United States Patent

[11] 3,597,594

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[33] **Great Britain**
[31] **46617/67**

[54] **SHEET COUNTING APPARATUS**
1 Claim, 7 Drawing Figs.

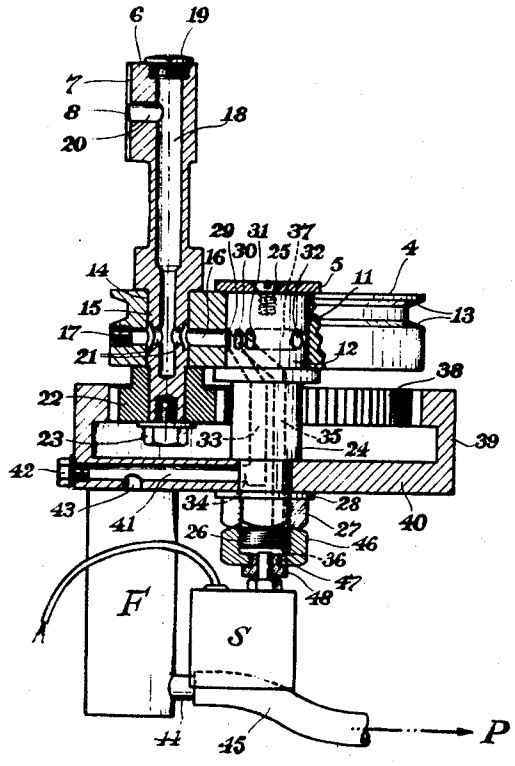
[52] **U.S. Cl.** ..... **235/92 SB,** 235/92 R, 235/98, 271/27
[51] **Int. Cl.** **G06m 9/02**
[50] **Field of Search** 235/92, 98; 271/27; 200/61.22

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ABSTRACT: The invention relates to apparatus for counting a stack of sheets of paper of the kind including a rotary member or grip provided with suction ports for gripping said sheets one at a time and arranged to deflect said sheets one by one on rotation of said member, and means comprising a pressure-sensitive device for counting suction pulses created by the application of suction to said sheets, the pressure-sensitive device comprises a pressure-deformable element adapted on receipt of a pulse to influence directly an electrical circuit which includes a digital counter for the pulses, preferably by closing a pair of electrical contacts in said circuit whereby the digital counter is advanced.



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SHEET 1 OF 4

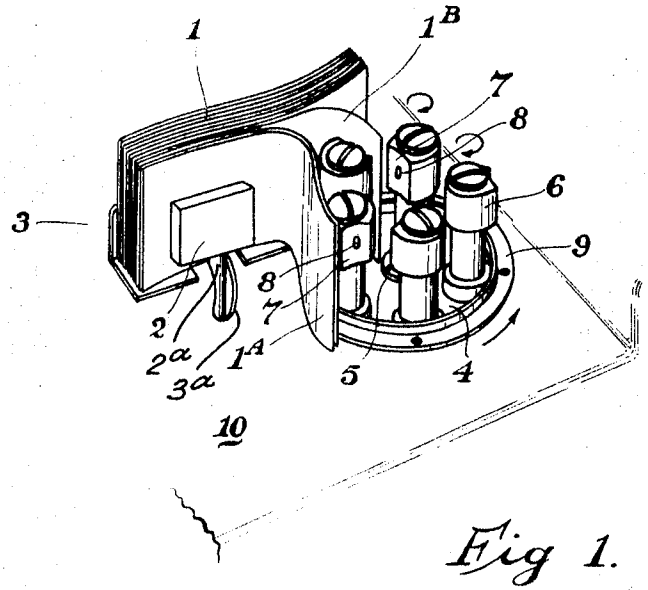


Fig 1.

