United States Patent

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[54] METHOD AND APPARATUS FOR STACKING SHEETS

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[52] **U.S. Cl.** **83/14**, 83/92, 83/94, 83/110, 83/152, 83/154, 83/175, 271/74

[51] **Int. Cl.** **B65h 29/32**

[58] **Field of Search** 83/94, 152, 154, 92, 23, 99–100, 83/151, 153, 110, 14, 18, 175; 271/74, 79

[56] **References Cited**

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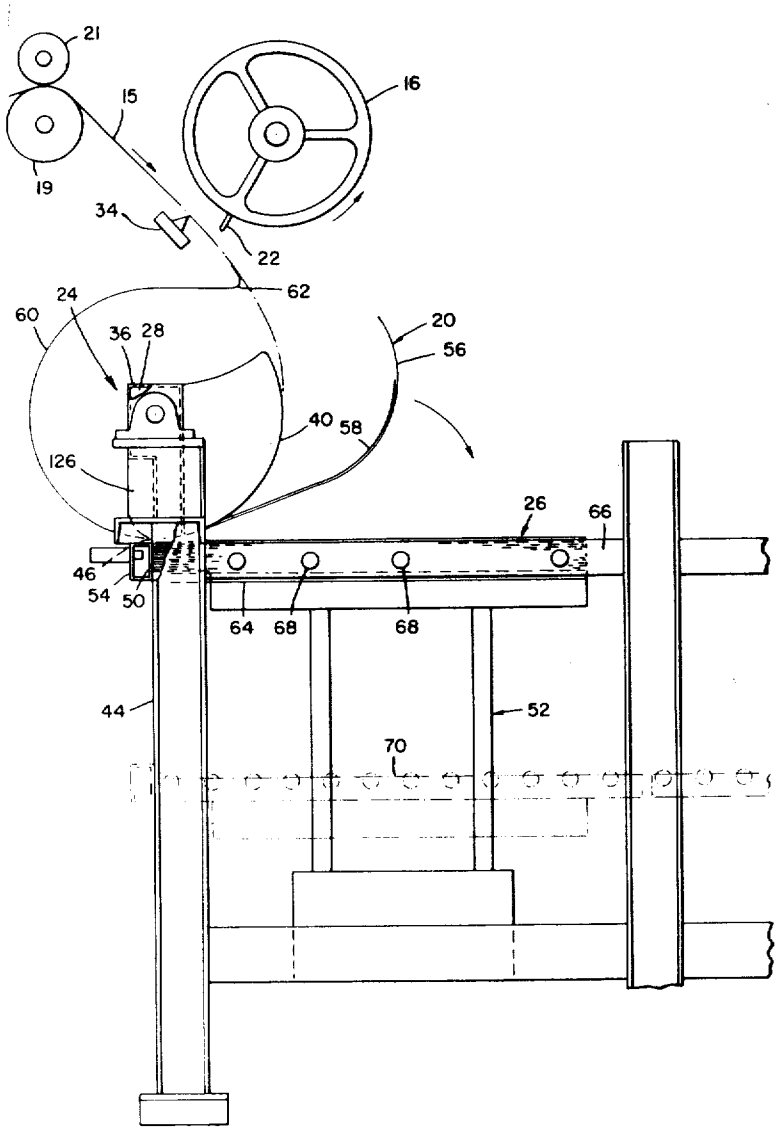
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[57] **ABSTRACT**

A method for stacking and aligning sheets, as during the manufacture of unexpanded honeycomb blocks, in which a long strip of the sheet material is moved towards and past a shear and grasped so that the lateral position of the sheet material strip determines the lateral position of the grasped sheet material portion. Thereafter a section of the sheet material including the grasped portion is severed and the severed section is moved from the shear to above the stack in alignment with the sheets previously deposited on the stack and the sheet is released for placement on the stack.

