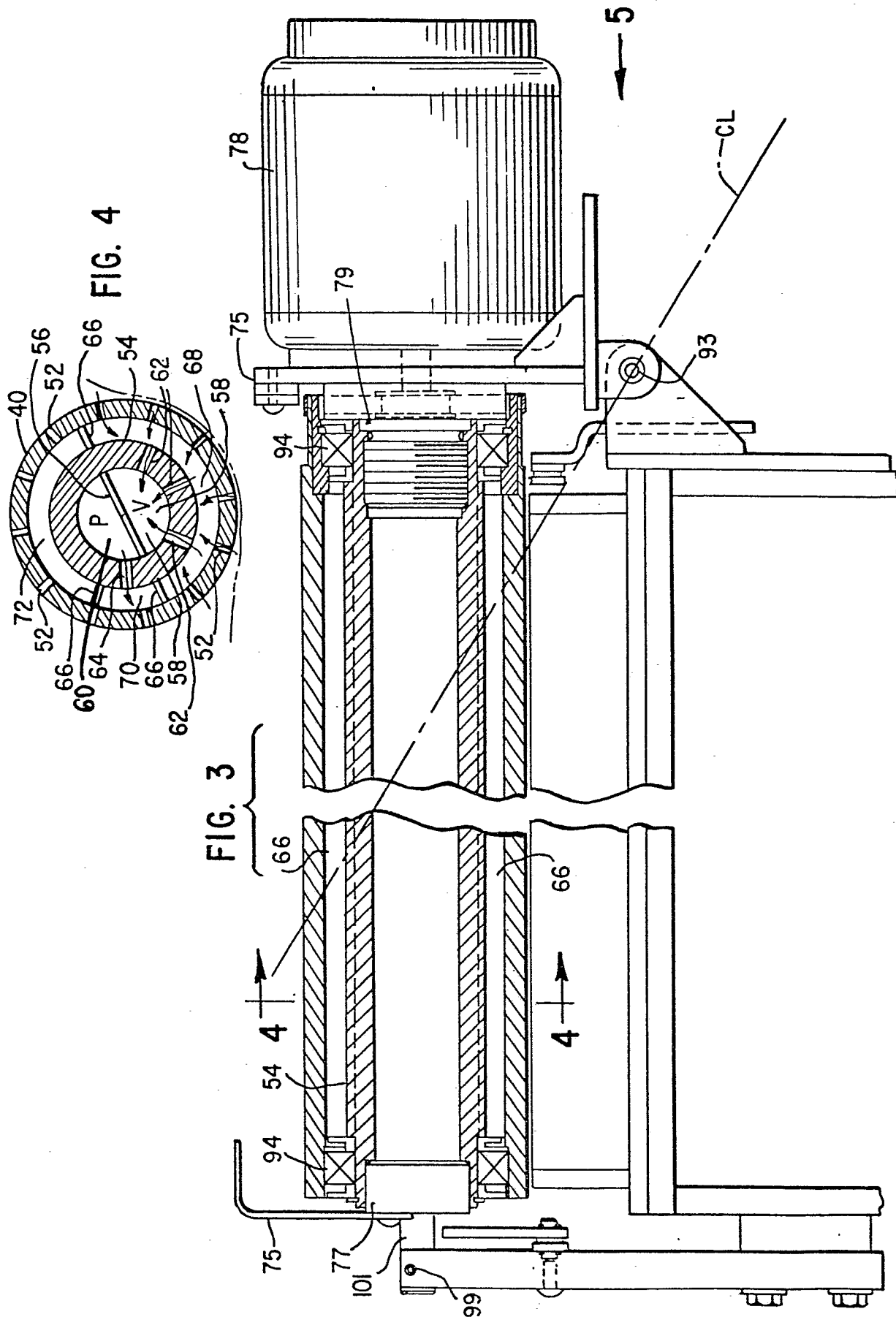
15. The apparatus of Claim 14, in which said drum provides the sole drive linkage between the common drive means and the exit conveyor.