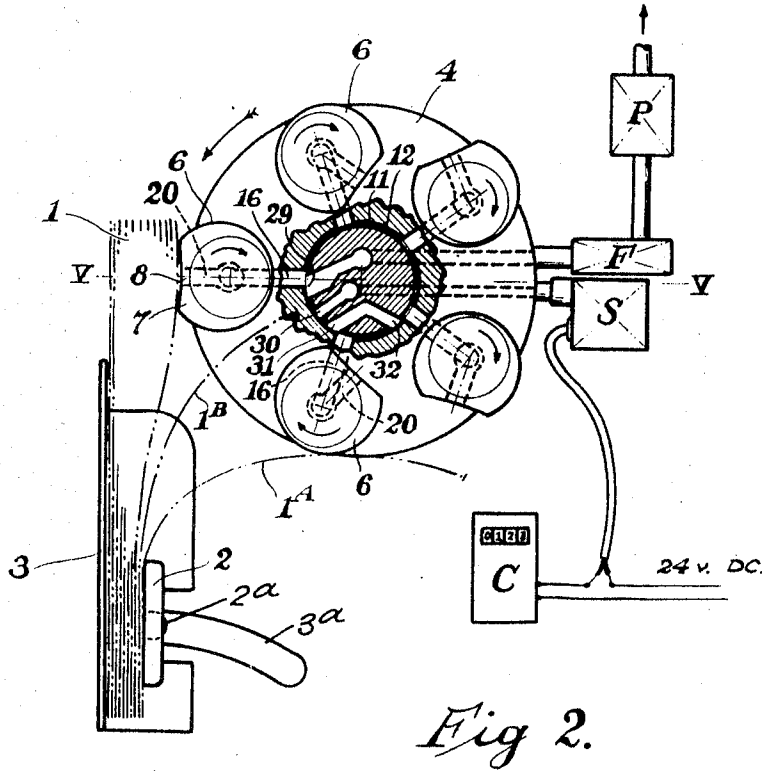


Fig 2.

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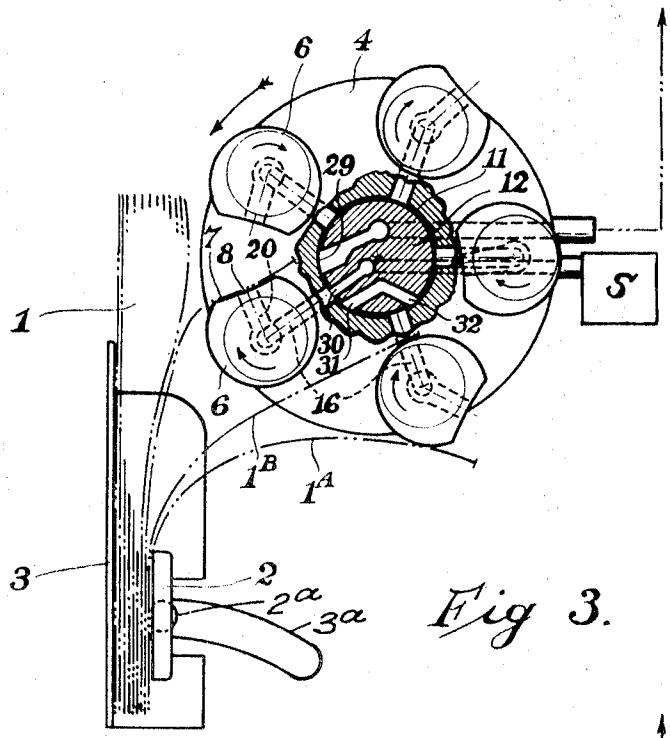

6
4
29
11
12
7
8
20
S
1
32
30
31
6
16
1B
1A
3
2
2a
3a

Fig 3.