11 Claims, 9 Drawing Figures



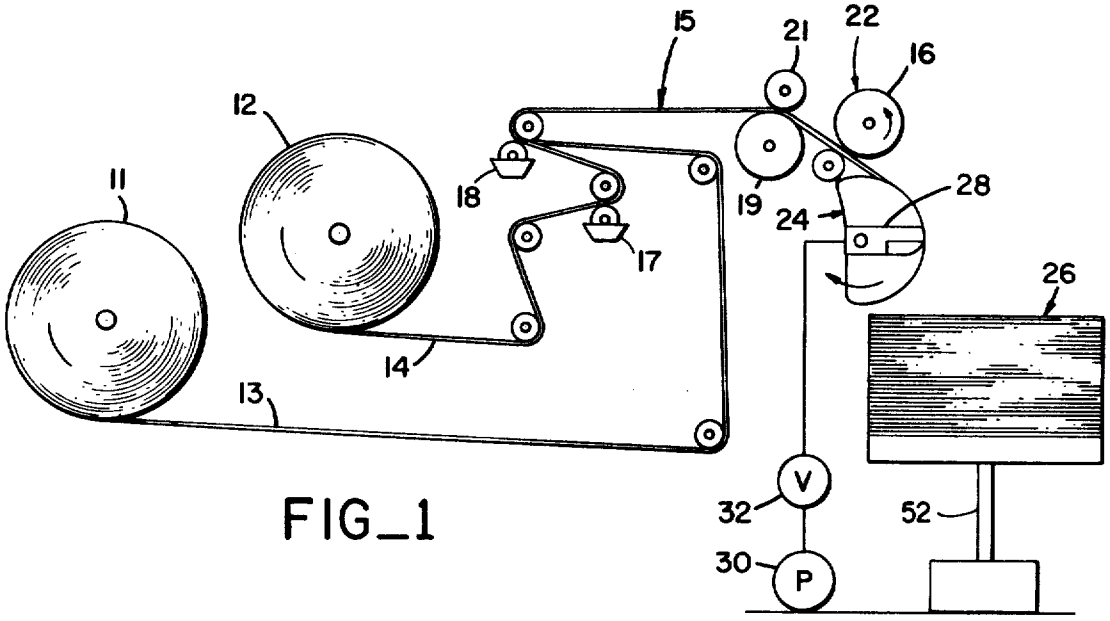


FIG_1

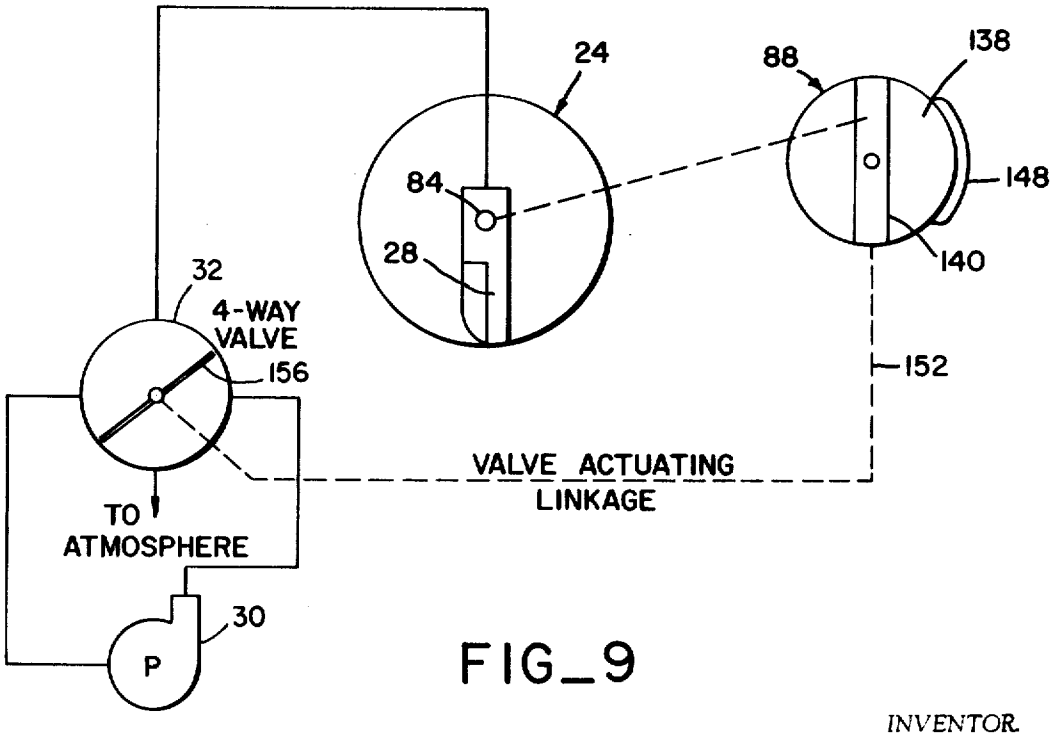


