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McInerny

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[54] **STACKERS FOR DOCUMENT COUNTERS AND THE LIKE**

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[52] **U.S. Cl.** **271/80;** 271/177; 271/178; 271/187; 271/219

[51] **Int. Cl.**[2] **B65H 29/40;** B65H 31/04

[58] **Field of Search** 271/80, 217, 219, 177, 271/178, 187

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Assistant Examiner—Robert Saifer
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

A stacker for use in paper and document counters and the like, which counters are adapted to receive a stack of documents at their infeed end, separate and count the received documents, and transfer the counted documents toward an outfeed facility. The stacker comprises a plurality of coaxially aligned rotary delivery fans having resilient blades arranged at spaced intervals around their peripheries to define document receiving pockets between each pair of adjacent blades of each fan. The fans rotate in the feed direction of the document and convey the documents received in the pockets toward an outfeed stacker. A stationary "stripper" plate acts to eject documents from each pocket whereupon the documents fall by gravity to a pivotally mounted stacker platform. The alignment of the stacker platform relative to the rotary fans is such as to provide a "free-fall" space or pocket between the extremities of the fan blades and the pivotally mounted platform. The blades serve to rapidly urge the documents toward the platform. As documents are collected upon the pivotally mounted platform, the weight of the documents counteracts a biasing force to urge or swing the platform downwardly and thereby increase the angle between the topmost document last fed to the pivotally mounted platform and the rotary fans to prevent curled, bent or mutilated documents from interfering with the delivery of succeeding documents to the platform.

11 Claims, 7 Drawing Figures

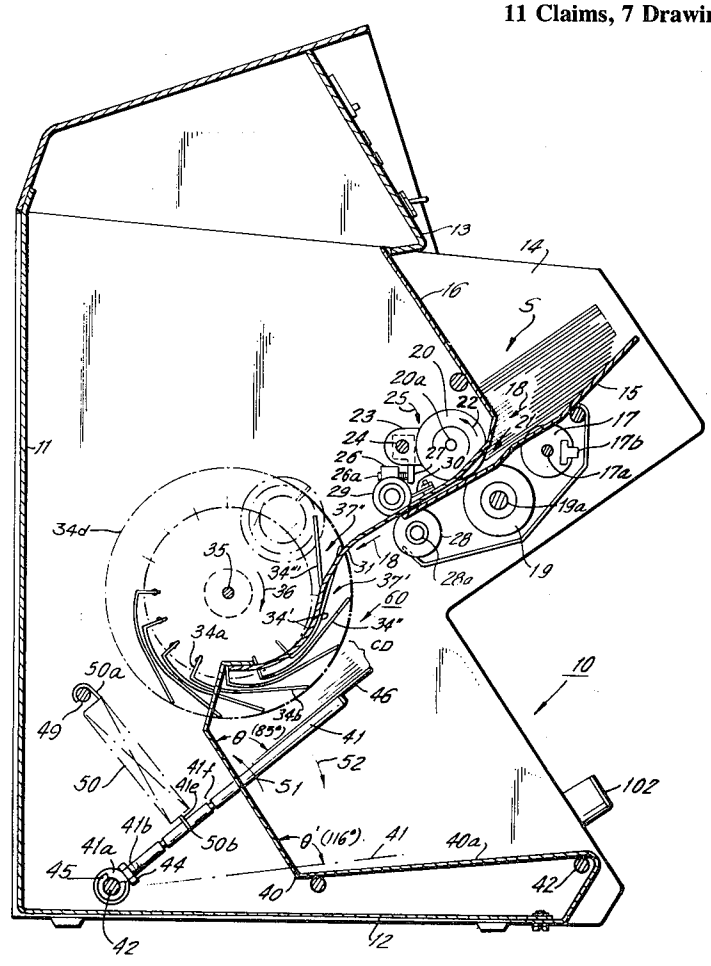


FIG. 1a.

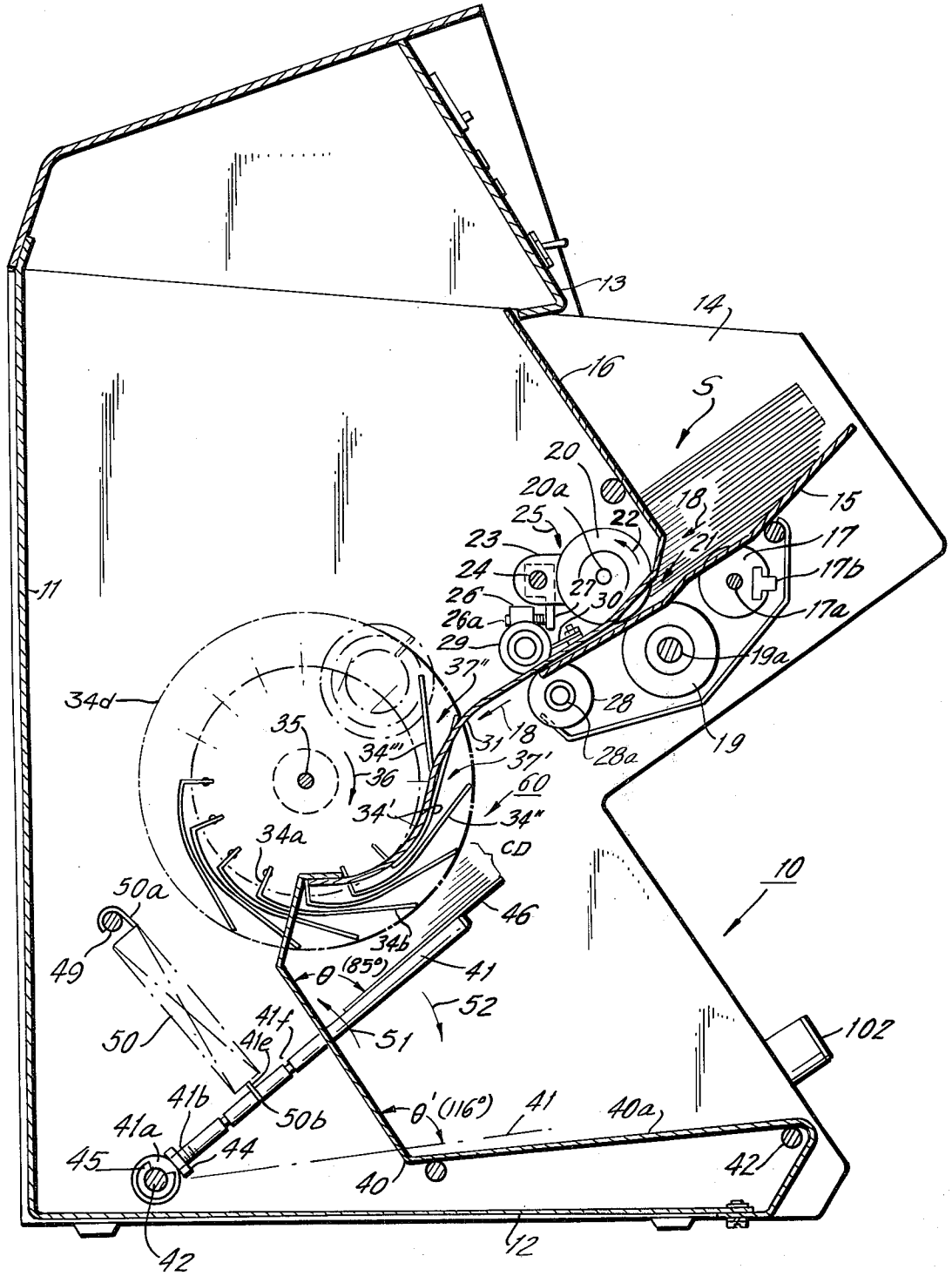

13
14
16
5
20
20a
25
22
23
24
27
30
26
26a
29
37"
34d
35
34"'
36
34'
34a
31
18
37'
60
34"
CD
28
28a
19
19a
17
17b
17a
15
18
21
11
10
102
50a
49
46
34b
θ (85°)
41
52
50
41f
41e
51
41b
41a
50b
θ' (116°)
41
40a
45
44
40
42
42
12