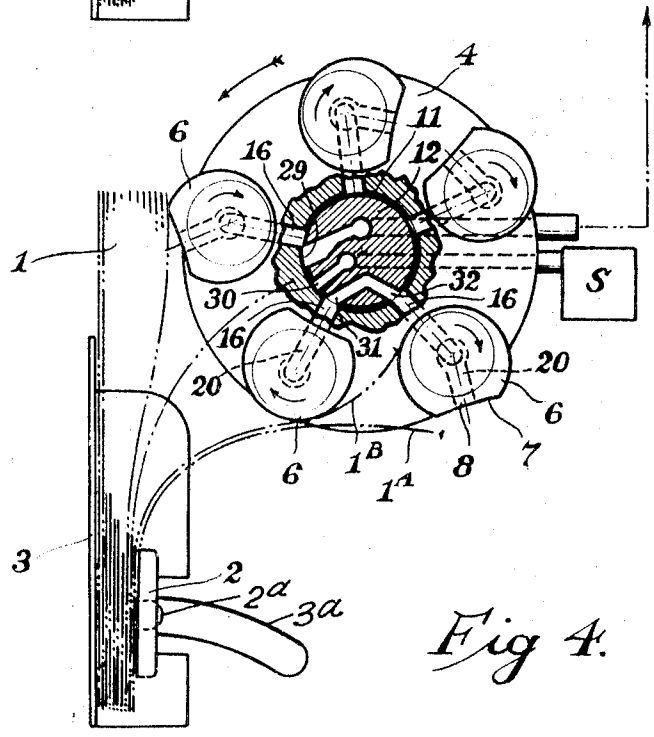

4
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1A
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2a
3a

Fig 4.

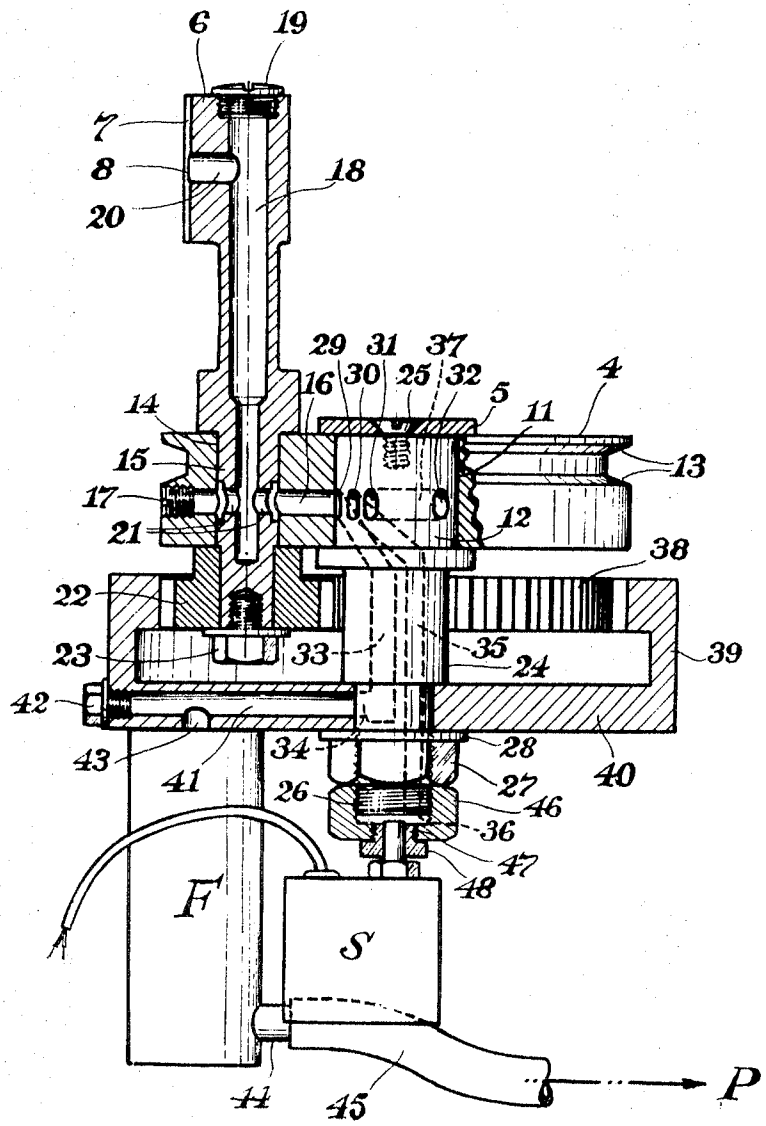

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36
47
48
F
S
44
45
P

Fig 5.