FIG_9

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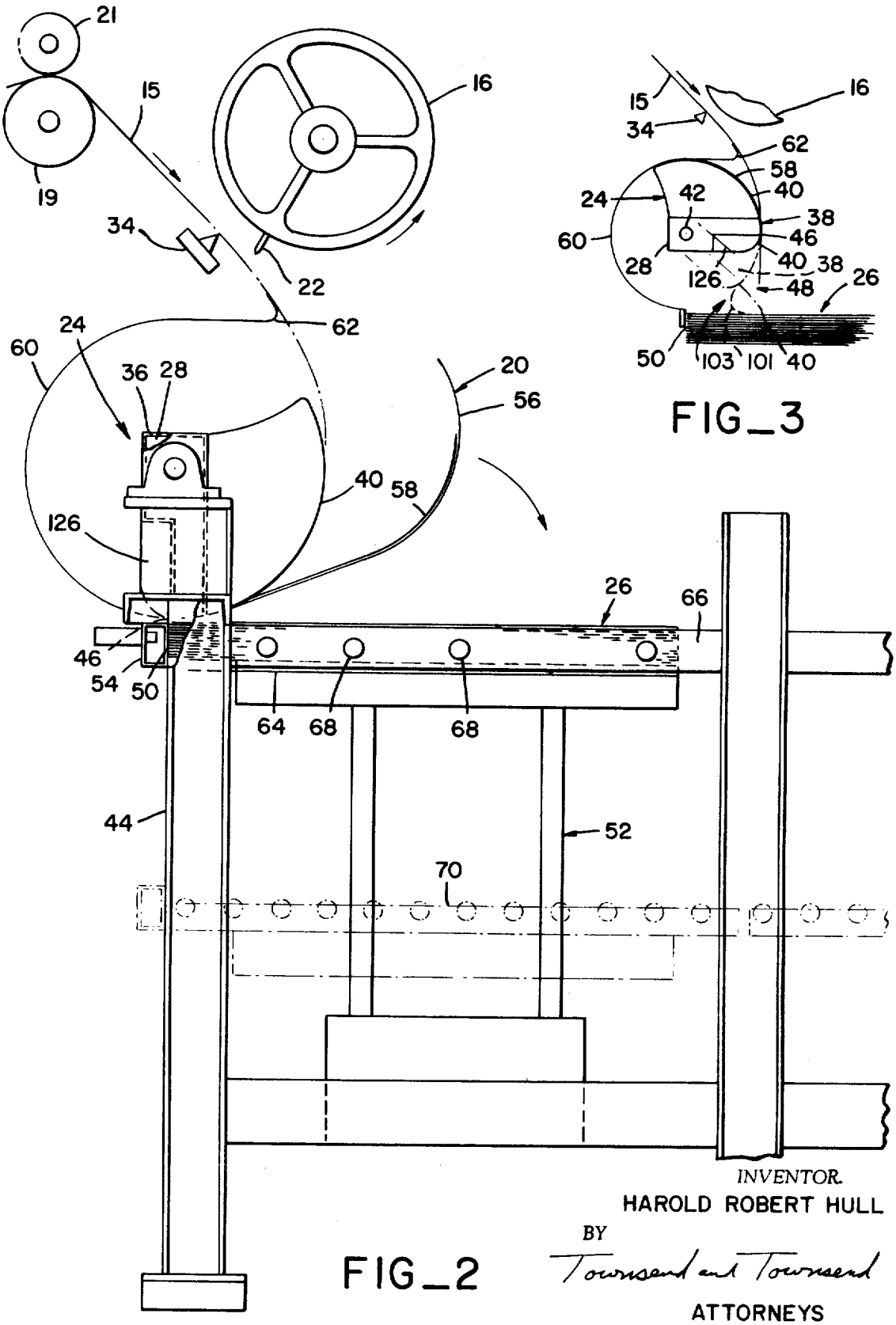