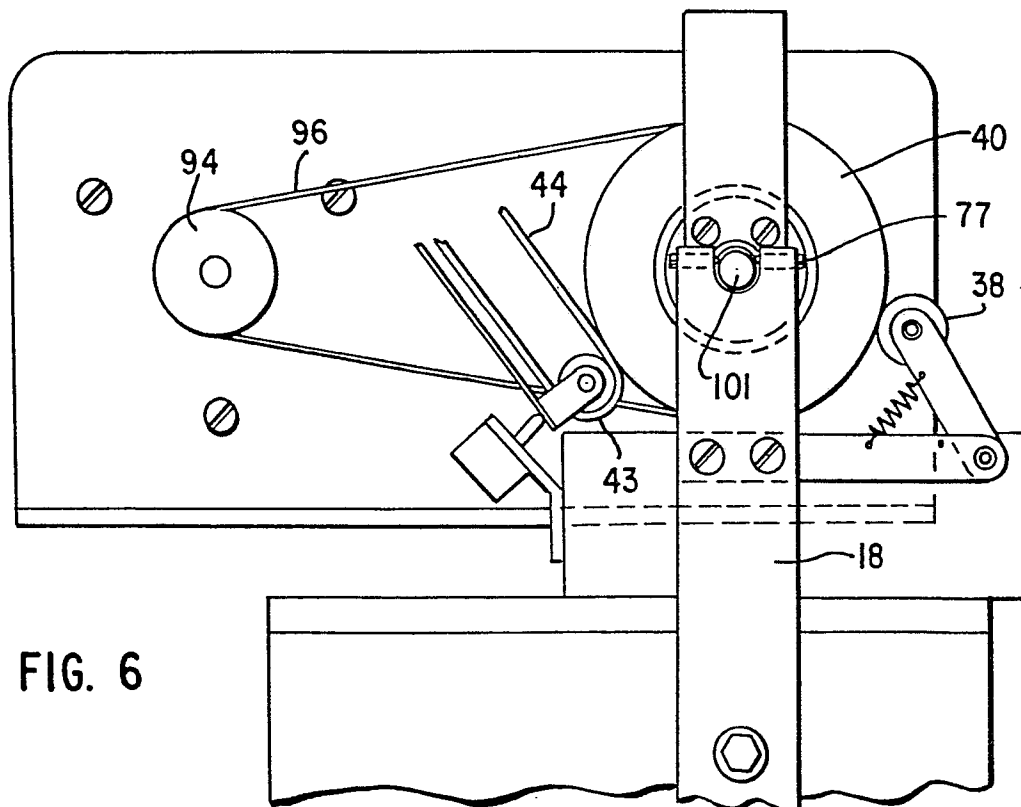
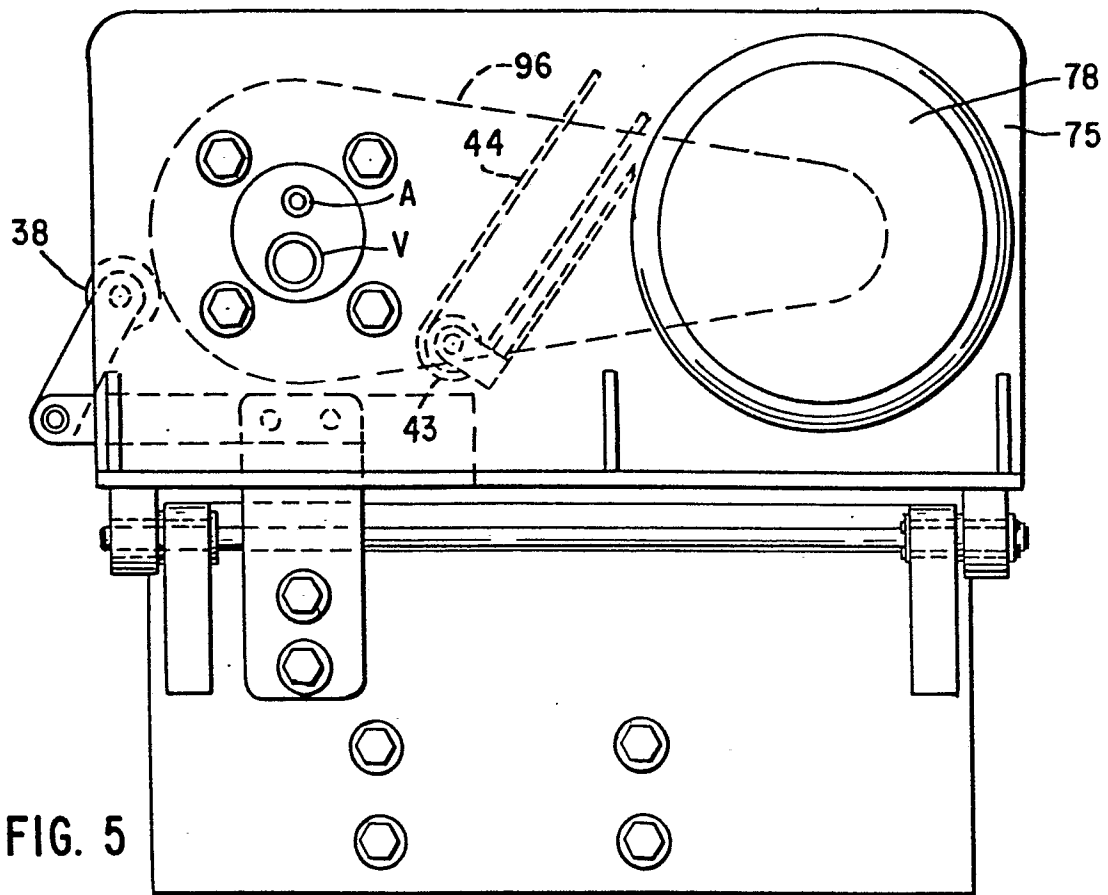
16. The apparatus of any one of Claims 8 to 15, in which the means for advancing the documents, in seriatum, from the storage means to the entry zone comprises a hollow drum having through apertures in the periphery thereof whereby a vacuum may be drawn on the drum for attracting a document thereto, a friction surface on the drum in the vicinity of the apertures, and means for selectively moving the friction surface into and out of the document path as the document is advanced from the storing means into the entry zone.

