United States Patent

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[73] Assignee **Recognition Equipment Incorporated Dallas, Tex.**

[54] **MULTI-ITEM DETECTOR**
8 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** 271/56, 73/37.7
[51] **Int. Cl.** **B65h 7/02**
[50] **Field of Search** 271/56, 47, 64; 73/37.5, 37.7

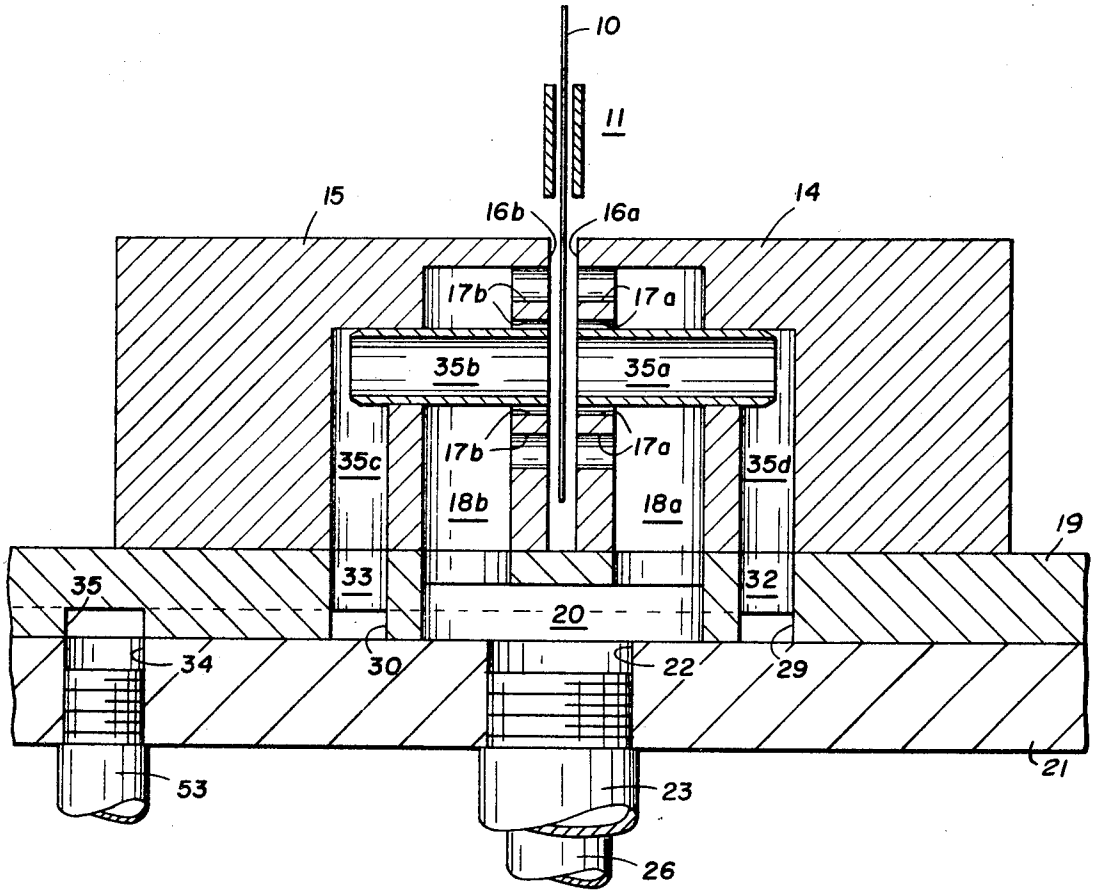
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ABSTRACT: Apparatus for detecting the occurrence of a simultaneous multiple feed of documents when a vacuum source operates on documents being carried away from a document feeder so as to attract the documents toward a sensing station having an exhaust port for positive air pressure. A multiple feed of documents increases the pressure at the exhaust port. A pressure sensing device is coupled to the exhaust port for detecting such increase in pressure, thereby detecting a multiple feed of documents.