FIG_2

FIG_3

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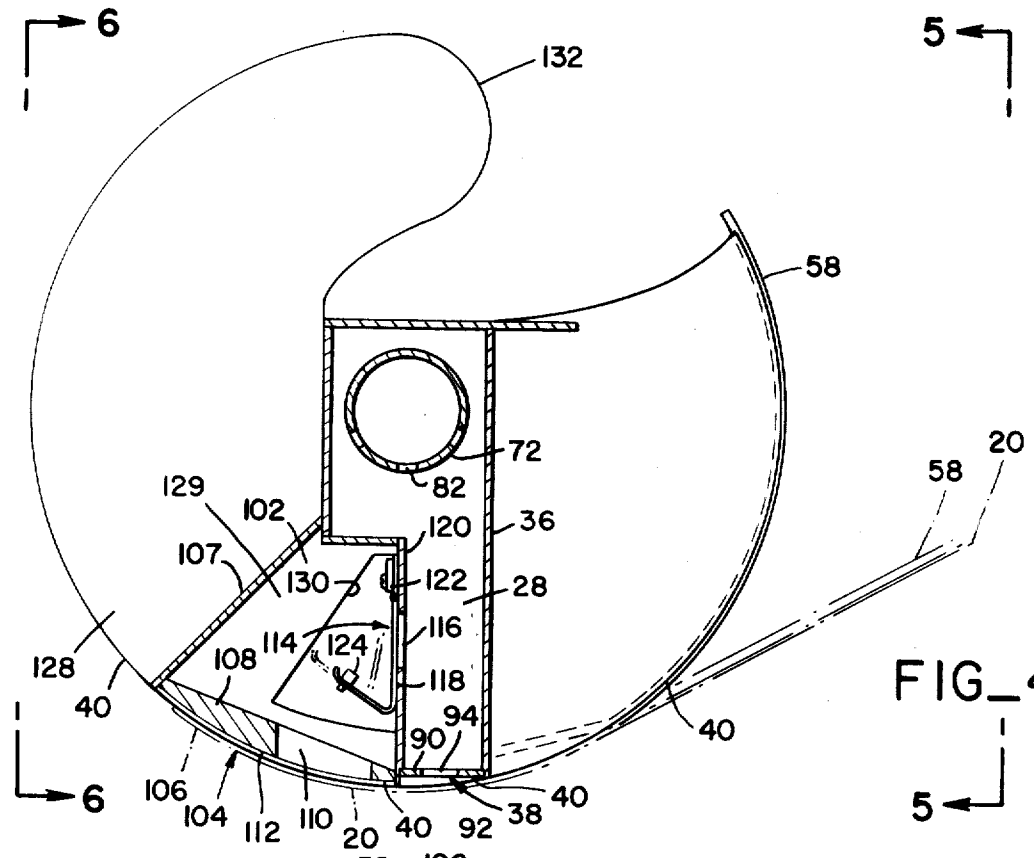