FIG. 1









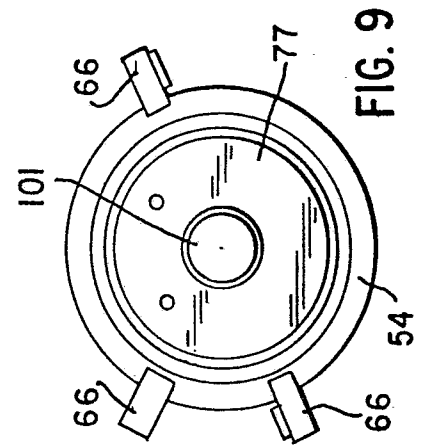
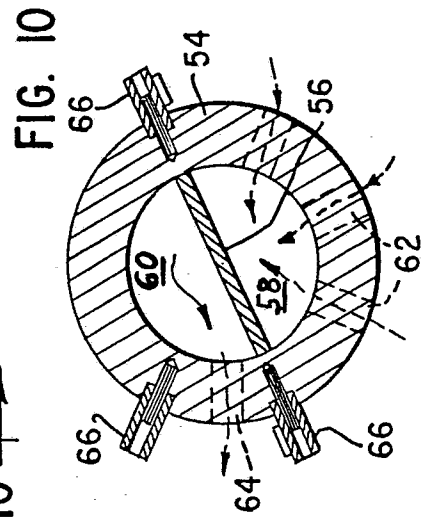
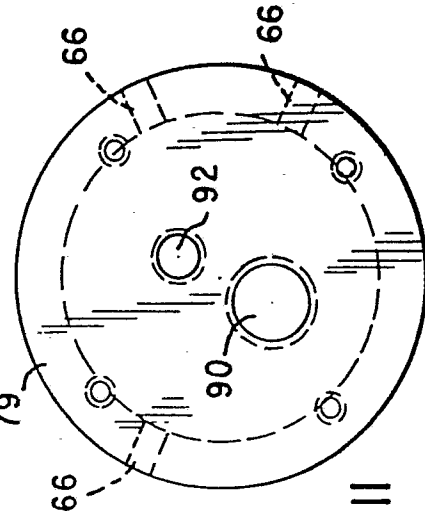
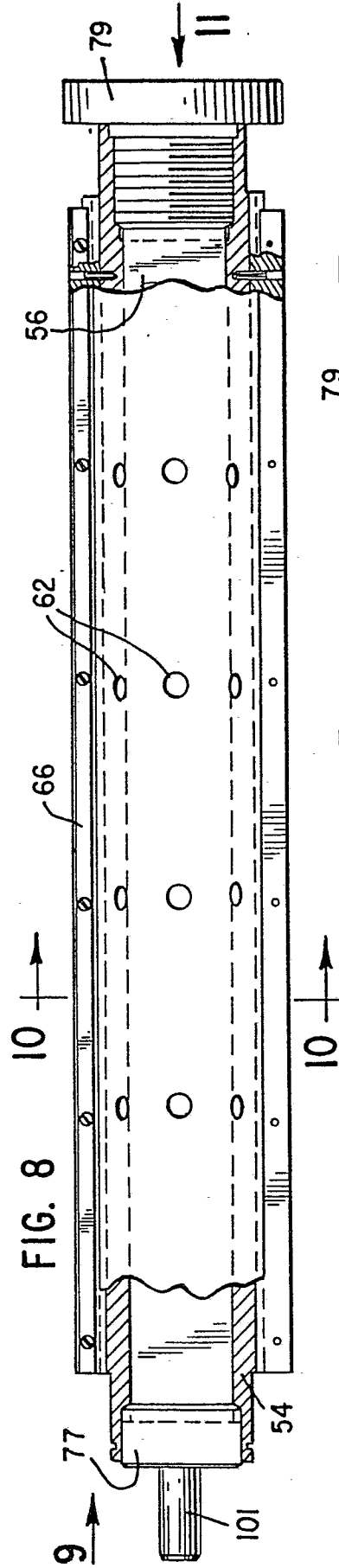
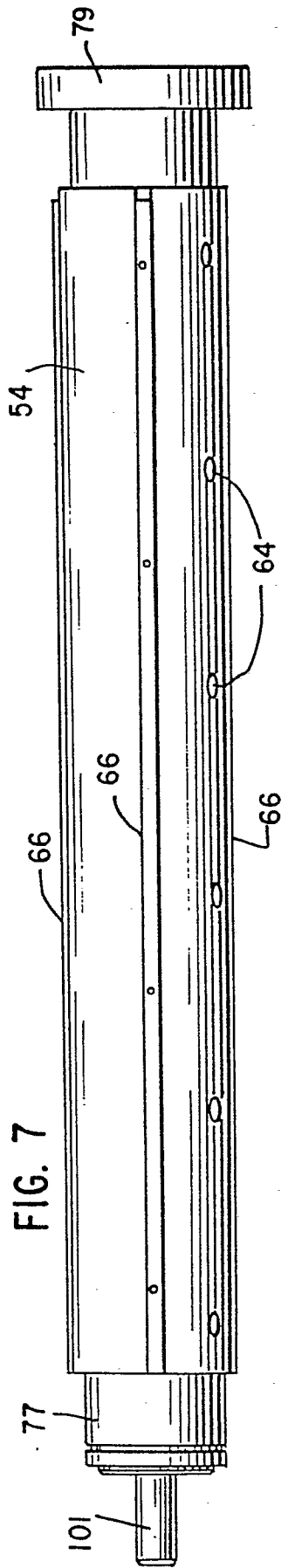