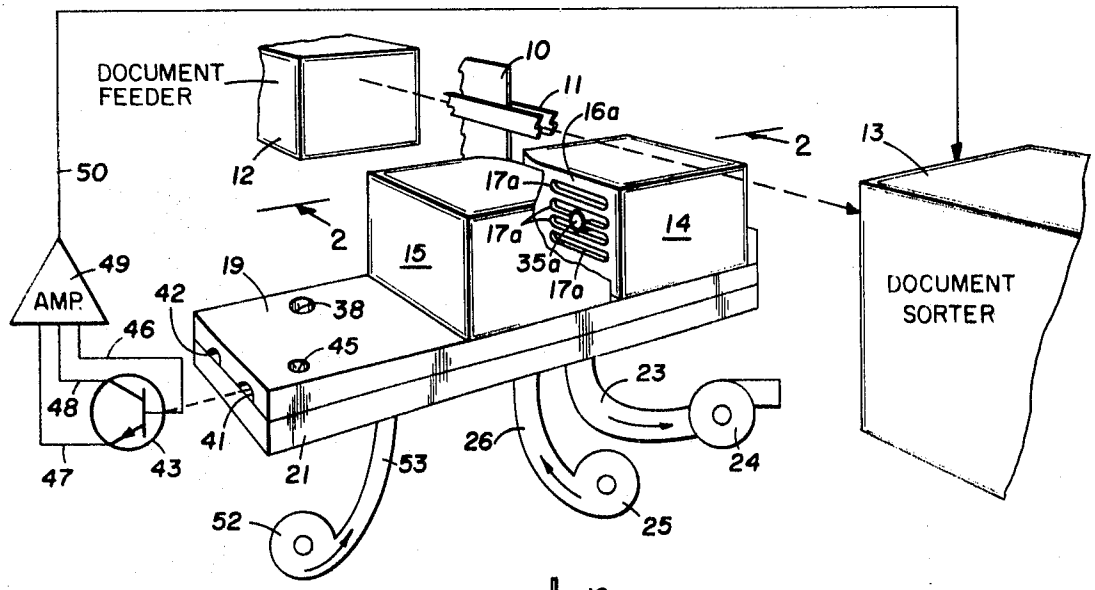


FIG. 1

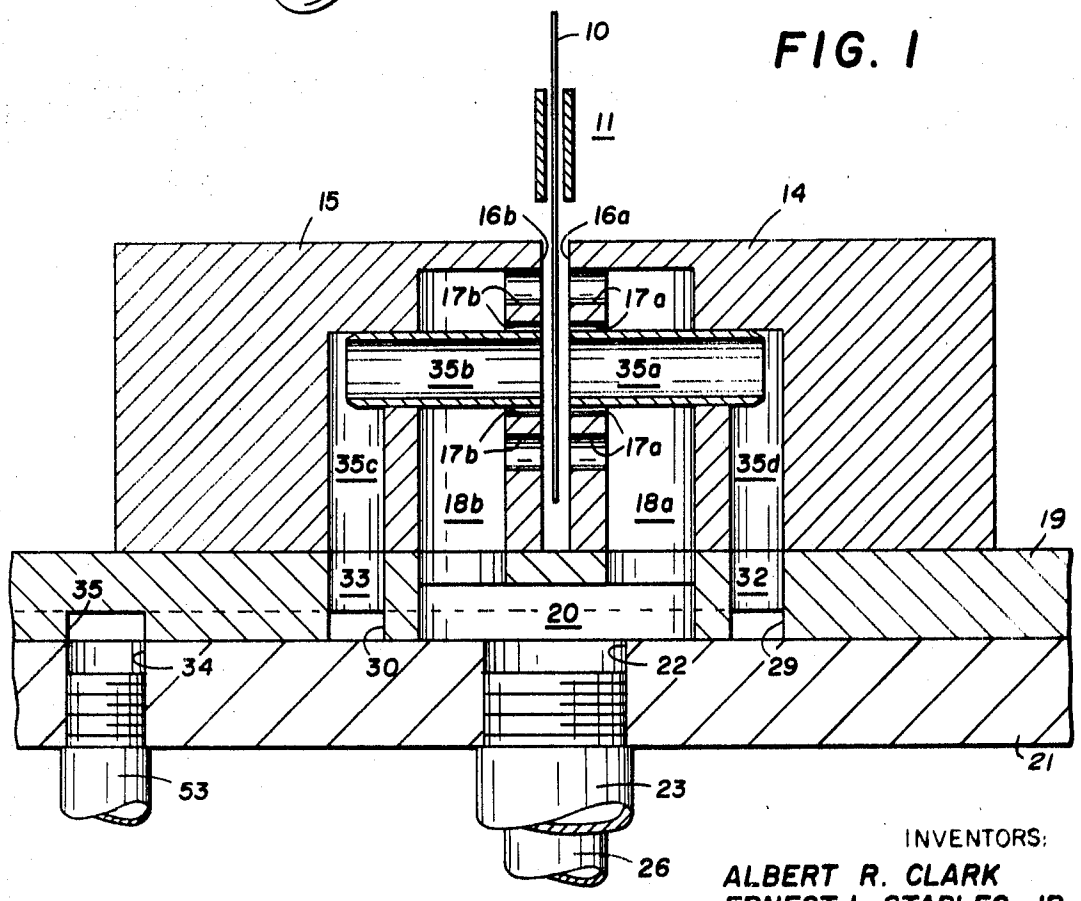


FIG. 2

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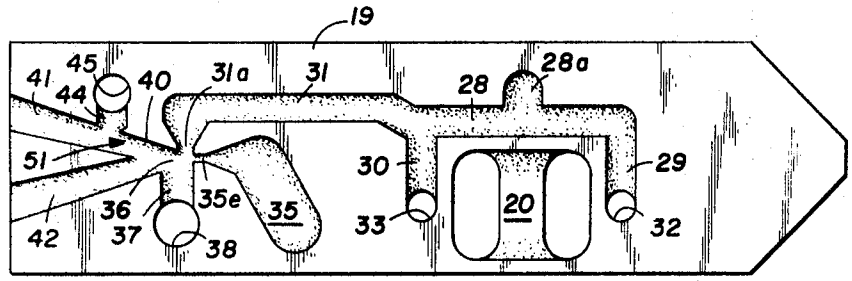


FIG. 3

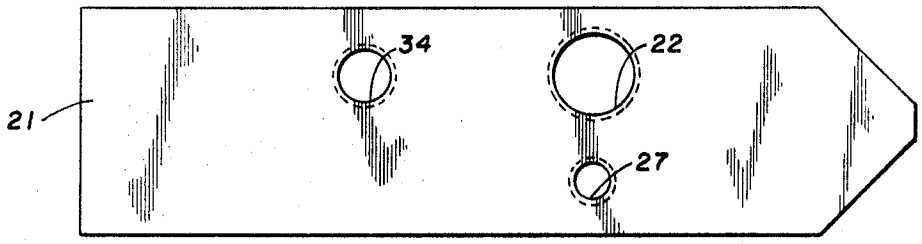


FIG. 4

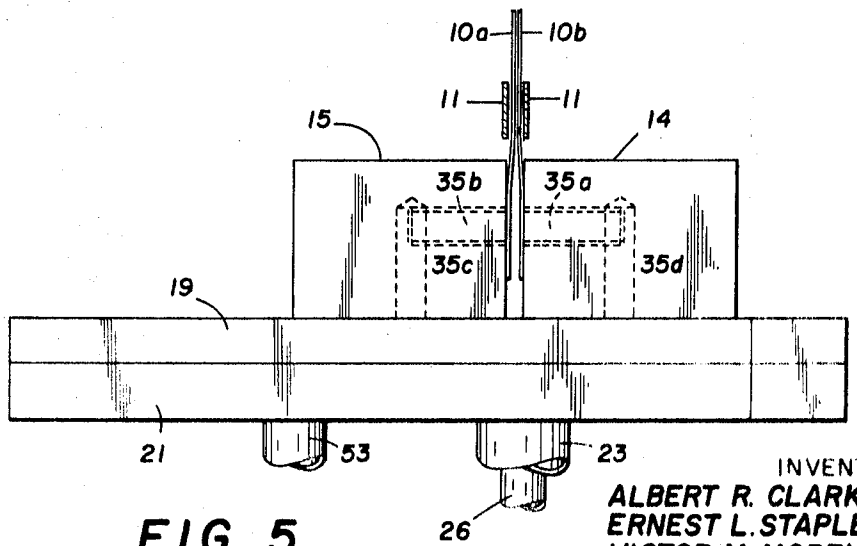


FIG. 5

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MULTI-ITEM DETECTOR

This invention relates to document feeding and more particularly to sensing the passage of more than one document at a time along a document travel path.

BACKGROUND OF THE INVENTION

Systems have heretofore been developed for feeding documents into document handling systems such as document sorting devices and document reading devices. Such documents may take a variety of forms, such as relatively thick punched cards and relatively thick bank checks.