FIG_4

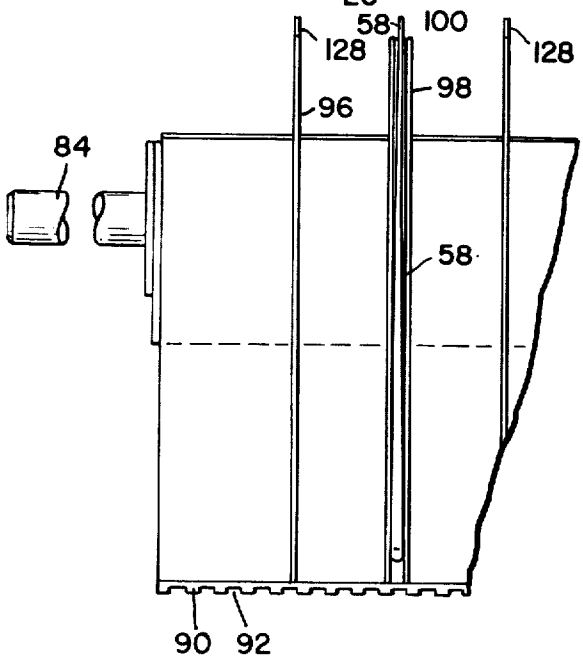


FIG_5

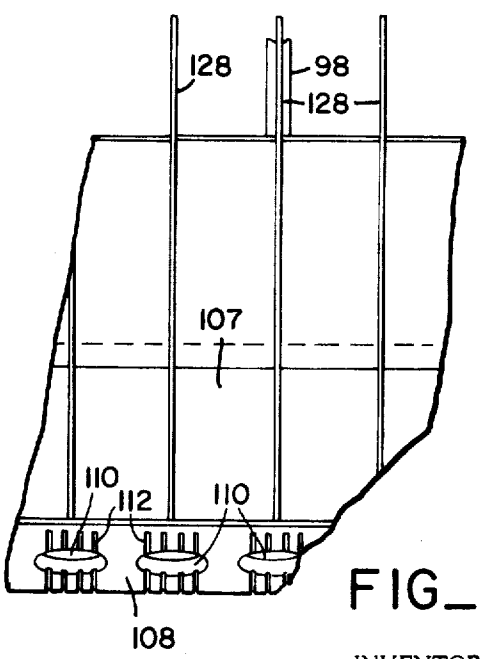


FIG_6

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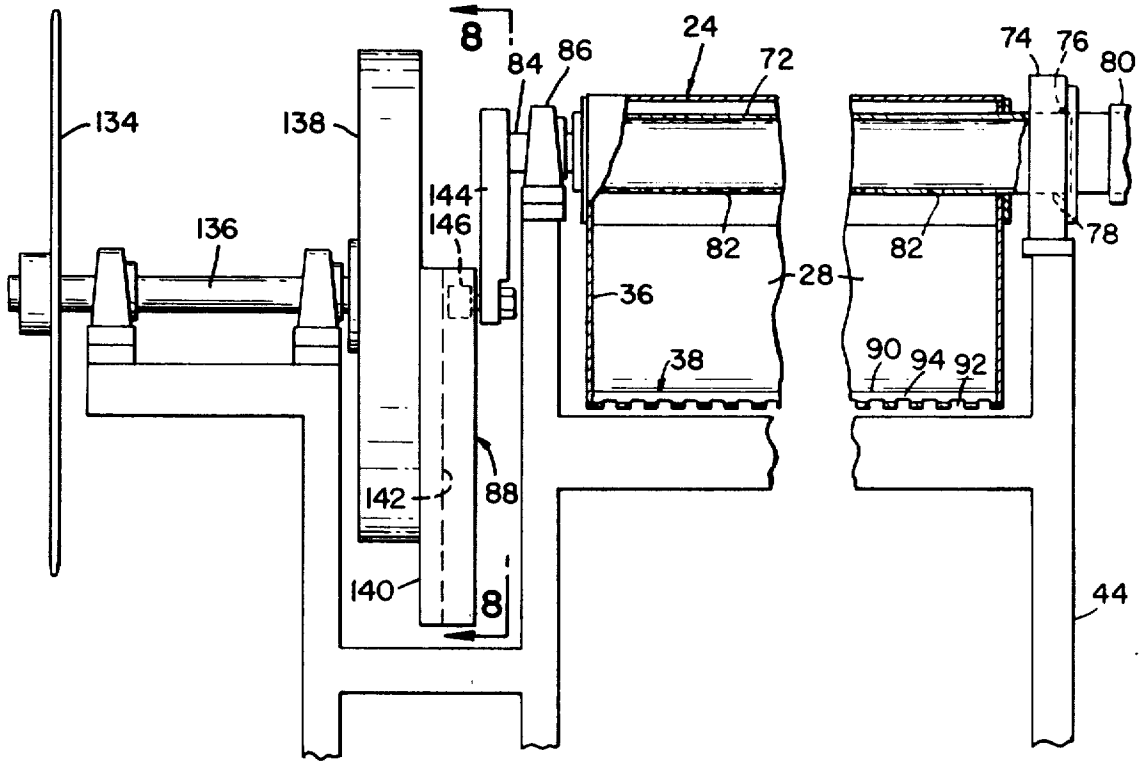