FIG. 1b

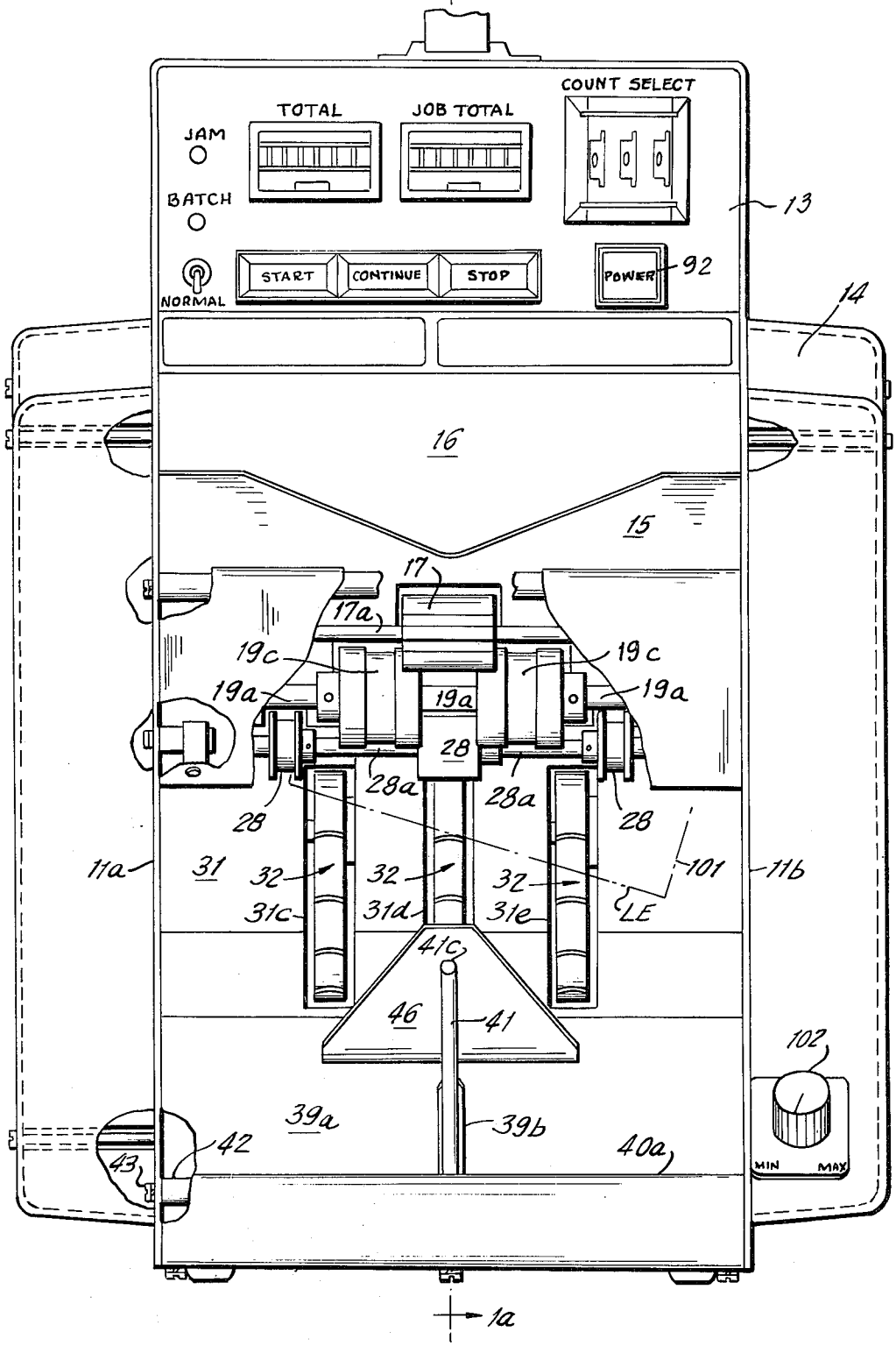

1a
COUNT SELECT
TOTAL
JOB TOTAL
JAM
BATCH
NORMAL
START
CONTINUE
STOP
POWER
92
13
14
16
15
17
17a
19c
19a
28
28a
11a
31
32
31c
31d
31e
101
LE
11b
41c
46
41
102
MIN
MAX
39a
39b
40a
42
43
1a

FIG. 1C

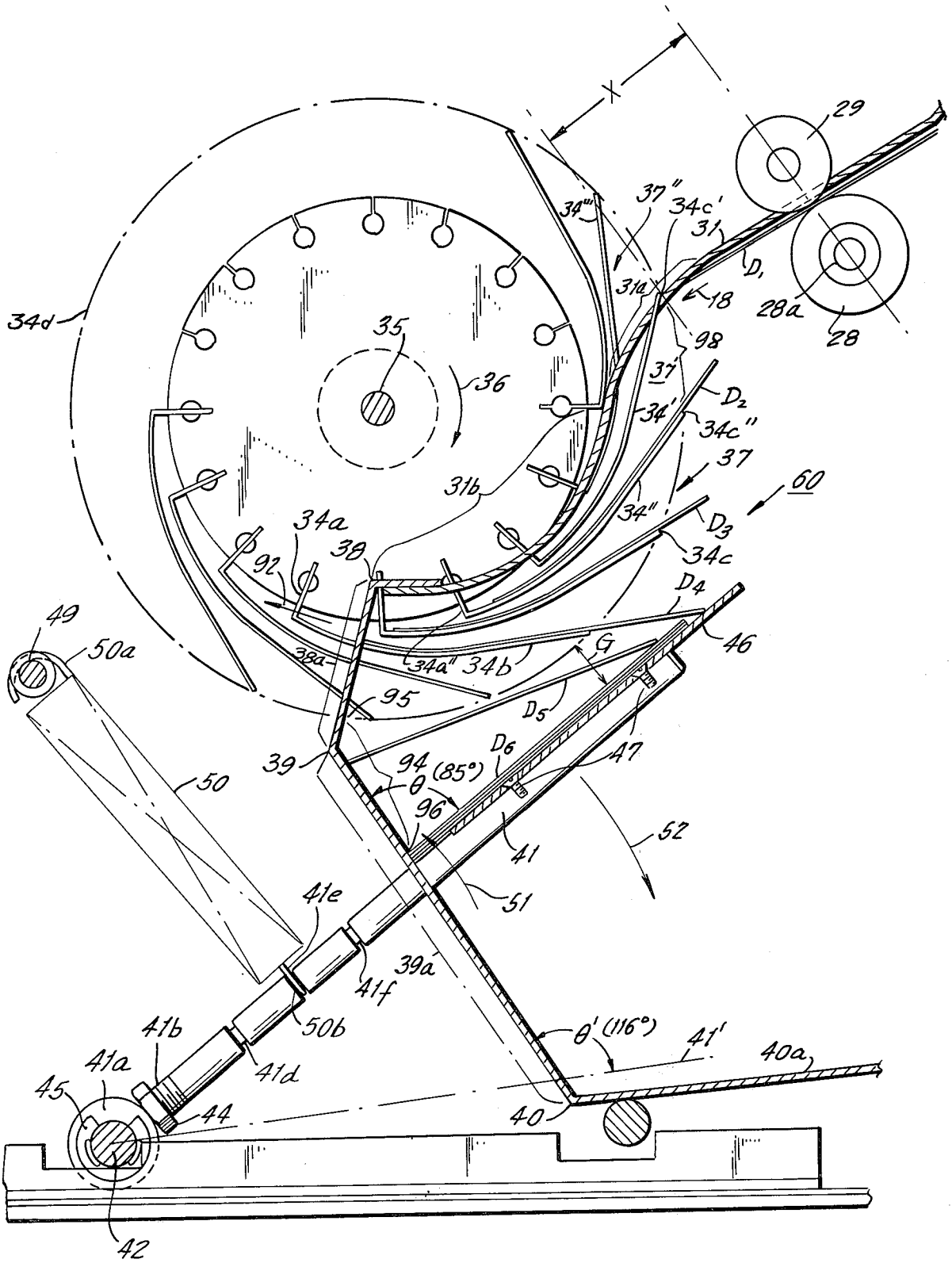

X
29
37"
34c'
34"'
31
D1
31a
18
28a
28
34d
35
36
98
37'
D2
34'
34c"
37
60
31b
34"
D3
34a
38
34c
92
D4
49
50a
46
38a
34a"
34b
G
95
D5
39
D6
47
94
(85°)
θ
96
50
41
52
51
41e
39a
41f
41b
50b
θ' (116°)
41'
40a
41a
41d
45
44
40
42

FIG. 3b.

