

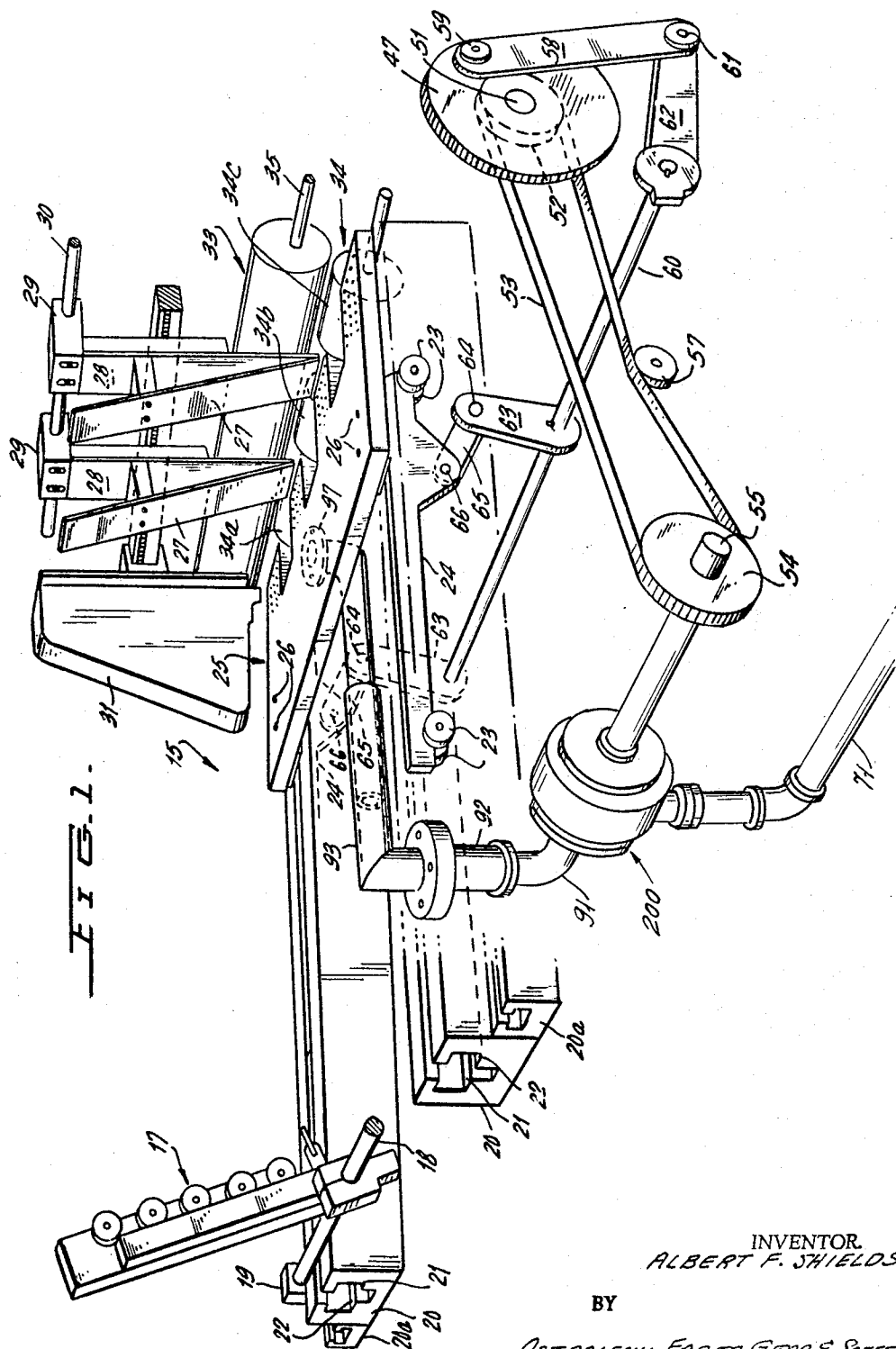
Oct. 18, 1966

A. F. SHIELDS
SHEET FEEDING MEANS

3,279,788

Filed Feb. 8, 1965

8 Sheets-Sheet 1



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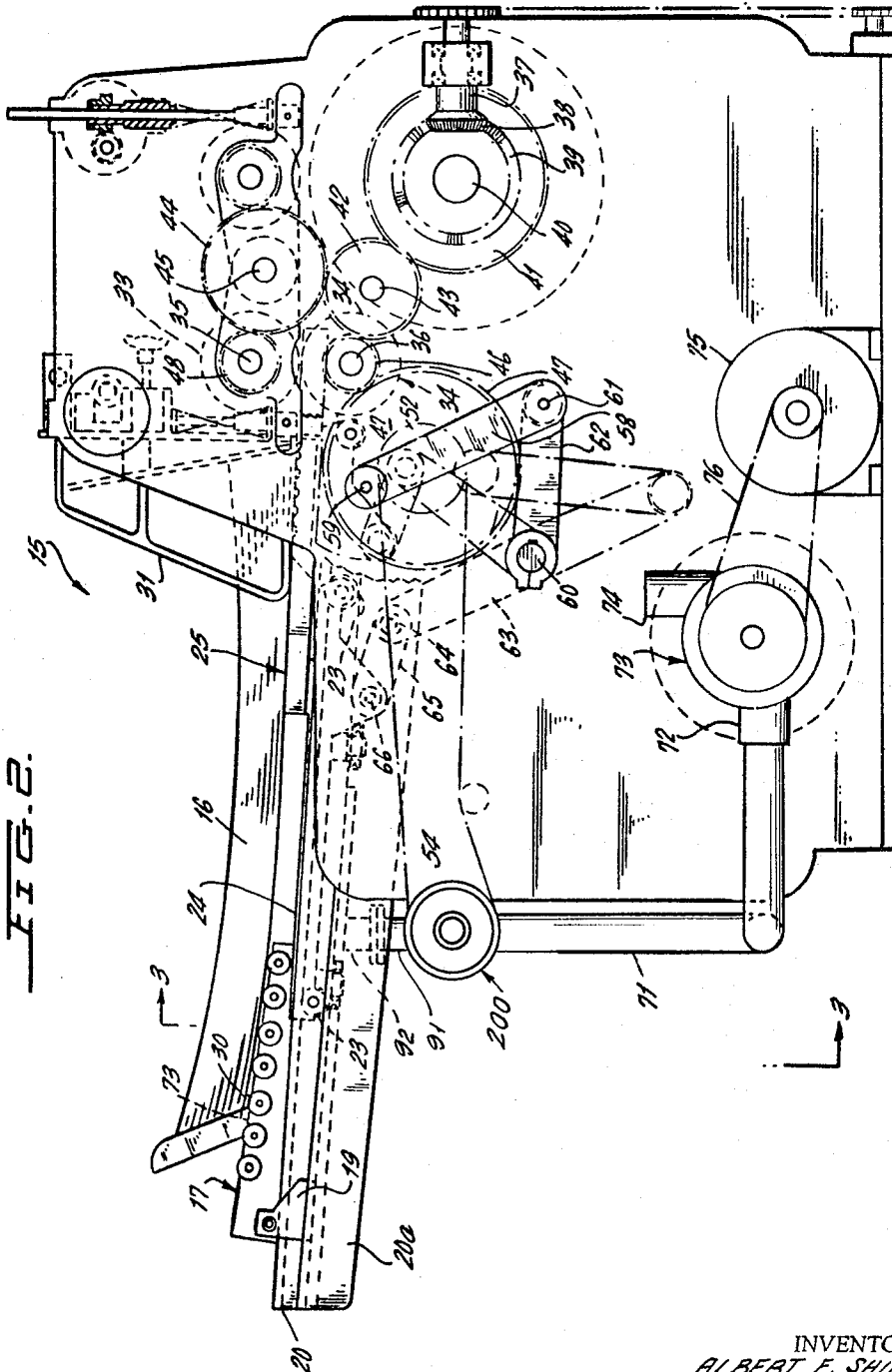
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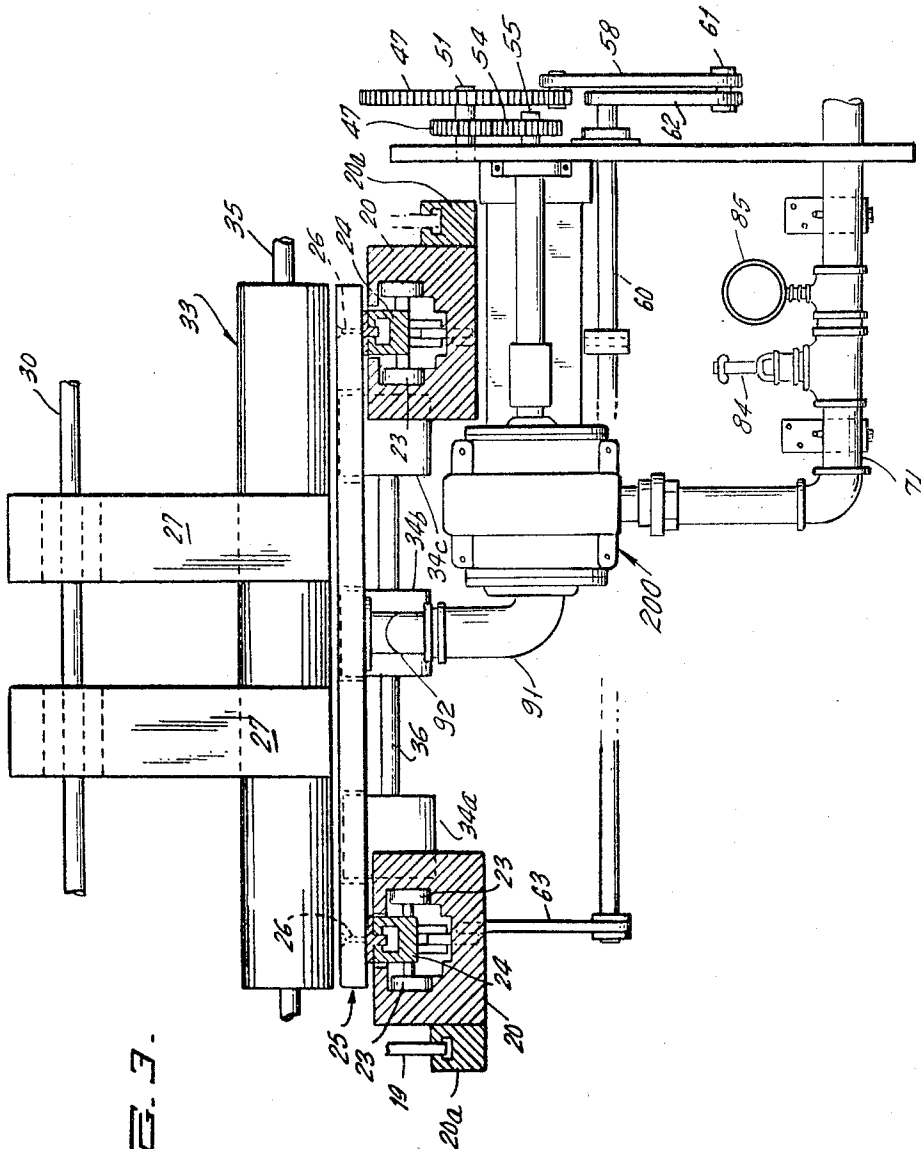