Document feeders may operate at extremely high speeds and feed documents one at a time through a conveyor to a handling system. A high-speed document feeder is disclosed in U.S. Pat. No. 3,300,207. While such document feeders have been developed so as to minimize the feeding of more than one document at a time into the conveyor, a problem arises when more than one document at a time reaches the document handling station. A need, therefore, exists for detecting the multiple feeding of documents so that appropriate operations may be performed by the system either to prevent the multiple fed documents from reaching the document handling station or to allow the document handling station to reject the multiple fed documents.

In the prior art, vacuum sensing means have been placed on opposite sides of a document pathway such that a multiple feed of documents is detected by the contraction and expansion of bellows used in conjunction with the vacuum air source. The effect of various and intermixed weights and flexibilities of the documents upon the vacuum sensing means and of slight variations in the separation vacuum (which also operates the bellows) has made such a method of detection highly unreliable. A need, therefore, exists for a reliable system of detecting the multiple feeding of documents which is independent of the physical characteristics of the documents or of the adjustment of the vacuum sensing means.

In accordance with the present invention, a vacuum field is applied on opposite sides of a document pathway and a positive airfield is applied in the zone of the vacuum fields. Multiple fed documents, when attracted by the vacuum fields, cause an increase in pressure in the positive airfield which is sensed.

More particularly a pair of document sensing blocks are located on each side of a document pathway having apertures to which a vacuum is applied and having an exhaust port through which air under positive pressure flows. A fluid-detecting device is coupled to the sensing blocks for sensing an increase in the positive pressure at the exhaust ports when documents simultaneously are drawn to both sensing blocks.

Preferably air under positive pressure flows to two channels. One channel allows air to exit out of the exhaust port of each block member facing the document pathway, while the other channel simultaneously applies positive air pressure to a pressure detecting device. As air flows in, the first of said channels is impeded by multiple fed documents being attracted toward both blocks simultaneously by the vacuum pressure, the positive pressure will increase in the second of said channels leading to the fluid-detecting device.

DESCRIPTION OF THE DRAWINGS

For a further understanding of the invention, reference may now be had to the following description in conjunction with the accompanying drawings in which:

FIG. 1 illustrates the present document processing system and includes a perspective view of document sensing means;

FIG. 2 is a sectional view of the document sensing means taken generally along the section lines 2–2 of FIG. 1 and along section lines 2–2 of FIG. 3;

FIG. 3 is a perspective view of the bottom of the sensor plate;

FIG. 4 is a top view of the bottom plate; and

FIG. 5 is a schematic plan view illustrating the operational aspects of the document sensing means upon documents carried by the belt transport system.

THE PREFERRED EMBODIMENTS

In FIG. 1, a document **10** is transported by a dual belt transport system **11** (fragmentarily shown) from a document feeder **12** to a document sorter **13**. A suitable feeder is described in U.S. Pat. No. 3,300,207. As the document is advanced by the belt transport system, it passes between document sensor blocks **14** and **15** located on opposite sides of the document pathway.

In the sectional view of FIG. **2**, sensor blocks **14** and **15** are shown to be identical. Both are mounted on an upper baseplate **19** which in turn is mounted on a lower baseplate **21**. Face **16***a* of sensor block **14** faces one side of document **10** while face **16***b* of sensor block **15** faces the other side. As a document is passed between faces **16***a* and **16***b* it moves past multiple apertures **17***a* and **17***b* respectively. Apertures **17***a* and **17***b* lead to channels **18***a* and **18***b*. Channels **18***a* and **18***b* exit through the base of blocks **14** and **15** respectively and interconnect with each other in plate **19** so as to form a single channel **20** which exits through the bottom of plate **19** and interconnects with channel **22** in baseplate **21**.

A vacuum source **24** is connected to the bottom of baseplate **21** through a hose **23**. Vacuum source **24** may be of the type manufactured by The Singer Company, Diehl Division, Somerville, New Jersey and identified as Model F1321–VOR925–1. A vacuum of approximately 20 inches of water is drawn in sensor blocks **14** and **15** through apertures **17***a* and **17***b*. Exhaust air passes from sensor blocks **14** and **15** by way of channels **18***a* and **18***b* into channel **20** of sensor plate **19**, passes from plate **19** by way of channel **20** into channel **22** of baseplate **21**, and thence to the vacuum supply **24** by way of hose **23**. The function of such vacuum source will be described later.

A positive pressure air source **25** is also connected to baseplate **21** by way of hose **26**. The airflow passes through baseplate **21** by way of channel **27** and interconnects with channel **28** of plate **19**. Channel **28** is formed such that the portion **28***a* is of the same radius as channel **27**.