FIG_7

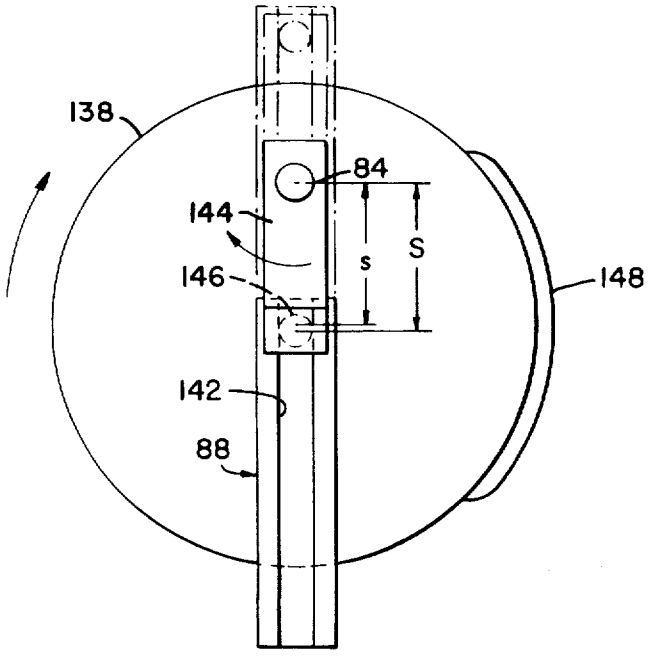


FIG_8

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METHOD AND APPARATUS FOR STACKING SHEETS

BACKGROUND OF THE INVENTION

The present invention relates to sheet stacking methods and apparatus and more particularly to stacking methods and apparatus in which each additional sheet must be placed on the stack without any sliding motions between the stack and the sheet.

In instances where sheets that are to be stacked may not slide with respect to each other, as when one or both sides of each sheet have wet print or glue lines thereon which may not be smudged, the stacking of the sheets becomes difficult because each additional sheet must be vertically lowered onto the stack. Due to the large surface areas of sheets they act like airfoils and it is virtually impossible to lower them over any appreciable vertical distance without uncontrolled horizontal movements of the sheet. Such movements would, of course, prevent the formation of a stack of aligned sheets.

In the past several attempts have been made to accurately and efficiently stack aligned sheets. Such attempts have concentrated in the area relating to the manufacture of unexpanded honeycomb blocks by stacking wet glue line honeycomb sheets, as distinguished from dry glue line sheets. In one such approach, wet glue lines are printed on an essentially endless sheet strip which is, thereafter, folded back and forth over itself to form a plurality of sheet layers. A stack of separate sheets is formed by slitting each fold. However, a time-consuming, difficult and relatively costly operation is required. Additionally, the accuracy with which the sheets are placed over each other is not always as high as desired.

In another approach an essentially endless strip of honeycomb sheet material is printed on one side and sheet material sections of equal length are then severed from the strip. The sections are guided onto a flop-over mechanism so that the dry side of the sheet rests against the mechanism. Thereafter, the sheet is flopped over, through substantially about 180°, and placed on top of a stack of sheets with the printed side of the sheet facing downward. Although relatively accurate positioning and stacking of the sheets is possible the severed sheets must be moved longitudinally over appreciable distances due to the physical configuration of the machine, during which the position of the sheet is not controlled so that its original position, as determined by the lateral position of the endless strip, is lost. This can necessitate the repositioning of the sheets before they are placed on the stack or, in the alternative, may cause a misalignment of the stacked sheets. To prevent such mispositioning of the severed sheets relatively complicated machinery including a host of small air jets which press the severed sheet against transport belts are employed. Aside from the relatively large physical size of the machine, which ties up valuable floor space, the machine is relatively expensive to install and requires substantial attention and maintenance to assure its proper operation.