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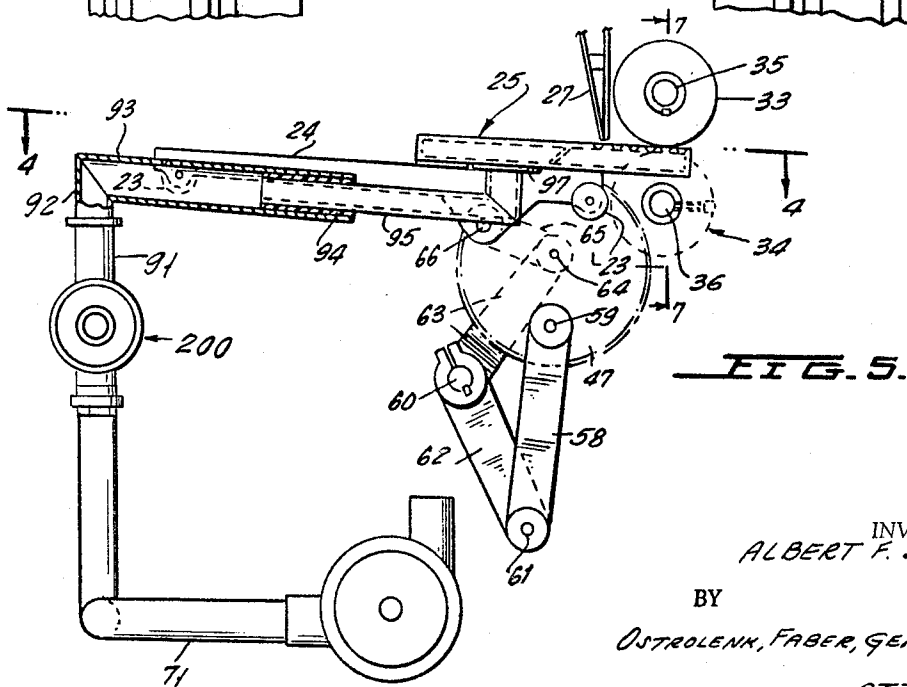
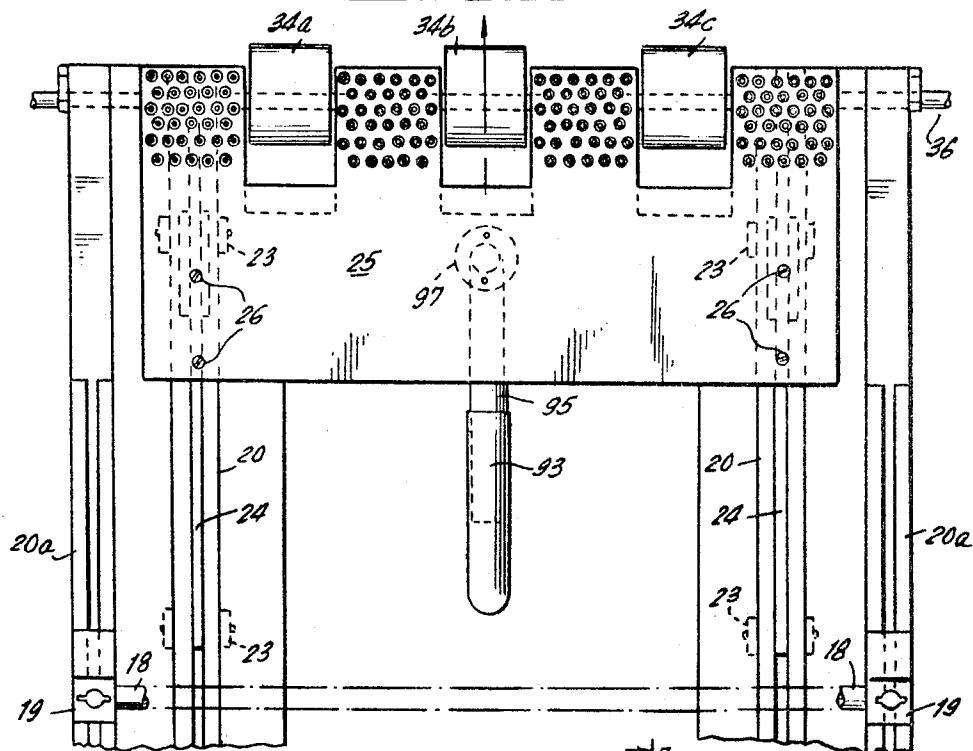
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Filed Feb. 8, 1965

8 Sheets-Sheet 4

FIG. 4.



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Filed Feb. 8, 1965

8 Sheets-Sheet 5

FIG. 6.

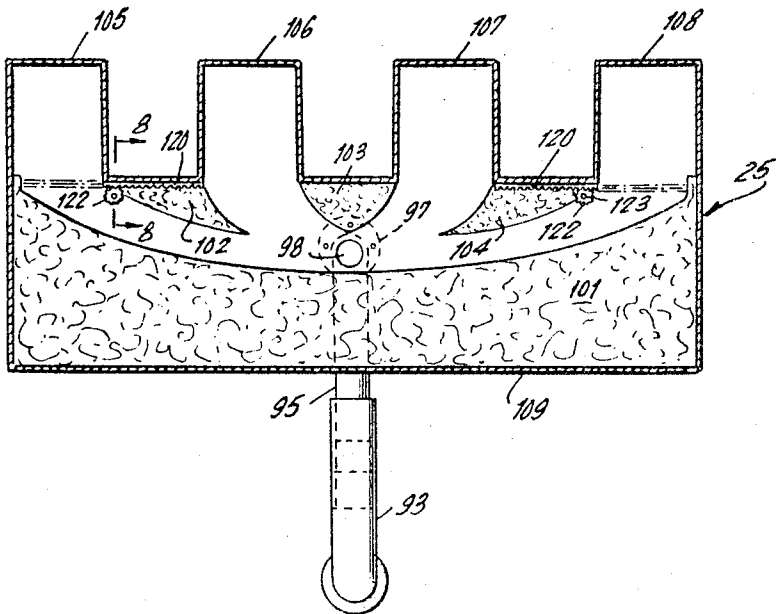


FIG. 7.