Plate **19** has a network of channels or grooves in the bottom thereof as shown in FIG. **3**. Channel **28** communicates with channels **29**, **30** and **31**. Channels **29** and **30** communicate with vertical channels **32** and **33** respectively which in turn communicate with channels **35***c* and **35***d* in sensor blocks **14** and **15** respectively. Channels **35***c* and **35***d* lead to exhaust ports **35***a* and **35***b* respectively.

In a preferred embodiment, the document belt transport **11**, FIGS. **1** and **5**, conveys documents from a document feeder **12** along a pathway between faces **16***a* and **16***b* of sensor blocks **14** and **15** respectively. The transport belts pass above sensor blocks **14** and **15**. Documents are grasped by the belts so that the lower portion margins are below apertures **17***a* and **17***b*.

The vacuum supply source **24** causes airflow into sensor blocks **14** and **15** through apertures **17***a* and **17***b*. The positive pressure source **25** causes airflow to exit out of sensor blocks **14** and **15** through exhaust ports **35***a* and **35***b*. Should two documents be transported simultaneously by the sensor blocks **14** and **15**, they will be diverted from a pathway immediately as they pass the two blocks. More particularly they will be drawn by vacuum into contact with the faces of blocks **14** and **15**. For example, in FIG. **5** document **10***a* is sucked by the vacuum against the face of block **14** and obstructs the flow of air out of exhaust port **35***a* while document **10***b* is sucked by the vacuum against the face of block **15** and obstructs the flow of air out of exhaust port **35***b*. The resultant obstruction of airflow from channel **28** into channels **29** and **30** causes an increase in pressure in channel **31** preferably to the equivalent of approximately an 8-inch column of water. Channel **31** leads to a fluid monostable amplifier **51**.

A second positive air supply source **52** supplies air at approximately 1.3 lbs./sq. in. of pressure to amplifier **51** by way of hose **53**. Hose **53** connects to channel **34** in baseplate **21**. The air flows through channel **34** in baseplate **21** into channel **35** of sensor plate **19**. Channel **35** is formed such that the end of channel **35** which interconnects with channel **34** is of the

same radius as channel 34. The opposite end of channel 35 is constrictive so as to create a power jet 35*e* through which the airflow exits out of channel 35. As the airflow emerges from power jet 35*e* it enters mixing zone 36.

Channels 31 and 37 lead into mixing zone 36 perpendicularly and on opposite sides of the airflow out of power jet 35*a*. Channel 31 narrows its point of entrance into the mixing zone so that it is approximately one-half the diameter of channel 37. Horizontal channel 37 interconnects with vertical channel 38 which exits out of the top of plate 19 into the atmosphere.

As the airflow emerges from power jet 35*e* it attaches, because of the Coanda effect, to wall 40 which is directly opposite the entrance of channel 37 and the mixing zone 36. The effect of ambient air pressure on mixing zone 36 by way of channel 37 reduces the pressure between the airflow from the power jet 35*e* and wall 40. Because of this lower pressure, the airflow bends toward and eventually attaches to wall 40. The result is that the airflow stream becomes stable in the attached position. The airflow stream, attached to wall 40 because the Coanda effect, thereby flows into channel 41.

Channel 31 is constricted so as to create a control jet 31*a* through which airflow exits out of channel 31 into mixing zone 36. So long as only one document at a time is transported past sensor blocks 14 and 15, the pressure in channel 31 is minimal and the airflow out of the power jet 35*a* will attach to wall 40.

When a multiple feed occurs, the pressure in channel 31 reaches a threshold level of approximately 8 inches of water due to the obstruction of exhaust ports 35*a* and 35*b* by the documents and the airflow out of the control jet 31*a* is sufficient to break the Coanda effect and switches the airflow out of the power jet from channel 41 into channel 42. When the pressure in channel 31 returns below the threshold level, the airflow from the power jet switches from channel 42 back into channel 41.