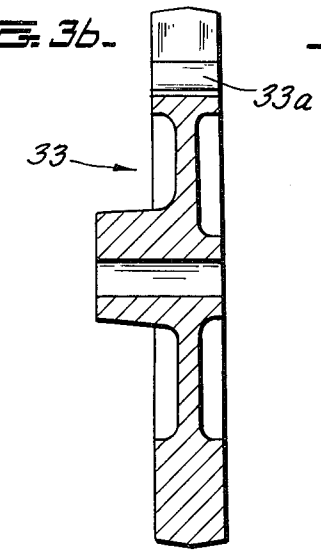
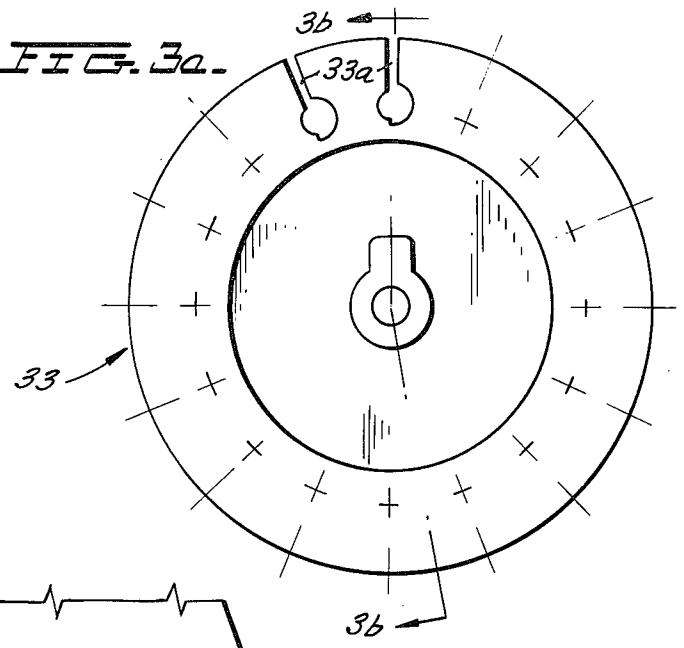


FIG. 3a.



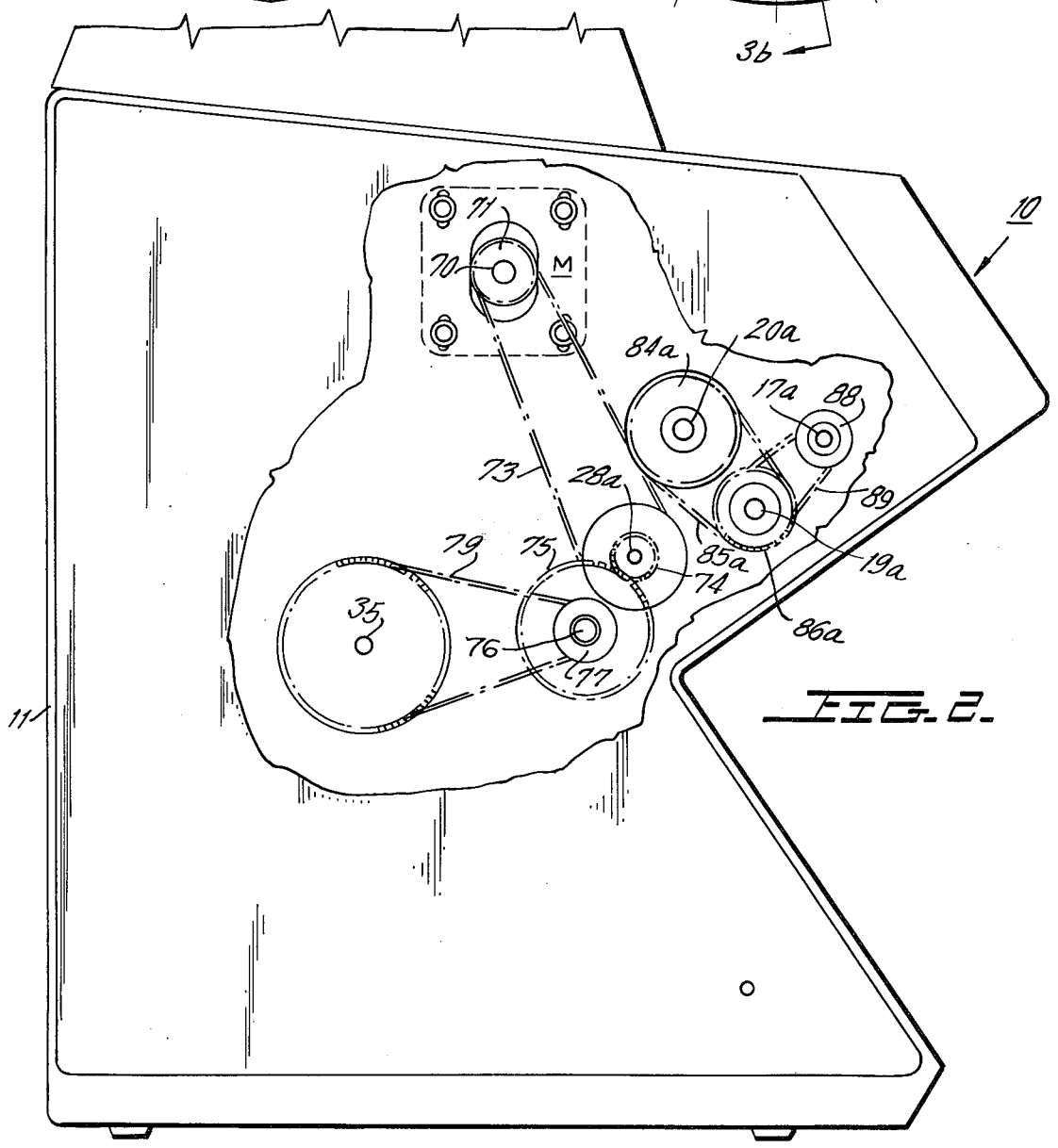


FIG. 2.