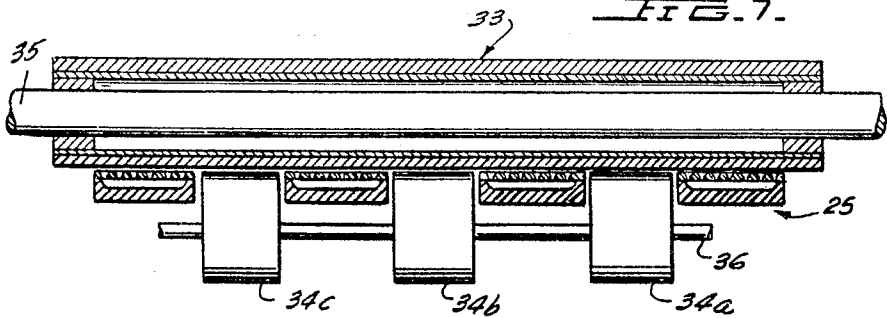


FIG. 8.

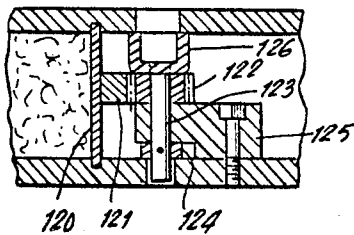
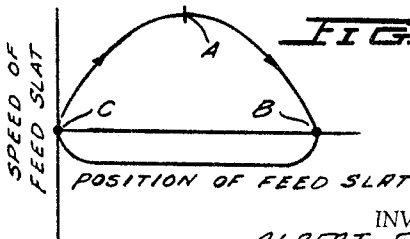


FIG. 9.



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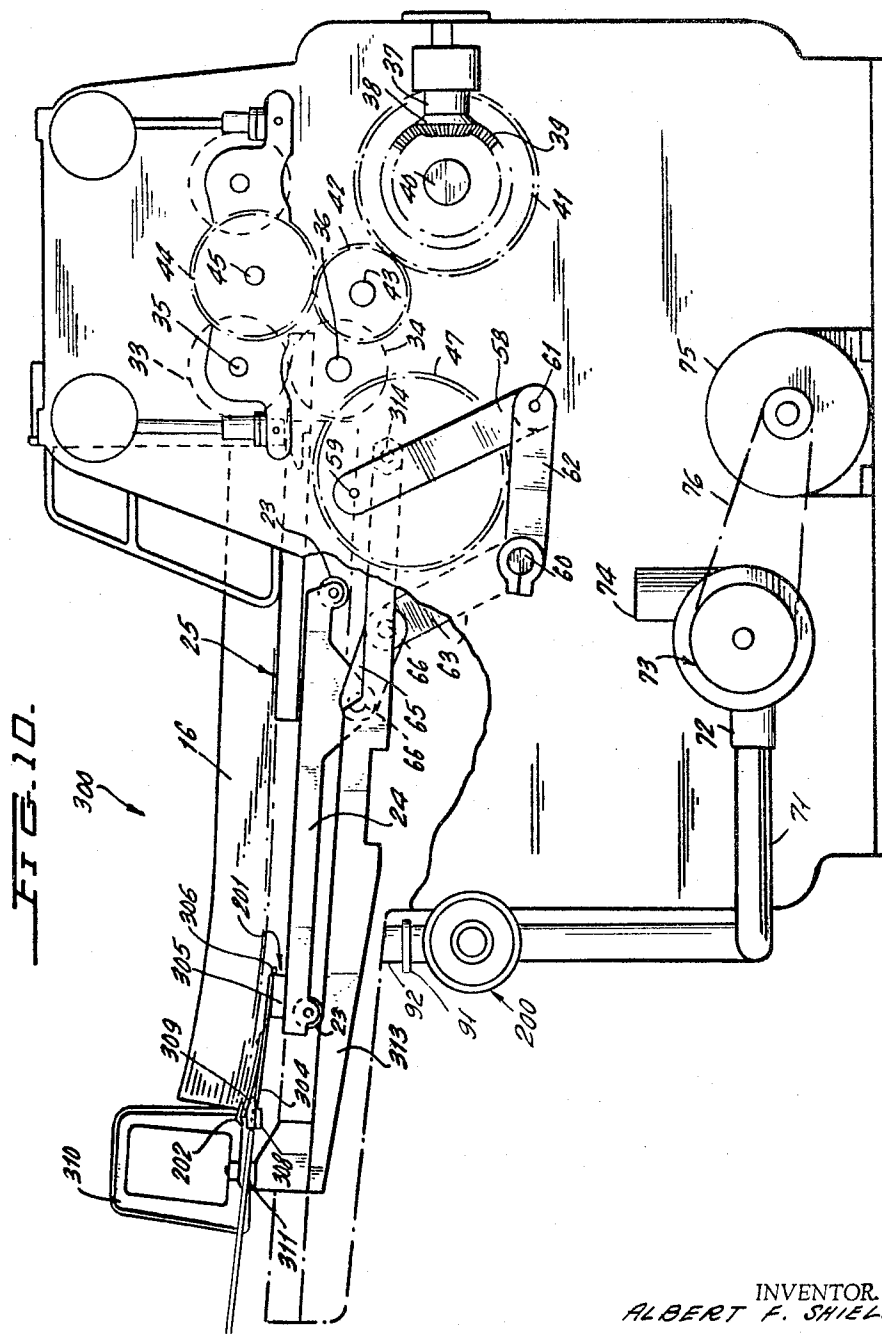
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8 Sheets-Sheet 6



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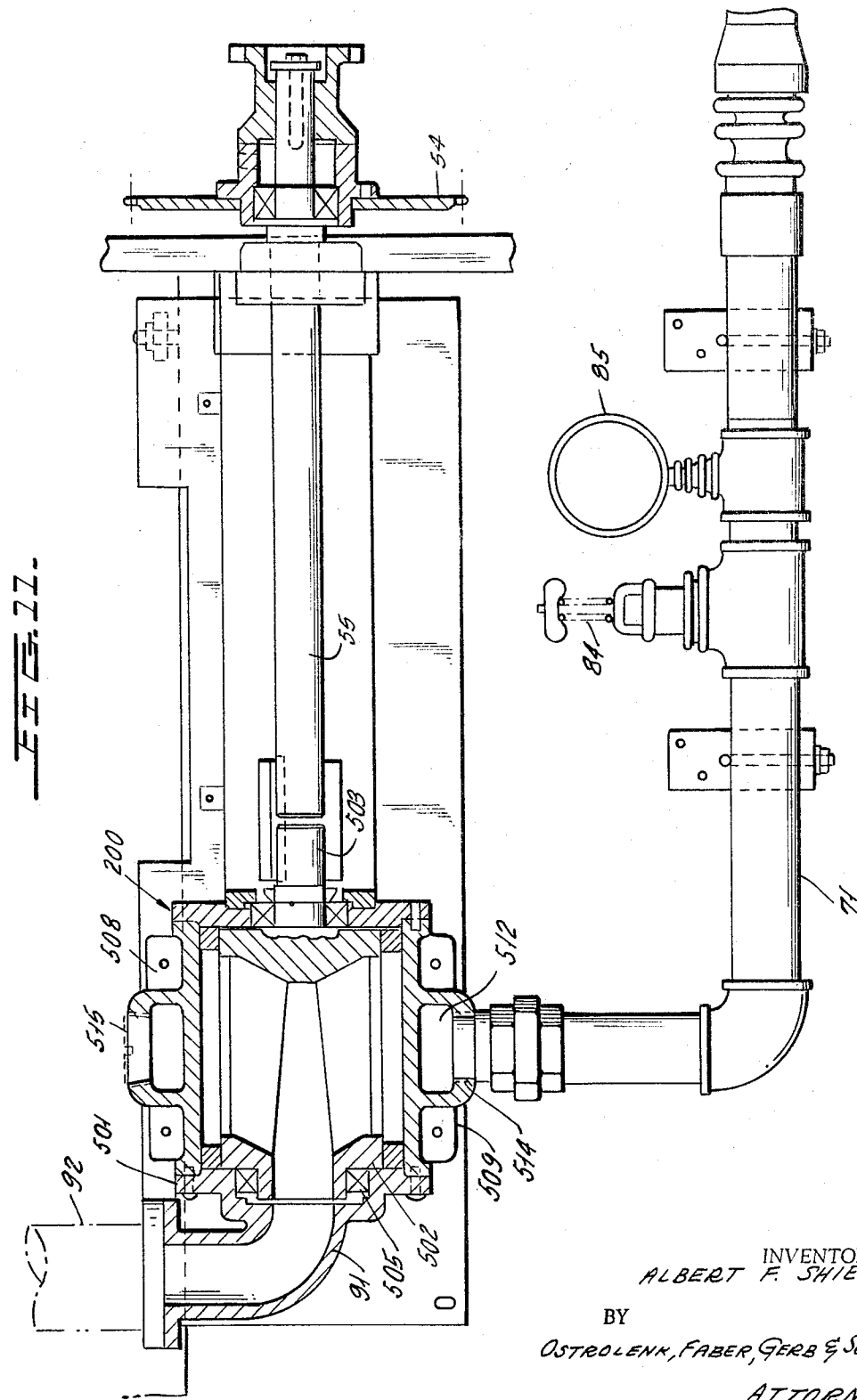
Oct. 18, 1966