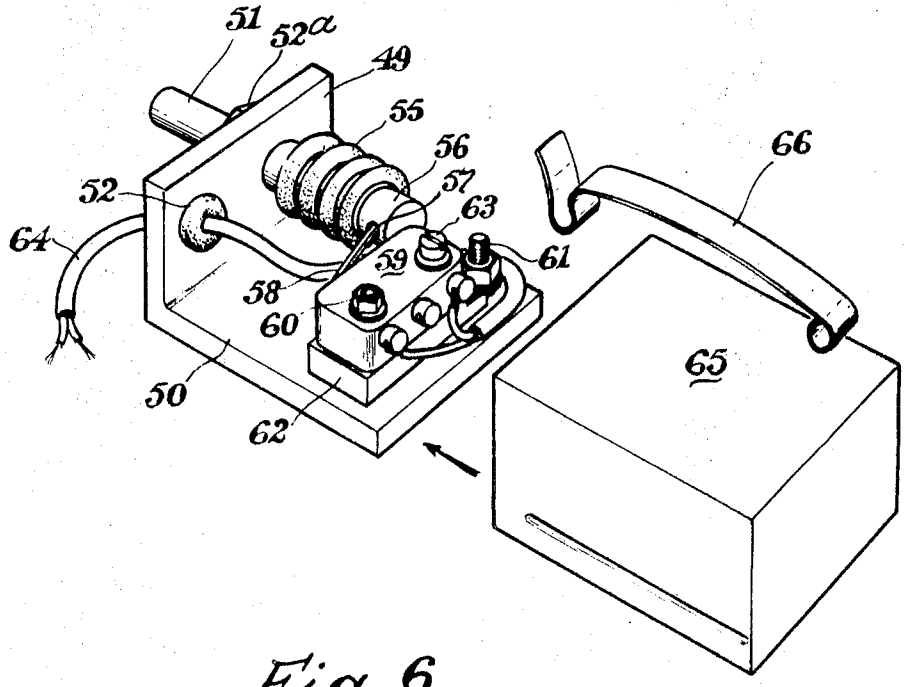

51
52a
49
55
56
57
63
66
52
64
59
61
58
60
65
50
62

Fig 6.

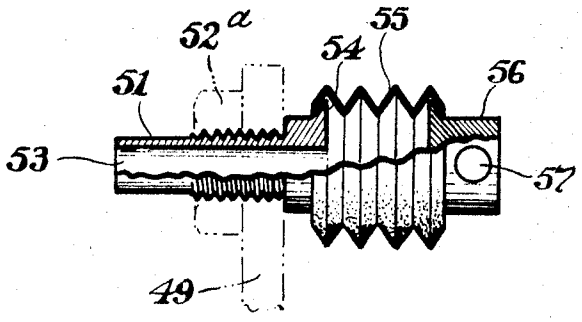

52a
55
54
51
56
53
57
49

Fig 7.

SHEET COUNTING APPARATUS

This invention relates to apparatus for counting sheets of paper in a stack, for example, a pile of banknotes, such apparatus being of the broadly defined type which includes a rotary disc incorporating a plurality of suction organs which are adapted to deflect each sheet from its initial position and to count the same, the deflecting and counting being accomplished through the application of suction to each of the suction organs in turn as the disc rotates.

In one example of such apparatus the disc is adapted to mount a plurality of contrarotating suction sheet removing organs, and the stack of sheets is clamped at one end. In operation, the free ends of the sheets are sequentially deflected across the disc to a second rest position as in the manner of turning over the pages of a book and during such movement counting takes place. In a second example of such apparatus, the suction organs are formed within the surface of the rotary disc and radially disposed slots are provided between adjacent suction organs; such a disc is conveniently arranged to act upon a corner of a stack of sheets and to count the sheet corners in turn as they are deflected from one side of the disc to the other.