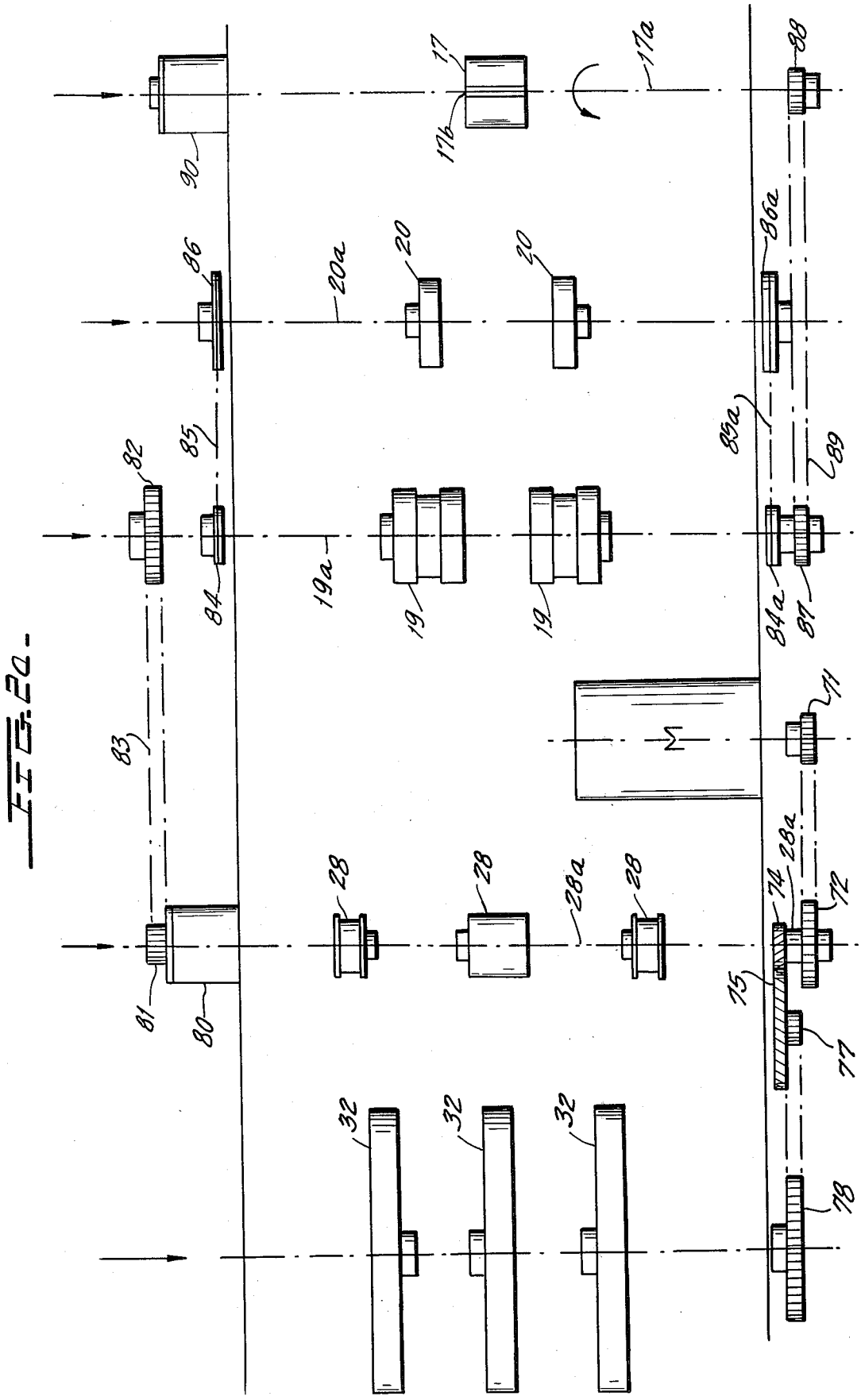

17
17a
17b
88
90
86
20a
20
20
86a
85a
82
85
89
19a
19
19
84a
87
84
83
11
M
28
28
28a
28
74
28a
12
81
80
15
77
32
32
32
78

FIG. 2a.

STACKERS FOR DOCUMENT COUNTERS AND THE LIKE

The present invention relates to paper and document feeding and counting devices and more particulary to a novel stacker for use in such devices, which stacker employs rotary fans and a cooperating pivotal platform for neatly and accurately stacking documents.

BACKGROUND OF THE INVENTION

Document feeding and counting devices have been found to be extremely advantageous for use in a wide variety of applications. For example, such devices have been used to great advantage in banks and other like institutions wherein it is desirous to provide such apparatus for accurately counting large stacks of bills (i.e., paper currency). One of the problems encountered in counting stacks of bills at relatively high rates of speed resides in the fact that some or many of the bills being counted may be either slightly or severely mutilated or creased from folding and hence require special care in handling or, alternatively, require that such damaged or mutilated bills must first be removed from a stack of like bills since conventional feeding and separating devices are incapable of counting such bills. In addition thereto, the bills which may be perfectly intact, but may be either severely folded or creased often requires special handling procedures wherein the bills must first be carefully and firmly pressed or smoothed down before they can be accurately handled and counted by conventional counting apparatus.

Banks and other similar institutions also handle tremendous volumes of checks and other documents which are of varying sizes, thicknesses, finishes and the like. In such applications, it has previously been necessary to separate stacks of documents of dissimilar characteristics into stacks of documents having similar characteristics, i.e. size, finish and the like. Only then may the stacks of documents having substantially identical characteristics by satisfactorily handled by present day equipment.

One suitable device for handling documents of dissimilar characteristics without performing any preparatory steps of separation of the documents is set forth in detail in copending application Ser. No. 227,847, filed Feb. 22, 1972, now U.S. Pat. No. 3,771,783, issued Nov. 13, 1973 and assigned to the assignee of the present application. The document handling device described in the above mentioned copending application has been found to satisfactorily handle documents of dissimilar sizes, thicknesses, finishes and the like and has further been found to accurately count stacks of documents in a substantially error free manner.

However, in apparatus of the type described in the above mentioned copending application, it has been found that documents of substantial length when measured in the direction of feed, while being capable of being accurately counted, do create some problem in the stacking operation which occurs immediately after the counting operation and in which operation documents are neatly stacked in an outfeed facility. One major cause of the difficulty in stacking such documents has been found to be due to the creasing or curling of documents which causes one free edge of the documents to extend into the path along which counted documents are delivered toward the outfeed facility. Whereas the problem is a minor one when counting documents of rather short dimensions measured in the feed direction, the problem becomes increasingly more significant when the counting apparatus is employed for counting documents whose length measured in the feed direction becomes increasingly larger. For example, it has been found that the problem is a significant one when using apparatus of the type described hereinabove to count certain foreign paper currency of rather sizable dimensions when measured in the feed direction.

A BRIEF DESCRIPTION OF THE INVENTION

The present invention is characterized by providing an outfeed facility which is capable of receiving and neatly stacking paper documents and the like delivered to the stacking facility regardless of the dimensions of the paper documents being stacked, which dimensions are measured in the feed direction.

The stacker apparatus of the present invention, while being usable with a variety of paper feeding and counting apparatus, is extremely advantageous for use in paper handling documents of the type described in U.S. application Ser. No. 227,847, now issued as U.S. Pat. No. 3,771,783, referred to hereinabove. Apparatus of the type described in the above mentioned copending application comprises an infeed hopper for receiving a sizable stack of documents and for feeding the bottommost document in the infeed hopper toward a combination drive/stripper means. The drive means serves to urge the document or documents fed thereto in the feed direction while the cooperating stripper means serves to prevent more than one document to be fed past the combination driver/stripper means in moving toward acceleration means.

The acceleration means receives documents in a one-at-a-time fashion from the combination driver/stripper means and abruptly increases the linear speed of documents received thereby in the feed direction. This operation causes at least a slight gap to be formed between a trailing edge of a document being accelerated by the acceleration means and the leading edge of the next document to be delivered toward the acceleration means. The gap between documents is utilized by a photoelectric sensing means to provide an accurate count of the documents delivered to the infeed hopper.

The documents passed by the acceleration means are delivered toward an outfeed facility where they are neatly stacked and may be simply and readily removed therefrom at any time during the operation of the document handling device.

The present invention comprises a plurality of rotary fans each having flexible blades arranged at spaced intervals around the peripheries of each fan. Each pair of adjacent blades forms a "pocket" for receiving a paper document.

The rotary fans rotate in the feed direction at an angular velocity such that the linear velocity of the fan blades (in the feed direction) is less than the linear velocity of the documents being delivered toward the rotary fans. In a preferred embodiment, only one document is delivered into each pocket which, due to the curved configuration of the blades, serves to decelerate each document delivered to the rotary fans as a document enters into a "pocket." The rotary fans cooperate with a stationary plate which is positioned in the path of movement of each document delivered to a pocket whereby the leading edge of each document strikes the surface of the stationary plate which serves to eject or

"strip" each document from the pocket into which it was inserted as the blades forming that pocket pass beyond the stationary plate.

As soon as each document is free of the downstream blade which forms the pocket into which it was delivered, the document is caused to be rapidly urged downwardly by the upstream blade so as to fall upon a swingable platform positioned a finite and preferably substantially closely spaced distance beneath the rotary fans so that the documents are collected upon the platform in a neat stack.

The spatial relationship between the rotary fans and swingable platform is such as to provide an open space or pocket therebetween in which each document ejected from a rotary fan pocket falls substantially downwardly a small distance upon the swingable platform. This pocket between the rotary fans and the swingable platform serves to provide sufficient clearance therebetween to prevent documents collected upon the platform from interfering with the delivery and collection of subsequent documents.