A. F. SHIELDS
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3,279,788

Filed Feb. 8, 1965

8 Sheets-Sheet 7



Oct. 18, 1966

A. F. SHIELDS
SHEET FEEDING MEANS

3,279,788

Filed Feb. 8, 1965

8 Sheets-Sheet 8

FIG. 12.

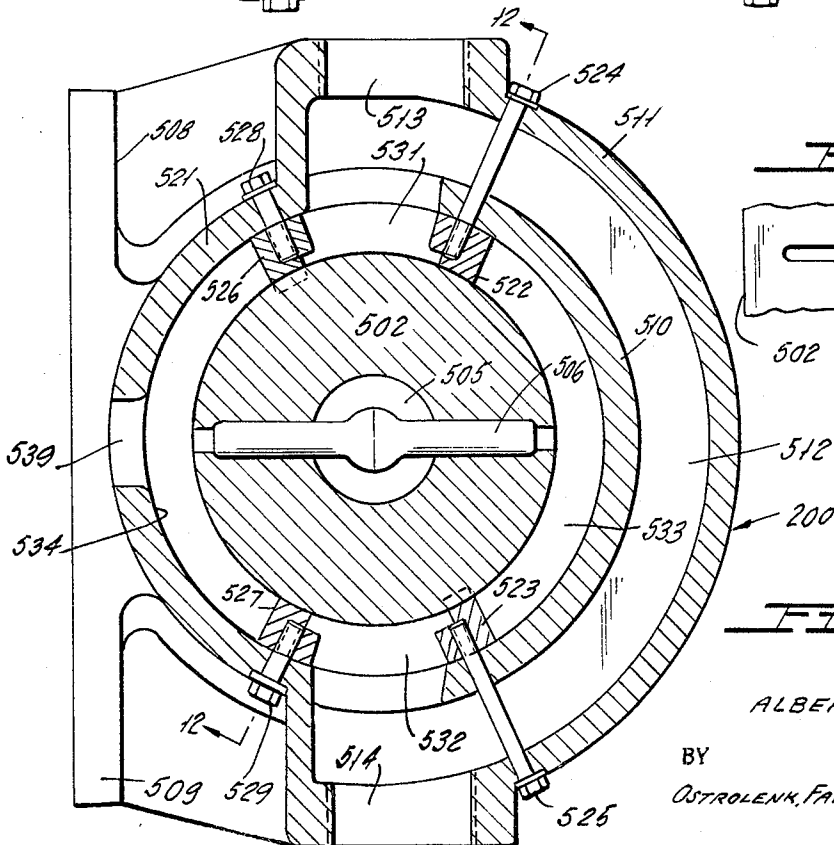
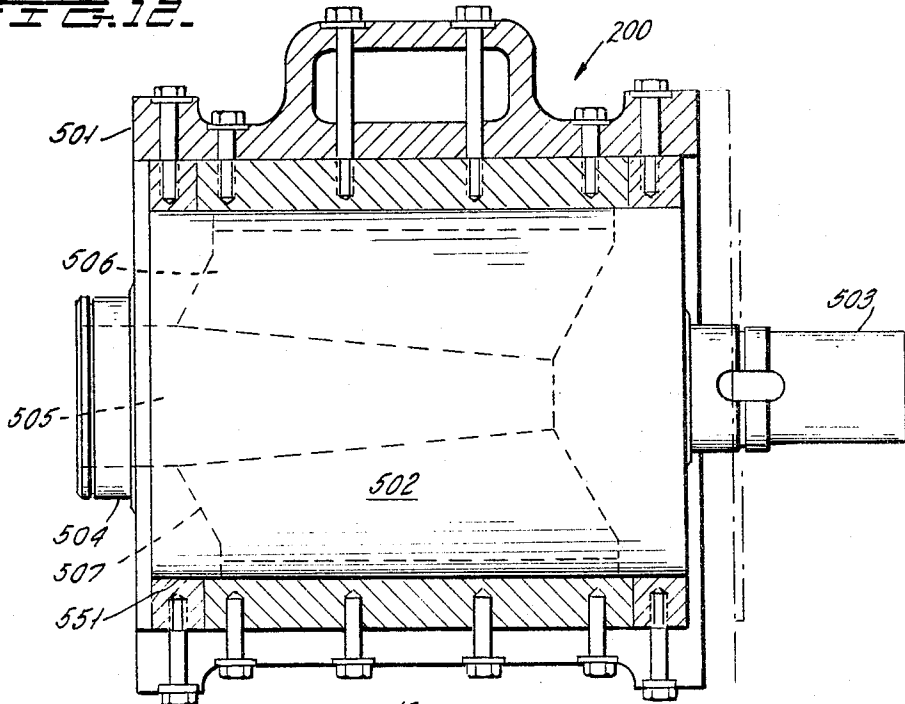


FIG. 14

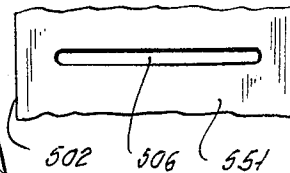


FIG. 15.

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1

3,279,788

SHEET FEEDING MEANS

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Filed Feb. 8, 1965, Ser. No. 430,955

19 Claims. (Cl. 271-32)

This application is a continuation-in-part of my co-pending application Serial No. 272,626, filed April 12, 1963, now abandoned. More particularly, this invention relates to a novel sheet feeding mechanism having a novel reciprocating vacuum means controlled by a valve whose movable member is of novel construction and rotates continuously in the same direction.

In the paper box making art cutting and creasing presses, automatic folding machines, and other apparatus are operated at high speeds and because of this are provided with automatic high speed sheet feeding equipment. It has been found that prior to feeding of the blanks it is advantageous to arrange them in a stack which is replenished from the top and from which the individual blanks are removed from the bottom by the automatic feeding equipment.

The prior art has provided both mechanical and suction feeding equipment of this type. My U.S. Patent 2,583,712, issued January 29, 1952, entitled Folding Machine, illustrates a purely mechanical feeding device. A continuous belt suction feeder is described in the J. P. Lopez U.S. Patent 2,995,316, issued August 8, 1961, and entitled Feeding Equipment. A reciprocated suction feeder is illustrated in U.S. Patent 2,862,709, issued December 2, 1958, to P. D. Labombarde, entitled Machine and Method for Feeding Sheets.

A positive mechanical feeder has proven best in obtaining close registration between feeding equipment and subsequent apparatus which receives blanks from the feeding equipment. However, a positive mechanical drive has proven less than satisfactory with odd shaped blanks (those blanks having irregular rear and/or front edges), blanks of thin or delicate material, or warped blanks. Since a mechanical feeder is usually reciprocated, extremely high speeds are not feasible. Suction feeding equipment has been employed for the applications where a positive mechanical feed has proven ineffective.