In either of the above examples the counting of the sheets is conveniently carried out by counting the number of suction pulsations which occur during the actual deflection of the sheets. The means for effecting the deflection operation includes essentially a stationary air distribution member which incorporates a suction port which is in communication with a source of suction to each of the suction organs in turn; the means for effecting the counting operation includes essentially a sensing port in the air distribution member which communicates, as the disc revolves, with both a pressure-sensitive device and the suction port, such latter communication being established momentarily whenever a sheet has been deflected.

Previously the pressure-sensitive device has been used in conjunction with associated electrical and/or mechanical devices, to count the number of suction pulses which occur, one being created whenever a sheet has been deflected. A Preferred device includes complicated and expensive transducer and amplifier arrangements.

It is a main object of the present invention to provide apparatus for counting a stack of sheets of paper which is simpler and less expensive than the aforesaid apparatus.

According to this invention in a sheet-counting machine of the type described, the pressure-sensitive device comprises a pressure-deformable element adapted to influence directly an electrical circuit which includes a digital counter.

The present invention therefore provides apparatus for counting a stack of sheets of paper including a rotary member provided with suction ports for gripping said sheets one at a time and arranged to deflect said sheets one by one on rotation of said member, and means comprising a pressure-sensitive device for counting suction pulses created by the application of suction to said sheets, characterized in that said pressure-sensitive device comprises a pressure-deformable element adapted to influence directly an electrical circuit which includes a digital counter.

Preferably the pressure-deformable element is adapted to close a pair of normally open electrical contacts in said circuit upon receipt of a suction pulse (negative pressure) whereby the digital counter is advanced.

Preferably the pressure-deformable element comprises a hollow corrugated bellows, e.g. formed of rubber or a rubber-like material, adapted to contract upon receipt of a suction pulse therein and arranged to throw an electrical switch contained in said electrical circuit.

One embodiment of the invention will now be described with reference to the accompanying drawings of which:

FIG. 1 is a perspective external view of one form of the apparatus according to the invention;

FIGS. 2 to 4 are diagrammatic partly-sectioned plan views illustrating three operating positions of the apparatus of FIG. 1;

FIG. 5 is a vertical cross section along the plane V–V of FIG. 2 showing some of the salient components;

FIG. 6 is a perspective view of the component marked S in FIG. 5 in a partly dismantled condition, and

FIG. 7 is a partial cross section of some of the parts contained in FIG. 6.

In FIG. 1 a stack of banknotes **1** is clamped at one end by means of spring-loaded pressure pad **2** in conjunction with a backing plate **3**. The pad **2** is mounted on post **2***a* arranged to move in an arcuate slot **3***a* and the whole assembly is lightly biassed in a clockwise direction by a spring (not shown) so that the free end of the stack always remains in light contact with the removing mechanism as the sheets are fed.

The feeding means comprise a circular disc **4** driven in an anticlockwise direction by a power unit (not illustrated) about a stationary vertical stub-shaft which will be described in detail later, and which is retained by a capping member **5**. The disc **4** is provided with five equally spaced suction organs **6** which are gear-driven from the disc **4** in a clockwise direction. The working surface of each of the suction organs includes a face **7** and a vacuum port **8** which is sequentially connected to a source of suction via a distribution port as the disc rotates. This porting arrangement is fully described below.

The working surface of the rotating disc **4** is shrouded by means of a ring **9** attached to the case of the apparatus **10**.

In operation the pressure pad **2** is withdrawn from the backing plate **3** and a stack of notes inserted as shown in FIG. 1. Upon starting the driving motor, sheets are progressively moved e.g. at a speed of 20 notes a second from the stack under the action of the suction organs until the whole of the stack is transferred to position 1A. A sheet 1B is adhered to one of the suction organs in the course of being conveyed. As each organ bearing a sheet is turned, a pulsation of suction causes a counter unit to advance by one increment with the result that the total number of sheets actually handled is recorded.

The construction of the rotary disc assembly will now be described in greater detail with reference to FIG. **5**. It should be noted that for simplicity reasons, only one suction organ is shown, furthermore, that antifrictional bushes and ball bearing assemblies etc. have been omitted so as to provide a clearer understanding of the salient features of the invention.