Since the documents to be counted preferably undergo no preparatory treatment whatsoever, the creasing or curling which may have been inparted to such documents may either individually or cumulatively cause the trailing edges of the documents (relative to the feed direction) to extend upwardly either toward or into the free space between the rotary fans and the swingable platform so as to interfere with the delivery operation.

Such interference is substantially eliminated by virtue of the fact that the swingable platform, which is normally biased so as to be urged in an upward direction, is caused to be gradually urged downwardly against the biasing force by either the weight of the documents accumulated upon the platform or the striking of the blades against the topmost document in the stack of accumulated documents, or both, so as to urge the swingable platform downwardly and thereby continually increase the spacing between the trailing edges of accumulated documents and the rotary fan blades so as to substantially fully compensate for any curl or folding in accumulated documents which might otherwise affect the stacking operation.

Thus, the novel stacker of the present invention provides for rapid high speed stacking of documents regardless of their length when measured in the feed direction so as to assure rapid and neat stacking of documents substantially independently of document size, thickness, finish and the like, as well as being substantially independent of the speed of the counting operation.

A BRIEF DESCRIPTION OF THE FIGURES AND OBJECTS

It is therefore one object of the present invention to provide a novel stacking device for use with counting apparatus and the like which is capable of neatly stacking documents immediately after a counting operation regardless of the speed of the counting operation and regardless of the size of the documents being counted.

Another object of the present invention is to provide a novel stacker for use in counting devices and the like and comprised of a plurality of coaxially aligned rotary fans each having a plurality of blades defining document receiving pockets which cooperate with stationary ejecting means for successively ejecting a document from each pocket and delivering same to a swingable platform positioned substantially beneath the rotary fans and adapted to rotate in a direction to move stacked documents away from the stacking region to prevent the stacked documents from interfering with the stacking operation.

The above as well as other objects of the present invention will become apparent when reading the accompanying description and drawings in which:

FIGS. **1***a* and **1***b* show side and front elevational views, respectively, of a document handling device incorporating stacker means embodying the principles of the present invention, wherein portions of the structure are shown sectionalized to more clearly expose the structure of the present invention.

FIG. **1***c* is an enlarged elevational view of the stacker of FIG. **1***a*.

FIG. **2** shows a partial elevational view similar to that of FIG. **1** wherein the mechanical power train for operating the various rotating elements is shown.

FIG. **2***a* shows a plan view of the power train elements useful in describing the mechanical operation of the present invention.

FIG. **3***a* shows an end view of the rotary fan wheel.

FIG. **3***b* shows a sectional view of the wheel of FIG. **3***a* looking in the direction of lines **3***b*—**3***b*.

DETAILED DESCRIPTION OF THE FIGURES

FIGS. **1***a*–**1***c* show a document handling device **10** embodying the principles of the present invention which is comprised of a housing **11** having a base portion **12** for supporting device **10** upon any preferably flat surface such as, for example, a table. Housing **11** is provided with a front face or panel **13** fitted with control switches and counter devices which will be only briefly described hereinbelow, it being understood that a detailed description of the mechanical operation and electronic controls are respectively set forth in copending applications whose serial numbers and filing dates are Ser. No. 227,847, filed Feb. 22, 1972, now U.S. Pat. No. 3,771,783, issued Nov. 13, 1973, and Ser. No. 273,999, filed July 21, 1972. It should be understood that these controls and counting devices provide a capability of turning the machine on and off, providing visually observable counts of the number of documents handled by the device and providing the other rather unique operations such as "batching" for example.

The control panel constitutes the upper part of the front of the device **10** which is further provided with an infeed hopper **14** having a stack supporting plate **15** and forward edge supporting plate **16.** A stack S of documents is positioned in the infeed hopper in the manner shown. The unique design of the infeed hopper is set forth in greater detail in application Ser. No. 227,847 and will be omitted herein for purposes of brevity.

Plate **15** is provided with a suitable opening (not shown) to permit a portion of the periphery of a picker wheel **17** to protrude therethrough. The picker wheel is mounted to rotate about a shaft **17***a* through a drive train to be more fully described hereinbelow so as to "jog" the stack S upwardly and feed the bottommost sheet S' in the forward feed direction as designated by arrow **18** toward a drive wheel assembly **19** and a stripper wheel assembly **20.** It should further be noted that the infeed hopper defined by plates **15** and **16** forms a tapered throat region **21** through which paper documents pass and subsequently undergo combined driv-

ing and stripping action by the drive and stripper wheel assemblies **19** and **20**, respectively.

The drive wheel assembly is in actuality comprised of a pair of drive wheels **19** mounted to rotate with shaft **19***a* which is journalled in suitable bearings provided in the side walls **11***a* and **11***b* which comprise the machine frame. As can best be seen from FIG. **1***b*, the drive wheels have recessed portions **19***c* about their peripheries which cooperate with a pair of stripper wheels **20** (see FIG. **2***a*) mounted to rotate about shaft **20***a*. The axial length of the stripper wheels **20** is such as to enable them to enter slightly into each recess **19***c* of an associated drive wheel **19**. The drive wheels **19** are controlled by the drive train, to be more fully described, so as to rotate in a direction shown by arrow **22** in order to urge documents in the forward feed direction designated by arrow **18**.

The stripper wheels rotate in the direction shown by arrow **22** so as to urge documents in a direction reverse that of the forward feed direction **18**, in a manner to be more fully described. The stripper wheels are rotatably mounted by shaft **20***a* upon a swingable support assembly **23** whose pivot axis is shaft **24**. The support assembly **23** of stripper wheels **20** are urged about mounting shaft **24** in the clockwise direction, as shown by arrow **25**, by virtue of the timing belt which is entrained about pulleys respectively mounted to shafts **19***a* and **20***a*, as will be more fully described in connection with FIG. **2**. The amount of swing or clockwise movement of support assembly **23** is limited by a set screw **26***a* which threadedly engages a threaded collar **26** secured to the machine frame. The right-hand edge of set screw **26***a* abuts against the downwardly depending projection **27** which cooperates with set screw **26***a* to provide an accurate setting for the stripper wheels **20** relative to the drive wheels **19**. In order to lock this setting a second set screw **28** threadedly engages a radially aligned tapped opening in collar **26** to positively lock the desired setting of the stripper wheels.

Acceleration wheels **28** are positioned downstream relative to drive wheels **19** and at the same side of the path of movement as the drive wheels. The acceleration wheels **28** (note especially FIG. **1***b*) are mounted to rotate with shaft **28***a* and act to accelerate the documents which come under the influence of the acceleration wheels, in the forward feed direction at a linear speed greater than the linear speed imparted to documents as they pass between the drive and stripper wheels. Cooperating with the acceleration wheels are a like plurality of idler wheels **29** which are spring loaded by a spring means **30** so as to urge the peripheries of the idler rollers toward engagement with the peripheries of their associated acceleration wheels.

Documents passing between the acceleration wheels and their cooperating idler rollers are fed in the forward feed direction **18** toward the stacker apparatus **60** of the present invention. The leading edges of the documents follow the curvature of a stationary curved plate **31** so as to move toward a plurality of rotary fan assemblies **32**. Each fan assembly **32** is further comprised of a wheel member **33** (note especially FIGS. **3***a* and **3***b*) having a plurality of radially aligned slots **33***a* which extend to the peripheral edges of the wheels and which are adapted to receive the radially aligned arm **34***a* which is bent substantially at right angles to the main blade portion **34***b* of a fan blade **34**. FIG. **1***a* shows some of the blades **34** and the manner in which they are mounted relative to wheel **33**. For purposes of simplicity, it should be understood that, in one preferred embodiment, **16** blades are provided for each rotary fan assembly.

Each rotary fan wheel is mounted upon a common shaft **35** which is adapted to rotate in the clockwise direction as shown by arrow **36** so as to cause the fan blades to move substantially in the same direction as the forward feed direction.