A continuous belt suction feeder of the type illustrated in the aforesaid Patent 2,995,316, may be operated at very high speeds but cannot be readily coordinated with the equipment which receives the blanks. Further, such a feeder is not capable of satisfactorily handling many odd shaped blanks nor is it capable of effectively handling blanks constructed of very thin material.

In the reciprocated suction feeder illustrated in the aforesaid Patent 2,862,709, coordination with succeeding equipment is effective. However, high speed operation is not possible nor is it possible to effectively handle many types of irregularly shaped blanks. Further, in the device of the aforesaid Patent 2,862,709, the elements which directly engage the blanks are constructed of yieldable material. Because of this these elements are caused to wear in a comparatively short time and in order to insure that these elements release the blanks after feeding, it is necessary to apply positive pressure to these elements rather than merely vent these elements to the atmosphere.

The device of the instant invention is constructed in a manner such that the basic drive mechanism for obtaining a reciprocating motion coordinated with apparatus operating forward of the feeding equipment may drive either a mechanical feeder or a suction feeder. In one embodiment of this invention both mechanical and suction feed slats are employed at the same time. The mechanical feeder is of a type described in my aforesaid Patent 2,583,712. The suction feeder is a hollow slat

2

having forward projections or fingers with the slat always positively supporting the stack at the forward end thereof.

The fingers, at the top surfaces thereof, are provided with a plurality of apertures at which suction is present during the feeding in portion of slat movement and at other times these apertures are vented to the atmosphere. The connection between the suction generating means and the feed slat includes a telescoping joint which expands during the feed stroke with the expansion of the joint serving to aid in the rapid build up of suction.

The feed slat is a hollow member constructed of metal or other rigid material. A rigid light weight filler, such as balsa wood, occupies selected portions of the slat interior thereby reducing the volume which must be evacuated upon the application of suction without adding appreciably to the weight of the slat. Because of the reduced volume pressure within the slat builds up within a short time after venting to the atmosphere. Since the slat material defining the suction applying apertures is constructed of a rigid material release of a blank being fed is accomplished as soon as venting occurs.

The slat fingers are very extensive in area extending between a plurality of axially spaced wheels constituting the lower feed roll which cooperates with a continuous upper feed roll to feed the blanks received from the feeding equipment to subsequent apparatus. The top surfaces of the fingers are substantially coplanar with the uppermost peripheral portions of the wheels thereby providing an extensive support surface for the lead edges of the blanks as they are engaged by the feed rolls. Because of this, engagement by the feed rolls takes place in a positive and uniform manner over the full width of the blanks thereby preventing skewing of the blanks.

There is known to be a prior art suction feeder with a slat carrying suction applying ports which cover a relatively small area at the center of the slat. In order to prevent skewing of the blanks, this prior art feeder must also be provided with stationary suction ports. Suction applied at the stationary ports serves to retard sheet feeding. In the device of the instant invention all of the suction ports move with the blanks so that no retarding suction force is present. In such prior art machine suction was generated as a function of feed slat speed. Thus, the machine was not capable of low speed operation since suction generated at that time was very low. In the device of the instant invention suction is generated by a pump which is operated by means independent of feed slat speed so that strong suction forces are generated even for low speed feeding.

In the device of the instant invention the application of suction to the feed slat is controlled by a novel valve means. More particularly, even though the feed slat is reciprocated, for the sake of economy and reliable operation a valve with a continuously rotating core is utilized. The core is provided with two radially extending passages disposed 180° apart. The valve body is constructed as a symmetrical unit with two suction ports and two exhaust ports. This duplication of ports and core passages results in a balanced unit. That is, the core passages communicate with diametrically opposed suction ports at the same time so that suction forces do not cause added pressure between the core and body nor do these suction forces exert radial forces on the valve bearings thereby reducing wear. Similarly, the core passages communicate with diametrically opposed exhaust ports at the same time.

Wear is further reduced by virtue of the fact that with the balanced valve construction the core is required to make only one revolution for each two feed strokes.

In order to assure rapid buildup of suction in the feed slat the valve core is an elongated cylinder with the passages extending substantially the full core length and having a short angular or circumferential dimension. Thus, slight angular movement is effective to expose extensive portions of the passages to the suction ports.

Accordingly, a primary object of the instant invention is to provide a novel construction for a timed suction feeding device.

Another object is to provide a novel construction for a reciprocated suction feeding device.

Still another object is to provide a suction feeding device which does not require the application of pressure above ambient in order to release the blanks being fed.

A further object is to provide a suction feeding device having novel means for accelerating the build up of suction.

A still further object is to provide a novel feeder for irregularly shaped blanks, especially for those blanks whose leading edges are not straight across.

Yet another object is to provide a feeding device of this type having novel valve means for controlling the application of suction.

Still another object is to provide a suction feeder which is interchangeable and/or useable in conjunction with a mechanical feed.

These as well as other objects of this invention shall become readily apparent after reading the following description of the accompanying drawings in which:

FIGURE 1 is a perspective in somewhat schematic form illustrating a reciprocated suction feeder constructed in accordance with the teachings of the instant invention.

FIGURE 2 is a side elevation of the feeder of FIGURE 1.

FIGURE 3 is a cross-section taken through lines 3—3 of FIGURE 2 looking in the direction of arrows 3—3.

FIGURE 4 is a fragmentary plan view of the suction feeder taken through line 4—4 of FIGURE 5 looking in the direction of arrows 4—4.

FIGURE 5 is a side elevation of the suction feeder with certain elements removed to reveal the positional relationship of key elements.

FIGURE 6 is a plan view of the feed slat with the top surface thereof removed.

FIGURE 7 is a front end view of the feed slat, partially sectioned, revealing the relationship between the feed slat and the delivery rolls which receive blanks from the feed slat and convey these blanks to another device.

FIGURE 8 is a fragmentary cross-section taken through line 8—8 of FIGURE 6 looking in the direction of arrows 8—8.

FIGURE 9 is a graph illustrating the relation between feed slat position and feed slat speed.

FIGURE 10 is a side elevation showing an embodiment of this invention in which both a mechanical and a suction feeder cooperate to feed blanks.

FIGURE 11 is an elevation illustrating the suction control valve in longitudinal cross section and the valve drive and pneumatic connections.

FIGURES 12 and 13 are cross sections of the control valve taken through lines 12—12 and 13—13, respectively of FIGURES 13 and 12, respectively, looking in the directions of the respective arrows.

FIGURE 14 is a plan view looking at the entrance end of one of the valve core passages.

Now referring to the figures. Suction feeder 15 is intended to feed blanks one at a time from the bottom of stack 16 with the stack being so positioned as to be replenishable by adding blanks to the top of stack 16 while feeder 15 is operating. Adjustable rear gauge means 17 is provided with a portion adjusted so as to be forwardly sloping and provide support for the rear of stack 16 in a manner generally known to the art. Although only one rear gauge 17 is shown in FIGURE 1, it should be obvious to those skilled in the art that a plurality of such gauges

are adjustably mounted to support bar 18 extending transverse to the feed path (indicated by line 2 of FIGURE 4) of the blanks. The ends of bar 18 are supported by blocks 19 which are mounted to projections 20a of longitudinally extending frame members 25 for adjustment parallel to the feed path.

Frame members 20 are positioned on opposite sides of the feed path Z and are each provided with a pair of internal tracks 21, 22 which support the rollers 23 for carriage sections 24 whereby carriage sections 24 are mounted for movement parallel to the feed path Z. Feed slat 25, whose construction will be hereinafter described in detail, extends transverse to the feed path and is secured by bolt means 26 to both carriage sections 24. As clearly seen in FIGURE 2, the forward portion of stack 16 is supported by feed slat 25 with the forward edges of the blanks in stack 16 resting against forwardly inclined front gauge members 27.

Included members 27 are carried by vertical members 28 which extend downward from blocks 29. The latter are mounted to cross bar 30 in such a manner as to be movable transverse to the feed path. Vertical members 28 are mounted to blocks 29 in a manner well-known to the art so as to be adjustable in a vertical direction and thereby establish a space between the lower ends of gauges 27 and the upper surface of feed slat 25 which is slightly greater than the thickness of sheets being fed and less than the thickness of two such sheets. The transverse position of stack 16 is established by transversely adjustable side gauges 31 mounted on opposite sides of the feed path F.