FIG. 12

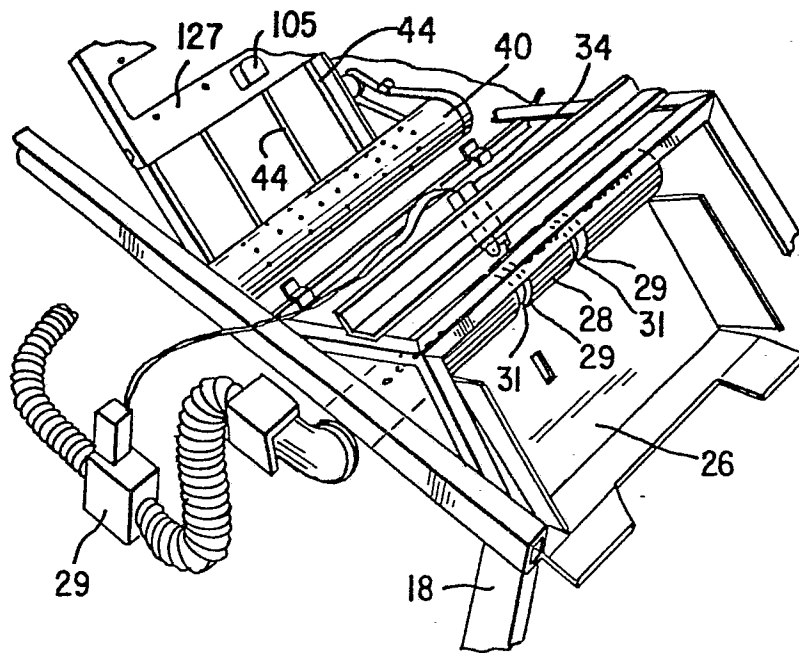


FIG. 13

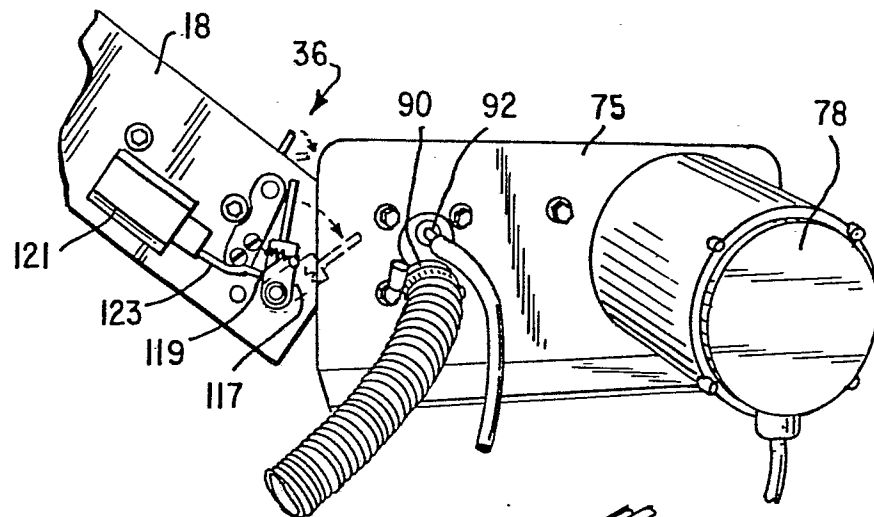


FIG. 14