Each adjacent pair of fan blades collectively define a document receiving pocket **37** which is adapted to have a document injected thereinto as a result of the linear velocity imparted to documents as they pass between the acceleration wheels **28** and their cooperating idler rollers **29**. The leading edges of the documents enter into a pocket **37** such as, for example, the pocket **37** defined by blades **34'** and **34''**. The curvature of the blades **34** causes the documents to assume a curved shape. The angular rotation of the rotary fans **32** is selected so that the tangential velocities of the blade tips **34***c* is less than the linear speed of the documents fed toward the rotary fans.

As can best be seen from FIG. **1***c*, stationary plate **31** curves first downwardly in the region **31***a* and then gradually curves toward the horizontal direction, as shown by plate portion **34***b*, at which point the stationary plate abruptly bends at corner **38** to define a straight plate portion **38***a* which is again bent at corner **39** to form a diagonally aligned plate portion **39***a* which is bent sharply at corner **40** to form the almost horizontally aligned surface portion **40***a*.

The dotted circle **34***d*, shown in FIG. **1***a*, defines the path followed by the extreme tips **34***c* of fan blades **34** as they experience rotary movement. As can best be seen in FIG. **1***b*, plate **31** is provided with three elongated slots **31***c*, **31***d* and **31***e* which provide clearance for the rotary fans **32** enabling a portion of the blades to extend through the aforesaid elongated slots.

Flat plate portion **39***a* contains an elongated slot **39***b* which provides sufficient clearance for elongated rod **41**. The lower end of rod **41** is provided with a collar **41***a* for receiving shaft **42** whose opposite ends are secured to the machine frame side plates **11***a* and **11***b*. For purposes of simplicity, one end of shaft **42** is shown as being secured to side plate **11***a* by a fastening member **43**. The opposite end of shaft **42** is secured in a like manner to side plate **11***b*. The portion of rod **41** immediately adjacent collar **41***a* is threaded at **41***b* to engage a tapped fastening nut **44**. Collar **41***a* is tapped to receive threaded portion **41***b* of rod **41**. The fastening nut **44** serves to lock rod **41** to collar **41***a*. Collar **41***a* is free to revolve about shaft **42** and is locked to the center of shaft **42** by means of a pair of snap-rings **45** adapted to be snapfitted within a pair of grooves provided along shaft **42**. Only one snap-ring is shown in FIG. **1***a* for purposes of simplicity, it being understood that a like snap-ring is positioned along the opposite side of collar **41***a* to prevent collar **41***a* from experiencing any movement in the axial direction along shaft **42**.

A trapezoidal-shaped platform plate **46** is secured along the upper surface of rod **41** by fastening members **47**, rod **41** being bevelled as shown at **41***c* in FIG. **1***b*, to provide a flat mounting surface for plate **46**.

An elongated shaft **49** which is secured between end plates **11***a* and **11***b* (in a manner not shown for purposes of simplicity) serves as a means for receiving one hook-shaped end **50***a* of a biasing spring **50**. Although

not shown for purposes of simplicity, it should be understood that rod **49** is provided with an annular groove for receiving hook-shaped end **50***a* so as to prevent the hook-shaped end of the biasing spring from experiencing any linear movement in the axial direction of rod **49.**

Biasing spring **50** is preferably a helically wound tension type spring and is provided at its lower end with a hook-shaped member **50***b* which may be selectively engageable with annular-shaped grooves **41***d*, 41*e* or **41***f* in rod **41,** which grooves are provided for adjusting the biasing force exerted upon rod **41** by biasing spring **50.**

The biasing spring **50** exerts a biasing force upon rod **41** which normally urges rod **41** in the counterclockwise direction, as shown by arrow **51.** By appropriate adjustment of the lower hook-shaped end **50***b*, the magnitude of the biasing force may be regulated so as to control the amount of counterforce exerted upon the stacking platform **46** by collected documents in order to swing the platform and rod downwardly in the clockwise direction as shown by arrow **52,** which swingable movement is provided for a purpose to be more fully described.

Although a detailed description of the mechanical operation of the document handling device **10** is set forth in copending application Ser. No. 227,847, now U.S. Pat. No. 3,771,783, issued Nov. 13, 1973, and a detailed description of the electronic control means is set forth in copending application Ser. No. 273,999, a brief description of the handling of documents will now be given in order to better appreciate the operation of the stacking assembly **60** of the present invention.

Turning first to FIGS. **2** and **2***a*, a motor M is provided with a drive gear **71** mounted to the motor output shaft **70.** The acceleration wheel shaft **28***a* is provided with a timing pulley **72** which is driven by motor M through a timing belt **73** entrained about timing pulleys **71** and **72.** Shaft **28***a* has further secured thereto a gear **74** which meshes with an idler gear **75** which rotates about a short shaft **76.** Locked for rotation with idler gear **75** is a smaller diameter timing pulley **77** which imparts rotation to the rotary fan timing pulley **78** secured to the rotary fan shaft **35** which is powered by pulley **77** by means of a timing belt **79** entrained about pulleys **77** and **78.**

The opposite end of shaft **28***a* (note especially FIG. **2***a*) is provided with an electric clutch **80** which, when normally deenergized, couples the rotation of shaft **28***a* to a timing pulley **81** mechanically coupled to the output of clutch **80.** Pulley **81** is utilized to drive a timing pulley **82** secured to the drive wheel shaft **19***a* by means of timing belt **83.** A second timing pulley **84** is mounted upon drive wheel shaft **19***a* and is caused to rotate the stripper wheel shaft **20***a* by means of a timing belt **85** which is entrained about pulley **84** and a timing pulley **86** mounted upon shaft **20***a*. A like pair of pulleys **84***a* and **86***a* are mounted upon the opposite ends of shafts **19***a* and **20***a* and a similar timing belt **85***a* is entrained about these pulleys **84***a* and **86***a* to serve the dual function of imparting rotation to the stripper wheels **20** through the drive wheel assembly and for exerting an evenly distributed force along stripper wheel shaft **20***a* so that the stripper wheels **20** exert even pressure upon their associated drive wheels **19.**

Drive wheel shaft **19***a* is further provided with a timing pulley **87** and picker wheel shaft **17***a* is provided with a driven timing pulley **88.** A timing belt **89** is entrained about pulleys **87** and **88** so as to impart rotation to picker wheel **17.** The opposite end of picker wheel shaft **17***a* is secured to an electromagnetic brake **90** which cooperatively functions with clutch **80** to selectively decouple the drive stripper and picker wheels from the drive train (through energization of clutch **80**) and to abruptly halt the rotation of these wheels (through energization of brake **90**).

The paper document handling operation functions in the following manner:

With a stack S of documents in infeed hopper **14** and with the machine turned on through the depression of power switch **92** in control panel **13,** the bottom-most document in stack S is urged in the feed direction by raised portion **17***b* of picker wheel **17** which is formed of a material having a predetermined coefficient of friction to perform the dual functions of urging the bottom-most document in the feed direction and toward the drive and stripper wheels and to "jog" the stack S upwardly to cause the documents in the bottom-most portion of the stack to be somewhat relieved of the weight of the entire stack to enhance the infeeding operation.

The bottom-most document enters between the drive wheels **19** and stripper wheels **20** which overlap in the manner previously described to impart a somewhat corrugated or undulating shape to the document passing therebetween. This shape imparted to the entering document acts to stiffen the document somewhat which serves to facilitate the driving and stripping operation. The relative coefficients of friction of the drive and stripper wheels are selected so as to cause the drive wheels to exert the predominant influence upon an entering document or upon entering documents. In the case where a single document is fed between the drive and stripper wheels, the frictional engagement between the drive wheels and the bottom surface of the entering document is greater than the frictional engagement between the stripper wheels and the top surface of the entering document, causing the major influence upon the entering document to be that of the drive wheels which causes the document to be fed in the forward feed direction **18** toward the acceleration rollers. In situations where a pair of documents enter into the region of influence of the drive and stripper wheels in either an overlapping or completely superimposed condition, the frictional engagement between the counter-rotating stripper wheels and the top surface of the upper document is greater than the frictional engagement between the two documents causing the stripper wheels to urge the upper-most one of the two documents backwards toward the infeed hopper. However, the frictional engagement between the drive wheels and the bottom surface of the bottom-most document is significantly greater than the frictional engagement between the two documents fed in overlapping fashion to cause the bottom-most document to continue to be fed in the forward feed direction **18** toward the acceleration wheels **28.** Further details on this unique operation are set forth in copending application Ser. No. 227,847, now U.S. Pat. No. 3,771,783, issued Nov. 13, 1973, and will be omitted herein for purposes of simplicity, it being sufficient to understand the basic operation of the drive and stripper wheels.