Upper and lower feed or delivery rolls 33 and 34, respectively, are keyed to shafts 35 and 36, respectively, extending transverse to feed path F. For a reason which will hereinafter become obvious, lower feed roll 34 consists of a plurality of wheels 34a, 34b, 34c spaced along the axis of shaft 36. As will be hereinafter explained in detail, delivery rolls 33, 34 are positioned to receive sheets conveyed below front gauges 27 below feed slat 25.

As is most clearly illustrated in FIGURE 2 the drive for feed device 15 is obtained through the rotation of shaft 37 extending parallel to feed path F. Bevel gear 38 keyed to shaft 37 drives a second bevel gear 39 keyed to shaft 40 extending transverse to feed path F. Spur gear 41 keyed to shaft 40 drives spur gear 42 mounted to shaft 43 which in turn drives spur gears 44 and 46 keyed to shafts 45 and 36, respectively. Gear 44 drives gear 48 keyed to shaft 35 thereby driving upper feed roll 33. Gear 46 is keyed to shaft 35 thereby driving lower feed roll 34.

Spur gear 46 also drives spur gear 47, keyed to stub shaft 51 (FIGURE 1), which carries a smaller diameter sprocket 52 keyed thereto. Sprocket 52 drives closed loop chain 53 which in turn drives sprocket 54 keyed to shaft 55 for operation of valve 200 as will hereinafter be described in detail. Idler sprocket 57 provides a tensioning guide for chain 53. Crank 58 is connected by pin 59 to spur gear 47 at a point remote from stub shaft 51. The other end of crank 58 is connected at pin 61 to one end of link 62 whose other end is keyed to rock shaft 60 also located at a point remote from stub shaft 51.

Drive link 63 is keyed at one end thereof to rock shaft 60 while the other end thereof is connected by pin 64 to one end of connecting link 65 whose other end is connected by pin 66 to carriage 24. Individual links 63 and 65 are provided for each of the carriage sections 24 with each of the links 63 being keyed to rock shaft 60. Thus, it is seen that as gear 47 is rotated with a uniform angular velocity, crank 58 acting through link 62 causes rock shaft 60 to pivot back and forth about its longitudinal axis. This rocking motion is amplified by drive links 63 and is transmitted through links 65 to reciprocate carriage sections 24 forward and backward parallel to feed path Z (FIGURE 4), in turn reciprocating feed slat 25 along feed path Z.

Valve 200 is connected through conduit 71 to the intake port 72 of pump 73 whose outlet port 74 exhausts to

5

the atmosphere. Pressure adjusting safety valve 84 and pressure guage 85 (FIGURE 3) are connected to conduit 71 for purposes well known to the art. Motor 75, acting through chain 76, drives pump 73 in a direction such that low pressure is present at intake port 72 for selected positions of feed slat 25 as controlled by valve 200 as will be hereinafter described.

Valve 200 consists of two main parts, namely, a body 501 and a core or rotor 502 keyed to shaft 55 for rotation thereby. As best seen in FIGURES 11 through 14, rotor 502 is a cylindrical member having rearward axial extension 503 keyed to shaft 55 and forward axial extension 504 seating forward bearings (FIGURE 11). Rotor 502 is provided with tapered axial chamber 505 whose wide end is opened and positioned forward while the rear end is closed. Slit-like radial passages 506, 507 extend from chamber 505 to the outer surface 551 of rotor 502. Passages 506, 507 are spaced apart by 180° for a purpose to be hereinafter explained.

Rotor 502 is disposed within housing 501 with the latter having mounting flanges 508, 509 and an internal arcuate partition 510 cooperating with outer wall portion 511 to form arcuate conduit 512 connecting ports 513, 514. Port 513 is closed by plug 515 while port 514 is connected to suction conduit 71.

Internal partition 510 is concentric with external partition 521 with the ends of these two partitions being spaced from one another at points in alignment with ports 513, 514. Radially projecting and axially extending replaceable dividers 522, 523 which act as sealing elements are positioned at the ends of partition 510 and are secured in place by bolts 524, 525, respectively, which extend through partitions 510, 511 and are received by threaded apertures of dividers 522, 523. In a similar manner, replaceable dividers 526, 527 which act as sealing elements are secured to partition 521 near the ends thereof by bolts 528, 529 respectively.

Dividers 522, 523, 526 and 527 are in good sealing engagement with the outer surface 551 of rotor 502 thereby forming four arcuate chambers adjacent to the outer surface of rotor 501. These chambers are designated as suction chambers 531, 532 and exhaust chambers 533, 534. More particularly, chambers 531, 532 communicate with chamber 512 and the latter communicates with port 514 connected through conduit 71 to suction pump 73.

Chamber 534 communicates with port 539 in partition 521 with port 539 being vented directly to the atmosphere. Chamber 533 is vented to atmosphere at both of its axial ends.

It is noted that when one of the slit-like passages 506, 507 is connected to a suction chamber or an exhaust chamber the other slit-like rear passage is connected to the same chamber. Thus, the structure is balanced in the sense that the air pressure controlled by valve 200 does not tend to move rotor 502 off center. It is further noted that each of the slit-like passages 506, 507 extends for a substantial distance along the length of rotor 502. The narrowness of the passages 506, 507 contributes to the accurate application of suction in relation to movement of the feed slat while the extensive axial length of passages 506, 507 enables suction to be established at the feed slat in a very short time interval. That is, with a very slight change in axial position of rotor 502 extensive openings are provided between rear passages 506, 507 and suction chambers 531, 532. Since rotor 502 turns only 180° for each complete forward-rearward cycle of the feed slat 25 wear of the valve parts is reduced.

It is also noted that each of the sealing elements 522, 523, 526, 527 is constructed with the portion engaging rotor 502 non symmetrical with respect to the bolts securing these sealing elements in position. Thus, it is apparent that sealing elements may be rotated 180° in order to satisfy different timing requirements of another machine. It is also apparent that a continuous adjustment within a small range may readily be provided by utiliz-

6

ing slotted rather than round apertures to position bolts 524, 525, 528, 529. In such case sealing washers carried by bolts 524, 525, 528, 529 would be utilized to seal the unused slot portions.

Valve chamber 89 is connected through fittings 91, 92 to one end of L-shaped pipe 93 which is fixedly mounted by means not shown. Pipe 93 is provided with a generally horizontal leg which is parallel to the carriage tracks 21, 22. As clearly seen in FIGURE 5, the generally horizontal leg of pipe 93 at the right end thereof is provided with an internal fluid sealing ring 94. Ring 94 is fixedly secured to pipe 93 and is closely fitted to the outside of pipe 95 which extends through ring 94. Member 94 is preferably constructed of Teflon and constitutes a low friction fluid seal with telescoping pipe 93.

Pipe 95 extends in a generally horizontal direction with the right end thereof as viewed in FIGURE 5 being connected to the lower end of fitting 97 secured to the lower surface of feed slat 25. Fitting 97 encompasses suction inlet 98 in the bottom surface of feed slat 25. Inlet 96 communicates with evacuated portions of feed slat 25 (FIGURE 6). Feed slat 25 is a hollow unit constructed of a rigid material, preferably an aluminum alloy. Selected portions of the interior are provided with lightweight inserts 101-104 to define air passages internal to slat 25 communicating with aperture 98.

Feed slat 25 includes fingers 105-108 extending forward of a main portion 109 which bridges the gap between spaced carriages 24. As clearly seen in FIGURES 1, 4 and 7, the upper wall portions of feed slat 25 forming fingers 105-108, is provided with a plurality of apertures which communicate with suction inlet 98 in the bottom wall of feed slat 25. It is noted that the apertures in fingers 105-108 are conical frustums with the larger diameter being at the outer surface of the slat top wall. As most clearly seen in FIGURE 4, wheels 34a, 34b and 34c constituting lower feed roll 34 are positioned to be received in the spaces between fingers 105-108 as feed slat 25 is moved forward.