Flush mounted to plate 19 at the end of channel 41 is a pressure-sensitive transistor 43. Transistor 43 may be of the type manufactured by Stow Laboratories, Inc., of Stow, Massachusetts and identified as Pitran PT–1 piezotransistor. As transistor 43 obstructs the exit of airflow out of channel a separate exit channel 44 is interconnected with channel 41 such that the airflow from channel 41 will pass through channel 44 into vertical channel 45 which exits out of the top of plate 19 into ambient air. The base, emitter and collector leads of transistor 43 are coupled by way of channels 46, 47 and 48 respectively to a suitable amplifier 49. Transistor 43 operates as a conventional input transistor in amplifier 49. Changes in the positive air pressure in channel 41 will modulate the diaphragm coupled to the emitter-base junction of transistor 43. When no more than one document at a time is carried by the belt transport between sensor blocks 14 and 15, the air pressure upon transistor 43 created by the power jet airflow is approximately one-half p.s.i. When a multifeed of documents occurs the air pressure in channel 31 will reach the threshold level of approximately 8 inches of water necessary to cause the airflow from control jet 31*a* to switch the airflow from power jet 35*e* from channel 41 to channel 42 which exits out of sensor plate 19 into ambient air. This decrease in air pressure in channel 41 from approximately one-half p.s.i. to zero is detected by the diaphragm of pressure sensitive transistor 43 so as to effect a change in the output of amplifier 49.

The output of amplifier 49 is applied by way of channel 50 to document sorter 13. When there is no multiple feed of documents, the output of amplifier 49 applies a signal which causes the document sorter 13 to perform its normal function. Should there be a multiple feed of documents, the output of amplifier 49 will cause the document sorter 13 to pass all multiple fed documents into a reject pocket so that these documents can be returned to the document feeder for subsequent reprocessing and sorting.

Having described the invention in connection with the foregoing embodiments thereof, it is to be understood that further modifications may now suggest themselves to those skilled in the art and it is intended to cover such modifications as fall within the scope of the appended claims.

What we claim is:

1. a multi-item detector for use in conjunction with a document feeder wherein documents are fed past a sensing station comprising:
   a. a pair of like sensing blocks forming a document pathway, each block having apertures in juxtaposed faces through which a vacuum is applied,
   b. a first port through which a fluid flows under a positive pressure into the document pathway in the face of one of said sensing blocks coupled by a channel to a pressure source,
   c. a second port through which a fluid flows under a positive pressure into the document pathway in the face of the second of said sensing blocks coupled by a channel to the pressure source, and
   d. a fluid-pressure-detecting device coupled to the channel leading to each said ports for sensing an increase in the fluid pressure in said channel when the vacuum draws documents into contact with both of said blocks.

2. The combination set forth in claim 1, in which said detecting device is a monostable fluid amplifier with means for sensing a change of state of said amplifier to indicate the presence of a multiple feed of documents.

3. The method of sensing a multiple feed of documents passing along a document pathway which comprises:
   a. establishing fluid suction fields on opposite sides of said pathway,
   b. establishing primary fluid flow under a positive pressure on opposite sides of said pathway within the zones occupied by said suction field, and
   c. sensing an increase in pressure in said fluid flow produced by two documents in said pathway responding to each of said suction fields simultaneously to impede both said flows.

4. The method of claim 3, in which said primary fluid flows are coupled to a pair of secondary fluid flows remote from said pathway and switched between said pair when said primary flows are both impeded.

5. The method of claim 4, in which an electrical signal is produced when pressure due to flow restriction in one of said secondary flows exceeds a predetermined level.

6. A system for determining the occurrence of a multiple feed of documents by a document feeder which comprises:
   a. dual block members spaced apart on opposite sides of the document pathway having multiple inner cavities with each such cavity opening at the sides of the blocks facing the document pathway,
   b. a vacuum supply means for supplying a vacuum to a portion of said inner cavities in both block members simultaneously to draw documents passing between the dual block members toward the cavity openings,
   c. a positive pressure air supply means for supplying air under pressure,
   d. a first port through which a fluid flows under a positive pressure into the document pathway in the face of one of said block members coupled by a channel to said positive pressure air supply means,
   e. a second port through which a fluid flows under a positive pressure into the document pathway in the face of the second of said block members coupled by a channel to said positive pressure air supply means, and
   f. a fluid-pressure-detecting device coupled to the channel leading to each of said ports for sensing an increase in fluid pressure in said channel when said vacuum draws documents into contact with both of said dual block members.

7. The combination set forth in claim 6, in which a document sorting means is responsive to the output of the detecting device for rejecting multiple fed documents.

8. The combination set forth in claim 6, in which said pressure detecting channel includes structure forming a forked flow path with airflow normally limited to one branch of said forked flow path and means for switching flow to the other branch when pressure therein increases and wherein a fluid pressure sensor is positioned in said other branch.