Once the trailing edge of a document is free of the influence of the drive and stripper wheels and thereby comes completely under the influence of the accelera-

tion wheels **28** and their cooperating idler rollers **29**, the document is abruptly accelerated so as to abruptly increase its linear speed thereby forming a gap between the trailing edge of the document completely under the influence of the acceleration wheels and the next document fed toward the acceleration wheels **28** by the drive wheels **19**. This "gap" is utilized by photosensing means (not shown for purposes of simplicity) positioned in the region between the drive wheels **19** and the acceleration wheels **28** and bridging across the feed path defined by plates **15** and **31** to count the number of documents which have been fed in a one-at-a-time manner through the document handling device.

As each document is abruptly accelerated by the acceleration wheels **28** its leading edge is caused to move along a path which is defined by the curved portion **31***a* of plate **31**. Note document D1 in FIG. **1***c*.

The rotary fans **32** are continuously rotated by motor M through the power train described hereinabove (note especially FIG. **2***a*) and at an angular velocity which is selected so that the tangential velocity of the tips of the fan blades is less than the linear velocity of documents as they pass downstream relative to the acceleration wheels **28**.

As the leading edge of a document passes downstream relative to acceleration wheels **28** it will move within a pocket, for example, the pocket **37'** defined by the fan blades **34'** and **34''**, with the leading edge of the document being the first to enter into the document receiving "pocket" **37'**. Since the angular velocity of the rotary fans is less than the linear velocity of the documents fed toward the rotary fans, the document (note D2, the example) will continue to move more deeply into the pocket **37'**. The relative timing of the rotary fan rotation and the linear speed of the document is such that, in the worst case, the leading edge of a document will reach and abut against the arm **34***a'* of fan blade **34'** (see D3 FIG. **1***c*) at about the same time that arm **34***a'* moves into alignment with flat plate portion **38***a* and preferably the leading edge of the document will not reach arm portion **34***a'* prior to its alignment with flat plate portion **38***a*.

Once arm **34***a'* moves into alignment with flat plate portion **38***a*, the leading edge of the document will strike against flat plate portion **38***a* preventing the document D4 from experiencing any further movement in the direction shown by arrow **92**.

A document which enters a pocket is caused to be urged in a generally curved configuration due to the shape of the fan blades **34'** and **34''** which define the pocket **37'**. This configuration causes the document which enters pocket **37'** (and each and every pocket for that matter) to be decelerated so that the linear velocity of the document is significantly reduced at the time its leading edge strikes flat plate portion **38***a*. The document will nevertheless have some linear velocity at this time and will bounce backwardly somewhat. However, the tangential velocity of the rotary fans **32** and the slight frictional engagement between the document and the blades which form pocket **37'** will impart sufficient movement to the document to cause its leading edge to again strike stationary plate portion **38** and thereby prevent the document from experiencing any further bouncing or movement toward the rearward direction.

As soon as the tip **34***c''* of blade **34''** passes to the left of stationary plate portion **38***a*, the document D5 in pocket **37'** is now in a free-fall region **94** extending between point **95** and point **96**. Point **95** marks the intersection between the path of movement **41** of the blade tips and flat plate portion **38***a* while point **96** marks the intersection between flat plate portion **39***a* and the top surface of the swingable platform or alternatively, the top surface of the top-most document collected upon the swingable platform.

The document which is not in the free-fall region is caused to be rapidly urged in a vertically downward direction in the "free-fall" region by the blade **34'** while its leading edge follows the surfaces of plate portions **38***a* and **39***a* unitl the document ultimately falls upon the upper surface of plate **46** and further has its leading edge substantially in engagement with the confronting surface of flat plate portion **39***a*. As can clearly be seen, there is a gap G between circular path **41** and plate **46** which also forms part of the "free-fall" region.

The gap G will be continually decreased in size as documents are collected upon plate **46**. However, plate **46** will have its weight continually increasing with the collection of documents thereon to exert a force which counters the biasing force of spring **50** so as to urge rod **41** in the clockwise direction (see arrow **52**) to cause the gap to be increased in size. The magnitude of the force imparted by biasing spring **50** upon rod **41** is adjustable to a maximum by placing hook-shaped end **50***b* in groove **41***f* to an average baising force by placing hook-shaped end **50***b* in groove **41***e* and to a minimum biasing force by positioning hookshaped end **50***b* in groove **41***d*. The adjustment is made in relationship to the size of the documents and to their weight such that larger documents may require positioning of the spring hook-shaped end in groove **41***f* while extremely short or small documents would necessitate positioning of the hook-shaped end of **50***b* in groove **41***d*.

It can thus be seen that the sheer weight of documents collected upon platform **46** may alone be sufficient to cause the platform to swing downwardly so as to provide a gap G of sufficient size to prevent documents collected upon the platform from interfering with the stacking operation.

Some of the conditions of documents which may cause interference are the creasing or curling of documents which may be due either to physically imparting a crease or curl to a document or may be due to the nature of the manner in which the documents have been coated or printed upon which is known to impart a curvature thereto. If all of the documents have a curvature imparted thereto, the collective effect of curled documents may cause the trailing edges of collected documents in the region CD to have their trailing edges extending upwardly and protruding into the path of movement of the tips **34***a* of the fan blades to impede feeding of documents into the pockets **37**. If the documents are of significant length, with the length being measured in the feed direction, their trailing edges, if curled upwardly, may collectively cause the trailing edge of the topmost collected document to protrude into the region designated as **37** and thereby interfere with the entry of a document into a pocket **37** as its leading edge moves downstream relative to the acceleration wheel **28**. However, as was mentioned hereinabove, by appropriate adjustment of biasing spring **50**, the increasing weight of the platform **46** due to the increase in the size of the stack of collected documents will cause the platform to swing downwardly and, in ad-

dition to moving the stack of collected documents away from the rotary fans also alters the angular orientation of plate **46** as well as the collected documents thereon. For example, it can be seen that rod **41** in its uppermost position shown in FIG. **1***a* forms an angle which is slightly less than a right angle with flat plate portion **39***a*. However, this angle θ continually increases as the platform swings downwardly until the platform reaches its bottom-most position shown by dotted line **41'** forming a final angle θ' of the order of 115°. Thus, the ever increasing angle θ of platform **46** causes the angular orientation of the collected documents to continually increase to increasingly move the trailing edges of collected documents further and further away from the entry region **97** of documents into a pocket. This arrangement can be seen to be significantly more advantageous than providing a sliding platform, for example, in place of platform **46,** which platform would form a constant angle with stationary plate portion **39***a* so that the collective effect of curled documents would not be offset by such a sliding platform.

It should further be noted that, in addition to the weight of collected documents exerting a counteracting effect to biasing spring **50,** the collected documents, as well as platform **46** are further urged downwardly by the tips of flexible blades **34** in cases where the collected shack of documents is greater than the gap G shown in FIG. **1***c*. The flexible nature of the blades, which are preferably formed of a spring steel, for example, permits the blades to flex or bend as they come into engagement with the topmost collected document in a stack to prevent the blades from damaging or mutilating the documents.