For the handling of narrow sheets it may be desirable to reduce the number of apertures in the slat fingers which communicate with inlet 98. Because of this feed slat 25 is provided with two gates 120 mounted so as to be movable to the positions shown in the dotted lines in FIGURE 6. As clearly seen in FIGURE 8, each gate 120 is provided with gear rack 121 engaged by spur gear 122. The latter is keyed to shaft 123 whose lower end is journaled for movement in a clearance aperture in the bottom wall of feed slat 25 and another aperture in L-shaped bracket 125 secured to the bottom wall of slat 25. Collar 124, sandwiched between the bottom wall of slat 25 and bracket 125 limits axial movement of shaft 123. Socket head screw 126, accessible through an aperture of the feed slat top wall, is secured to the upper end of shaft 123 for the purpose of receiving a tool for rotating shaft 123 and thereby rotating spur gear 122. Rotation of spur gear 122 in one direction moves rack 121 so that gate 120 slides across the rear end of a finger thereby isolating this finger from inlet 98 while reverse rotation of shaft 123 moves gate 120 from the blocking position.

Operation of suction feeder 15 takes place in the following manner. A stack of blanks 16 is delivered to device 15 and positioned as shown in FIGURE 2. When feed slat 25 is brought to its most rearward position shaft 55 positions rotor 502 so as to connect chamber 505 with the intake to pump 73. Pump 73 then proceeds to evacuate air from the inside of feed slat 25. Thus, low pressure is present at the apertures in fingers 105-108 and the bottom sheet in stack 16 is firmly held against the top surface of feed slat 25.

As feed slat 25 moves forward a portion of pipe 95 emerges from pipe 93 thereby increasing the volume between valve 56 and feed slat 25. Since the quantity of air in this volume is not being increased at this time the increase in volume results in a reduction in pressure which adds to the suction created by the action of pump

73 so that low pressure holding the blanks against feed slat 25 increases very rapidly. The forward or feed stroke of slat 25 carried the lowermost blank in stack 16 below front gauges 27 to a point at the nip formed by delivery rolls 34, 35.

After the blank is engaged by delivery rolls 34, 35 valve rotor 502 is so positioned that rotor chamber 505 is connected to exhaust chambers 533, 534 and pressure within slat 25 is brought up to ambient so that the blank is released by slat 25. This condition of valve 200 prevails until the point where feed slat 25 is next returned to its most rearward position.

It is noted that the top surfaces of feed slat fingers 105-108 are coplanar with the upper peripheral edge portions of wheels 34a, 34b, 34c (FIGURE 7) so that a large surface is provided for the support of a blank at the time it is initially engaged by feed rolls 33, 34. Point A on the graph of FIGURE 9 is the maximum speed of slat 25 in the forward direction with this speed being equal to the peripheral speed of feed rolls 33, 34, with this speed being attained at the time that feed rolls 33, 34 engage the blank. As feed slat 25 moves forward from point A to point B of the graph in FIGURE 9 the feed slat rapidly decelerates to zero speed. Between points B and C in the graph of FIGURE 9 feed slat 25 is moving rearward while between points C and A of FIGURE 9, the feed slat is moving forward in the rapidly accelerating feed stroke. Suction is applied at point C and is discontinued at point A where slat 25 is vented to the atmosphere.

As noted in the description of FIGURE 6 the outer surfaces of feed slat 25 are constructed of metal. This material is substantially heavier than the material of which inserts 101-104 are constructed. Suitable material for inserts 101-104 is balsa wood. Because of the high speed reciprocating motion of feed slat 25 it is essential that this member be made as lightweight as possible yet mechanical strength cannot be sacrificed because of the ruggedness required for continuous high speed operation over long periods of time.

The apertures in fingers 105-108 are tapered so as to reduce losses in pressure which will occur when some of these apertures are not covered or isolated from inlet 98. The larger dimensions for these fingers apertures are provided so that extensive low pressure regions are presented to the sheets for effective gripping thereof. Gates 120 are provided to isolate the apertures of fingers 105 and 108 from inlet 98 when the blanks being fed do not rest against these fingers or when only insignificant areas of these fingers are used to support the blanks. Under these circumstances by isolating an entire finger from inlet 98, pump 73 is more effective in maintaining low pressure at the other fingers of slat 25.

The suction feeder hereinbefore described is extremely accurate as compared to pure suction devices of this type. However, there are certain applications which require even greater degrees of accuracy. One such application is the feeding of unfolded box blanks to printing apparatus having rollers which print matter that must be precisely positioned with respect to the transverse score lines of the box blanks. For such applications a pure suction feed has not proven to be entirely satisfactory since the instant the blank moves forward may vary. This is due to the fact that with the aerodynamic principles of suction holding many variables enter the picture.

In order to overcome this difficulty the feeder 300 of FIGURE 10 provides a reciprocating suction applying slat 25 and a mechanical kicking or feeder means 201. As in the embodiment previously described, slat 25 supports stack 16 at its leading edge and also applies suction holding to the leading edge of the bottom-most blank. Spring feeders 202 of means 201 engage the trailing edge of the bottom-most blank and cooperate with slat 25 in conveying this blank forward to delivery rolls 33, 34.

Longitudinally extending plates 304, hinged at their for-

ward ends to transverse slat 305 at 306, carry spring feeders 202. The ends of slat 305 are connected to carriages 24 at a point to the rear of suction applying slat 25. Plates 304 are slidably supported by transverse member 308 whose blocks 309 support the rear end of stack 16 from the bottom. Rear gauges 310, mounted to cross member 311, support member 308 and also confine the rear of stack 16. Cross member 311 extends between arms 313 and is connected to the top surfaces of arms 313 at the rear ends thereof. The forward ends of arms 313 are supported to the apparatus frame at fixed pivots 314 so that the rear gauges 310 are adjustable vertically. My U.S. Patent 2,902,280, issued September 1, 1959, on a Spring Feeder for Warped Board describes the details of mechanical kicker means 201 and the manner in which plates 304 enable spring feeders 202 to follow the contour of even badly warped sheets without damage to the sheets remaining in the stack. It is noted that mechanical kicker means 201 travels only the short stroke required to deliver the leading edge of a blank to delivery rolls 33, 34.

Trolleys 24 move forward at point C in the diagram of FIGURE 9. At this time low pressure is also applied to slat 25 but this drop in pressure does not always act to instantaneously firmly grip the lowermost sheet. Even if the lowermost sheet is not firmly gripped by slat 25 there is a sufficient gripping force applied so that with the aid of mechanical feeder 201 acting at the rear of the lowermost blank this blank will move forward at the instant trolleys 24 move forward thereby assuring extremely accurate registration with respect to printing rollers or any other apparatus which follows.

It is noted that the utilization of a so-called contour type spring feeder that is vertically adjustable contributes substantially to registration accuracy in that spring feeders 202 are capable of remaining in engagement even with badly warped board until feed rolls 33, 34 are fully engaged with the sheet. Because of the action of suction feed slat 25, mechanical feeder 201 will not crush the trailing edge of delicate material or cross-corrugated material. Further, because of suction feeder 25 delicate material will not be caused to bow when struck by the hammer-like blow of the rapidly accelerating mechanical feeder 201. If mechanical feeder 201 were to cause bowing before engagement of the sheet by feed rolls 33, 34 in accuracy of registration will occur.

Thus, this invention provides a novel construction for a reciprocating suction feeder for sheet material. The construction is such that the feeder may be accurately coordinated with the operation of the device which receives the blanks being delivered by the feeder even when this device is being operated at extremely high speeds. Further, the feeder of the instant invention is constructed in such a manner that blanks of extremely thin or delicate material and of very odd shapes are readily handled.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. In equipment for successively feeding the bottom sheet of a stack of said sheets along a generally horizontal feed path to additional apparatus positioned forward of said equipment; side guides on opposite sides of said path for maintaining the stack in position transverse to said path, rear gauge means for supporting said stack at the rear thereof, a feed slat for supporting said stack at the front thereof, front gauge means positioned above said slat to define a space between the lower end of said gauge means and said slat equal to slightly more than the thickness of one sheet and less than the thickness of two sheets,

first means for reciprocating said slat along the same path for forward and rearward movement along said feed path, said slat having a plurality of apertures in the top surface thereof, said apertures being positioned at said front gauge when said slat is in its most rearward position, means for applying suction at said apertures while said slat is moving forward from its most rearward position; a roller means including opposed upper and lower rollers with the lower roller being constructed of a plurality of axially spaced wheels, said upper roller including a plurality of axially spaced wheel-like first portions and a plurality of axially spaced wheel-like second portions interposed between said first portions, said first and said second portions being of substantially equal diameters, said slat including forwardly extending arms movable between said wheels for delivery of said sheets to the nip formed by said wheels and said first portions, and means for driving of said roller means for transfer of sheets by said roller means to the additional apparatus, said second portions positioned above and confronting said arms when said arms are positioned between said wheels to engage sheets being delivered by said slat, said arms having top surfaces coplanar with the upper peripheral surfaces of said wheels and cooperating therewith to form an extensive surface opposite said upper roller when sheets delivered to said nip are engaged by said roller means.