The disc member **4** provided with a central bore **11** capable of rotating freely about a vertical stub-shaft **12** includes a "V" groove **13** in its outer surface to accommodate a driving belt from a geared electric motor (not shown). Five equally spaced bores **14** are drilled parallel to the central bore **11** to receive the reduced cylindrical ends **15** of the suction organs **6** in a free manner. Five radial conduits **16** are provided in the disc **4** to connect the bores **14** with the central bore **11** and for practical purposes these are externally drilled and plugged at **17** as shown.

Each suction organ is drilled longitudinally to provide a conduit **18** and is also plugged at its upper end by means of a detachable cap **19**. A filter unit (not shown) is incorporated within the conduit **18** to prevent ingress of dust etc. Radial holes **20** and **21** connect **18** with the suction port **8** and with the radial conduits **16** respectively. An annular groove is machined out of the surface of the organ ends **15** to ensure that fluid communication is continuous between the conduit **16** and the suction port **8** as the organ rotates on its axis.

The lower end of each suction organ is provided with a driving pinion **22** securely attached thereto by means of a set screw **23** and a key and keyway (not shown).

The vertical stub-shaft **12** is provided with a shouldered spacing sleeve **24** which, together with the capping member **5** attached to the top of same by means of a countersunk screw **25**, locates the rotating disc **4** axially. The lower end of the shaft **12** is threaded at **26** to receive a horizontal attachment nut **27** and associated washer **28**.

The cylindrical working surface of the shaft is provided with four angularly spaced ports **28, 30, 31** and **32** all of which are in alignment with the radial conduits **16** in the disc **4**; the exact position of these ports will be more apparent from FIGS. **2** to **4**. The port **29** (suction port) is connected to an external source of suction by means of axial and radial holes **33** and **34** drilled in the shaft **12**. The port **30** (sensing port) is connected to a pressure-sensitive switch S by means of a second axial hole **35** terminating at **36** in the end of the shaft; finally the exhaust port **31** is connected to port **32** by means of an internal passage **37**, the ports **31** and **32** being spaced at 72° to each other in plan view. The various bore holes within the shaft are illustrated diagrammatically in FIG. **5** but in actual practice they are drilled and plugged where necessary in accordance with convenient machining techniques.

The suction organs **6** are rotated on their respective axes by the engagement between the pinions **22** and a stationary internally toothed gear ring **38**, which also constitutes the structural support for the stub-shaft **12**. The gear ring **38** is integrally formed with a tubular portion **39** and a disc portion **40**, the latter being centrally drilled to receive the threaded end **26** of the shaft **12** which is secured by means of the nut **27**. A radial hole **41** plugged at **42** and cross-connected by a hole **43** establishes a fluid connection between the bore **33** and detachable filter F. The filter F is connected to a vacuum pump P through the medium of a pipe **44** and a flexible tube **45**.

The lower threaded extremity of the shaft **12** is provided with a lock nut **46** adapted to bear against the underside of the attachment nut **27** and also to form a mounting for the pressure-sensitive switch S. The lock nut **46** is provided with a second threaded bore **47** into which a squareheaded plastics adapter **48** is screwed. The adapter is longitudinally drilled to receive the end of the pressure-sensitive switch which will now be described with reference to FIG. **6** and **7**.

The switch assembly comprises an L-shaped base plate having two right-angled planar surfaces **59** and **50**. Surface **49** is drilled to receive a tubular connection piece **51** and a rubber cable grommet **52**. The connection piece is secured in position by means of a nut **52a** and is provided with a central thoroughfare **53** and an enlarged chamfered extremity **54** capable of rigidly supporting the interior of a lightweight corrugated rubber bellows **55** in a fluidtight manner. The bellows is able to operate at high speed, of course without lubrication. The opposite end of the bellows is sealed by means of a chamfered plug member **56** cross drilled at **57** to receive the switch actuating blade **58** of a microswitch **59**.