As was mentioned hereinabove, the relative speeds of documents leaving the acceleration wheels **28** and the tangential velocities of the tips of blades **34** are such that only a single document, in one preferred embodiment, will enter into any pocket. However, it should be understood that if the timing is altered so that the rotational speeds of the rotary fans is significantly reduced, it is still nevertheless possible to cause two documents to be fed into a single pocket wihtout altering the effectiveness of the stacking operation. In fact the apparatus shown in FIGS. **1***a* and **1***b* provide for speed adjustments between minimum and maximum values by means of the manually operable speed control knob **102.**

Considering further the operation of the novel stacker of the present invention, the document handling device is preferably designed to handle documents whose length (measured in the forward feed direction) is as least as great as the distance X between an imaginary line passing through the axes of acceleration wheels **28** and idler rollers **29** and the intersection **98** between dotted circle **34***d* and stationary plate **31.** The reason for this design characteristic is as follows:

Let it be assumed that a document passing between acceleration wheel **28** and idler rollers **29** has its leading edge arriving at point **98** at substantially the identical moment that the tip of a blade reaches the same point. Under this rather severe condition, and due to the relatively high rate of speed of the paper document, which may for example be greater than 100 inches per second, the leading edge will be caused to strike the extreme edge of the blade tip and bounce back. However, due to the fact that the document will still be under the influence of the acceleration wheels and cooperating idler rollers, the document will be prevented from either being kicked backwards or flying out of position and missing the stacker, and the acceleration wheels **28** and cooperating rollers **29** will therefore continue to urge the document in the forward feed direction in spite of the fact that the leading edge may have rebounded due to striking the extreme edge of a blade tip (or blade tips). Since the rotary fans are continuously in motion, the blade tip or tips which have just been struck by the leading edge of a paper document will continue to move generally downwardly below point **98** thereby causing the paper document to be inserted into pocket **37''** between blades **34'** and **34'''**. Thus, by virtue of the relative spacing between the rotary fans and the cooperating acceleration wheels and rollers, there is little possibility that a misfeed of a document will occur. Obviously, it is possible to adjust the spacing distance X referred to hereinabove, if documents whose length measured in the forward feed direction are less than X. However, as a practical matter, experimentation has shown that there is no need for any shorter adjustment of the spacing distance X which was selected for the preferred embodiment described herein after exhaustive experimentation with a very wide variety of documents which are normally handled by such devices.

In order to significantly reduce the possiblity of a collision between the extreme edges of rotary fan blades and the leading edge of the document, the blade tips **34***c* are curved, as shown best in FIG. **1***b*.

As has been further noted, documents whose leading edges are skewed as they are delivered toward the stacker apparatus will still, nevertheless, be handled and neatly stacked by the apparatus **60.** Exhaustive experimentation has shown that a skewed document may have one portion thereof entering into aligned pockets of two of the rotary fans while a remaining portion of document may enter into a pocket of the remaining rotary fan which is downstream relative to the first two rotary fans. FIG. **1***b* shows the leading edge LE of a document **101** being delivered toward the rotary fans in a skewed manner. Document **101** is shown in dotted fashion and only a portion thereof is shown in FIG. **1***b* for purposes of simplicity. In spite of the skewed alignment as shown in FIG. **1***b*, it has been found that the rotary fans will still nevertheless deliver the skewed document to the stacker platform and that the skewed document will be "straightened out" or re-aligned so as to fall upon the stacker platform in substantially perfect alignment with all other documents in the collected stack.

It can therefore be seen from the foregoing description that the present invention provides a novel stacking assembly for use in document and paper handling devices and the like which is capable of neatly and accurately stacking paper documents delivered thereto at extremely high linear speeds, which stacker forms neatly aligned stacks of paper documents regardless of the fact that the documents may have been creased, mutilated, folded, curled and so forth. It should be further noted that the stacker is capable of handling documents of dissimilar size with equal success.

Although the present invention has been described in connection with a preferred embodiment thereof, many variations and modifications will now become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the

specific disclosure herein, but only by the appended claims.

What is claimed is:

1. Stacker apparatus for receiving and neatly stacking documents, paper sheets, cards and the like comprising:

means for delivering documents along a delivery path and toward said stacker in seriatum;

said stacker apparatus including

a plurality of rotary fans mounted upon a common shaft;

means for rotating said fans in a first direction;

said fans each comprising a wheel having a plurality of curvilinear fan blades secured at spaced intervals along said wheel, said blades each being formed of a thin flexible material and having their free ends extending in a direction counter to the direction of rotation of said fans;

each adjacent pair of blades cooperatively forming a pocket for receiving documents delivered to said fans, whereby the leading edges of documents are caused to enter said pockets;

a swingable platform positioned substantially below said rotating fans;

a stationary stripper plate having slots forming passageways for said rotary fans and being positioned in the path of documents carried in the pockets of said rotary fans to eject the documents from said pockets as the fan blades pass through said plate;

said fan blades being adapted to rapidly urge stripped documents downwardly toward said platform as soon as the documents are freed from their respective pockets;

said platform being urged downwardly by the weight of the collected documents as well as by the fan blades which slidably engage the stack of collected documents to move the trailing edges of stacked documents increasingly further away from said delivery path to prevent stacked documents from interfering with the stacking operation.

2. Stacker apparatus for receiving and neatly stacking documents, paper sheets, cards and the like comprising:

means for delivering documents along a delivery path and toward sad stacker in seriatum;

said stack apparatus including a plurality of rotary fans, each fan having a plurality of flexible curved blades, adjacent blades of each fan forming pocket means for receiving documents fed along said delivery path;

a stationary plate positioned between said fans and in the path of said documents for sequentially freeing documents from said pocket means as the fans rotate;

a swingable arm pivoted at a first end and extending through an opening in said plate, said plate being positioned intermediate the ends of said arm, the free end of said arm extending through said plate having a platform positioned substantially below said rotary fans;

the free ends of said fan blades being adapted to rapidly urge documents downwardly toward said platform as soon as the documents are free of their respective pocket means;

said platform being urged downwardly by the weight of the collected documents as well as by the rotary fan blades which slicably engage the stack of documents to move the leading and trailing edges of stacked documents increasingly further away from said delivery path to prevent stacked documents from interfering with the stacking operation.

3. The apparatus of claim **2** wherein said delivery means comprises rotating wheels and cooperating rollers positioned to receive documents therebetween and rapidly urge the documents toward said stacker.

4. The apparatus of claim **3** wherein the spacing of said cooperating wheels and rollers relative to said rotary fans is selected to cause the delivery means to maintain positive drive upon each document at least until the leading edge of a document enters into a pocket means.

5. The apparatus of claim **1** wherein said stripper plate further comprises a flat surface confronting the leading edges of a document in one of said pockets which is substantially normal to the leading portion of said document to facilitate removal of the document from its associated pocket.

6. The apparatus of claim **5** wherein said delivery path is substantially linear;

a curved guiding plate for deflecting a document leaving said delivery means away from said linear path to reduce the angle between said document and the fan blade struck by the document as it enters a pocket to less than 45°.

7. The apparatus of claim **2** further comprising biasing means for normally urging said platform upwardly toward said rotary fans.

8. The apparatus of clain **2** wherein said arm comprises an elongated rod;

stationary pivot means;

means secured to one end of said rod for swingably mounting said rod about said pivot means;

said platform comprising a substantially flat plate secured to said rod near its opposite end and adapted to receive and support collected documents.

9. The apparatus of claim **7** wherein said arm comprises an elongated rod;

stationary pivot means;

means secured to one end of said rod for swingably mounting said rod to said pivot means;

said platform comprising a substantially flat plate secured to said rod near its opposite end and adapted to receive and support collected documents;

stationary spring mounting means positioned above said rod;

said biasing means comprising a tension spring having a first end secured to said spring mounting means and a second end secured to said rod.

10. The apparatus of claim **9** wherein said rod is provided with a plurality of notches arranged at spaced intervals along said rod intermediate the ends of said rod;

said spring second end comprising a hook shaped end for selectively engaging one of said notches to adjust the biasing force imposed upon said rod by said spring.

11. The apparatus of claim **1** wherein said curvilinear blades are each bent at their inner ends to provide a radially aligned short arm portion wherein the curvilinear portion is substantially longer than said short arm portion;

said short arm portions each being secured to said wheel;

the radial distance between said blades and said common shaft being increasingly greater toward the free end of said blades to serve as the means for rapidly urging documents in the free-fall region downwardly toward said platform.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,912,255

DATED : October 14, 1975

INVENTOR(S) : George P. McInerny

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, Line 9, change "not" to --now--;

Claim 2

Column 14, line 3, change "slicably" to --slidably--

Signed and Sealed this

Sixth Day of *December 1977*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

LUTRELLE F. PARKER
Acting Commissioner of Patents and Trademarks