2. The equipment as set forth in claim 1 in which the top surface of said slat is constructed of rigid material; said apertures of said slat being tapered with their largest dimensions being at the upper surface of said slat.

3. In equipment for successively feeding the bottom sheet of a stack of said sheets along a generally horizontal feed path to additional apparatus positioned forward of said equipment; side guides on opposite sides of said path for maintaining the stack in position transverse to said path, rear gauge means for supporting said stack at the rear thereof, a feed slat for supporting said stack at the front thereof, front gauge means positioned above said slat to define a space between the lower end of said gauge means and said slat equal to slightly more than the thickness of one sheet and less than the thickness of two sheets, first means for reciprocating said slat along the same path for forward and rearward movement along said feed path, said slat having a plurality of apertures in the top surface thereof, said apertures being positioned at said front gauge when said slat is in its most rearward position, pump means for generating a suction, motor means operating independently of said first means and driving said pump means, additional means for applying said suction at said apertures while said slat is moving forward from its most rearward position; said additional means including a valve means and a conduit connecting said pump means to said slat, said conduit including a portion which increases in volume as said slat moves forward.

4. The equipment of claim 3 in which the portion which increases in volume comprises first and second telescoping pipe sections, means mounting said second section for movement limited substantially along the longitudinal axis of said second section.

5. The equipment of claim 4 in which the first pipe section is stationary and the second pipe section is secured to said slat and moves therewith.

6. In equipment for successively feeding the bottom sheet a stack of said sheets along a generally horizontal feed path to additional apparatus positioned forward of said equipment; side guides on opposite sides of said path for maintaining the stack in position transverse to said path, rear gauge means for supporting said stack at the rear thereof, a feed slat for supporting said stack at the front thereof, front gauge means positioned above said slat to define a space between the lower end of said gauge means and said slat equal to slightly more than the thickness of one sheet and less than the thickness of two sheets, first means for reciprocating said slat along the same path for forward and rearward move-

ment along said feed path, said slat having a plurality of apertures in the top surface thereof, said apertures being positioned at said front gauge when said slat is in its most rearward position, means for applying suction at said apertures while said slat is moving forward from its most rearward position, said slat comprising a hollow member constructed of a first material, a rigid filler of a second material occupying selected internal regions of said slat forming passage boundaries between an inlet to said slat and said apertures, said second material having a substantially lower specific gravity than the specific gravity of said first material.

7. In equipment for successively feeding the bottom sheet a stack of said sheets along a generally horizontal feed path to additional apparatus positioned forward of said equipment; side guides on opposite sides of said path for maintaining the stack in position transverse to said path, rear gauge means for supporting said stack at the rear thereof, front gauge means positioned above said slat to define a space between the lower end of said gauge means and said slat equal to slightly more than the thickness of one sheet and less than the thickness of two sheets, a carriage, means for reciprocating said carriage parallel to said feed path, a first means for applying suction to the lowermost sheet in said stack as said carriage moves forward, said first means including a portion carried by said carriage means and positioned at and below the leading edge of said stack when said carriage is in its most rearward position, and a mechanical feeder carried by said carriage, said mechanical feeder operatively positioned at the rear of said stack when said carriage is in said most rearward position and operatively disposed to engage the trailing edge of said lowermost sheet as said carriage moves forward from said most rearward position.

8. In equipment for successively feeding the bottom sheet a stack of said sheets along a generally horizontal feed path to additional apparatus positioned forward of said equipment; side guides on opposite sides of said path for maintaining the stack in position transverse to said path, rear gauge means for supporting said stack at the rear thereof, a feed slat for supporting said stack at the front thereof, front gauge means positioned above said slat to define a space between the lower end of said gauge means and said slat equal to slightly more than the thickness of one sheet and less than the thickness of two sheets, first means for reciprocating said slat along the same path for forward and rearward movement along said feed path, said slat having a plurality of apertures in the top surface thereof, for selected positions of said slat, said means for applying suction at said apertures including a pump having an intake side, conduit means connecting said intake side to said slat, and valve means connected in said conduit means, drive means connected to said valve means and said first means and operating same in timed relationship, said valve means including a core rotated by said drive means, said core having passage means, said core during predetermined angular positions thereof forming a block in said aperture means, said passage means venting said slat to atmosphere when said core is in said predetermined angular positions, and for other predetermined angular positions of said core said passage means providing a suction path between said intake side and said slat.

9. The equipment of claim 8 in which a complete reciprocating cycle of said slat consists of a forward and rearward stroke, in a given time interval said core being rotated for a number of revolutions equal to a sub-multiple of said cycles which have taken place during said interval.

10. The equipment of claim 8 in which the passage means includes a first and a second part 180° apart with each of said parts radially extending, said valve means also including a body wherein said core is disposed, said body having partitions defining suction chamber means

11

continuously connected to said intake side and exhaust chamber means continuously connected to ambient, both said first and said second parts connected to said exhaust chamber means when said core is in said predetermined angular positions, both said first and said second parts connected to said suction chamber means when said core is in said other predetermined angular positions.

11. The equipment of claim 10 in which said core is an elongated cylindrical member, each of said parts having a cross-sectional configuration in which there is a first dimension taken parallel to the cylindrical and a second dimension taken at right angles thereto, said first dimension being at least three times as large as said second dimension.

12. The equipment of claim 11 in which a complete reciprocating cycle of said slat consists of a forward and rearward stroke, in a given time interval said core being rotated for a number of revolutions equal to a submultiple of said cycles which have taken place during said interval.

13. The equipment of claim 10 in which said core is an elongated cylindrical member, each of said parts having a cross-sectional configuration in which there is a first dimension taken parallel to the cylindrical axis and a second dimension taken at right angle thereto, said first dimension being at least nine times as large as said second dimension.

14. A valve means of the class described including a body means, an elongated cylindrical core mounted within said body, means defining a rotational axis for said core coinciding with the longitudinal axis thereof, said body means having partitions defining suction chamber means and exhaust chamber means segregated from one another, said body means having an exit port, said core having passage means connecting said suction chamber means to said port for predetermined angular positions of said core, said passage means including first and second radially extending ports 180° apart, both said first and said second ports connected to said exhaust chamber means when said core is in said predetermined angular positions, both said first and said second ports connected to said suction chamber means when said core is in said other predetermined angular positions.

15. The valve means of claim 14 in which each of said ports is provided with a cross-sectional configuration in which there is a first dimension taken parallel to the cylindrical axis and a second dimension taken at right angles thereto, said first dimension being at least three times as large as said second dimension.

16. The valve means of claim 14 in which each of said ports is provided with a cross-sectional configuration in which there is a first dimension taken parallel to the cylindrical axis and a second dimension taken at right angles thereto, said first dimension being at least nine times as large as said second dimension.

12

dical axis and a second dimension taken at right angles thereto, said first dimension being at least nine times as large as said second dimension.

17. The valve means of claim 14 in which there is a plurality of sealing elements extending parallel to the cylindrical axis and positioned in operative engagement with said core, and additional means removably mounting said sealing elements to said body means.

18. The valve means of claim 17 in which the additional means mounts the sealing element for angular repositioning.

19. In equipment for successively feeding the bottom sheet of a stack of said sheets along a generally horizontal feed path to additional apparatus positioned forward of said equipment; side guides on opposite sides of said path for maintaining the stack in position transverse to said path, rear gauge means for supporting said stack at the rear thereof, a feed slat for supporting said stack at the front thereof, front gauge means positioned above said slat to define a space between the lower end of said gauge means and said slat equal to slightly more than the thickness of one sheet and less than the thickness of two sheets, first means for reciprocating said slat along the same path for forward and rearward movement along said feed path, said slat having a plurality of apertures in the top surface thereof, said apertures being positioned at said front gauge when said slat is in its most rearward position, means for applying suction at said apertures while said slat is moving forward from its most rearward position; said means for applying a suction including a pump and a conduit, said conduit connecting said pump to said slat, said conduit including a portion which increases in volume as said slat moves forward, said portion which increases in volume comprising first and second telescoping pipe sections, means mounting said first section to a fixed point, means mounting said second section to said slat for movement therewith, and a sliding fluid seal interposed between said pipe sections.

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