The surface **50** is provided with a pair of upstanding threaded studs **60** and **61** adapted to secure the microswitch **59** through the medium of a spacer **62** in a rigid but adjustable manner. The stud **60** passes through the body of the switch and secures same by means of a nut and washer as shown. Stud **61** is provided with a retaining nut and washer adapted to bear against the top surface of a rebate formed in the end of the spacer **62**. Relative movement between the switch **59** and the spacer is prevented by means of screw **63**. In operation, when a source of suction is admitted to the interior of the bellows the latter contracts longitudinally and thus deflects the actuating blade **58** and closes the electrical contacts within the switch **59**. Any initial adjustment which is required is carried out by temporarily slackening the securing nuts on the studs **60** and **61** to permit the switch and spacer to be rotated about the stud **60**. The correct adjustment is achieved when the switch contacts are open when the bellows is in its static position, viz when its interior is not subjected to reduced pressure. A cable **64** directed through the grommet **52** connects the switch with the circuit of the counter unit C which is diagrammatically illustrated in FIG. **2**. A rectangular cover **65** which is retained by means of a leaf spring **66** is provided to prevent dust from entering into the interior of the switch. The switch assembly is attached to the underside of the machine by inserting the connection piece **51** into the bore of the adapter **48**.

The sequence of operation of the suction distribution system will now be described with reference to FIGS. **2** to **4** inclusive.

In FIG. **2** a suction organ is shown in the start of its operative cycle; viz when it is mechanically phased so that its face **7** is positioned in contact with the end of the foremost sheet in the stack **1** and the source of suction is being applied to the sheet from the pump P via the filter F, the suction port **29**, the conduit **16**, and thence up the axis of the suction organ to the hole **20** and the port **8**.

As the disc and contrarotating suction organ rotate, the sheet is lifted from the stack and the conduit **16** momentarily bridges both the suction port **29** and the sensing port **30** connected to the pressure sensitive switch S. Immediately after this the suction port **29** is closed and the conduit is wholly connected to the switch S as illustrated in FIG. **3**. The effect of this is to admit suction to the interior of the bellows **55** to thereby momentarily close the contacts of the microswitch **59** and thus the counter unit C is advanced.

Continued rotation of the suction organ assembly causes the port **30** to be closed gradually with the result that conduit **16** then bridges the exhaust **31** thus admitting atmospheric air into the suction organ. The effect of this is to release the sheet adhered to its face and also to restore the equilibrium of the bellows within the switch S. In FIG. **4**, the conduit **16** is shown in full alignment with the exhaust port **31** and furthermore it will be noted that the port **32** is also in alignment with the conduit **16** of the suction organ in advance of the one being described, thus permitting unrestricted entry of air. After the sheet has been released by the suction organ it will not be free to return to the stack **1** as the following organ will mechanically propel it through the revolving assembly to the ultimate propel it through the revolving assembly to the ultimate position **1A**.

With the above-described arrangement it will be apparent that if an organ inadvertently misses a sheet, no vacuum will be maintained in the suction organ and consequently the pressure sensitive switch will not be influenced and no count will be recorded. Furthermore the counting means suits the mechanical speed of the apparatus without the necessity of employing expensive and complicated transducer arrangements.

What I claim is:

1. Apparatus for counting a stack of sheets of paper and like flexible materials comprising a rotary member provided with a plurality of suction organs for gripping sheets one at a time and arranged to deflect sheets one by one on rotation of said member; a stationary air distributor having a suction port in communication with a source of suction, and a single separate counting port in fluid communication with a single pressure-sensitive bellows; a conduit formed in the said rotary member for each of the said suction organs, said conduits each terminating respectively at a suction organ and a port capable of being sequentially alignable with both the suction port and the counting port of the said stationary air distributor upon rotation of the said rotary member to first establish a suction within the respective conduit and hold such suction when a sheet is engaged by a respective one of said suction organs and then relieving such suction through said counting port to actuate said pressure-sensitive bellows; and an electrical counting circuit comprising a source of electricity, an electromagnetic digital counter unit and a switch adapted to be actuated by movement of said pressure-sensitive bellows.