Other prior art approaches to forming aligned stacks of sheet generally exhibit the same shortcomings, namely, relatively complicated machinery, slow operating speeds and relatively high installation, operation and maintenance expense, and, not infrequently, an inaccurate positioning of the sheets.

SUMMARY OF THE INVENTION

The present invention provides a method in accordance with which long sheet strip material is moved through a line printer while its relative lateral position remains substantially constant.

The free end, while it is still integral with the remainder of the strip, and, therefore, laterally positioned by the strip, is grasped by a sheet transfer mechanism. Thereafter, a section of the sheet strip is severed from the remainder and, while it is continued to be held by the transfer mechanism, it is moved to immediately above a stack of sheets that has previously been placed there by the transfer mechanism. There the sheet section is released and then deposited on top of the stack.

Since the lateral position of the sections is practically identical by virtue of the constant lateral position of the sheet strip moving through the printing machine, and since it is relatively easy to virtually exactly repeat the position of the section in the direction of movement by the grasping means, the resulting stack consists of sheets which are aligned with a high degree of accuracy.

In the presently preferred form of the invention, the sheets are grasped by a vacuum in a vacuum chamber placed against one side of the sheet for retention of the sheets on the transfer mechanism. Additionally, the vacuum chamber is moved with respect to the section over a substantial portion of the length thereof before the section is severed from the remainder of the strip material. Wrinkles, creases and uneveness in the sheet material are thereby straightened and removed, or at least reduced, to enhance the uniformity of the unexpanded honeycomb block and to prevent substantial air pockets in the block. The vacuum chamber is rotatably mounted, forms an integral part of the transfer mechanism and moves between the sheet section cut-off point and the stack. A drive mechanism for the chamber is so constructed that initially the chamber moves at a greater speed than the speed with which the sheet moves whereby the aforementioned sheet straightening effect is obtained. At the moment at which the sheet section is severed from the remainder of the strip, which occurs at a known point, the vacuum chamber is aligned with the leading edge of the sheet section and thereafter the chamber and the section remain stationary with respect to each other until the vacuum is released for placement of the sheet on the stack. The drive mechanism is further so constructed that when the sheet being transferred is aligned with the stack the vacuum chamber is momentarily substantially stationary to eliminate substantially all kinetic energy of the sheet section and thereby preventing displacements of the already aligned sheet section with respect to the stack.

Furthermore, to enhance the operating speed of the apparatus it is preferred to apply forces to the sheet section when the section is placed over the stack which biases the sheet against the stack and speeds up the separation of the transfer mechanism and the section. In the preferred embodiment of the invention the sheet biasing forces are obtained from elongate, resilient rods which are spaced across the width of the sheet section and by temporarily pressurizing the vacuum chamber to above atmospheric pressure to thereby blow off the section.

The sheet stacking mechanism of the present invention is particularly well suited for use when stacking wet line honeycomb sheets to form unexpanded honeycomb blocks. It is, however, equally advantageous for use in other sheet stacking applications. Positioning accuracy of the stacked sheets is obtained from grasping the sheet section before it is severed from the remainder of the sheet so that the lateral position of the sheet section is determined by the remainder of the sheet strip. Since the lateral sheet section is practically constant variations in the lateral alignment of the stacked sheets are virtually eliminated. Complicated and expensive positioning devices for severed sheets, which are clumsy to operate and, due to the peculiar configuration of large size sheets, often relatively ineffective, have been eliminated. Additionally, the operating speed of the device is substantially increased over what was heretofore possible since the sheet continues to move in the same direction without significant changes until it is aligned with the stack, and since the transfer mechanism rotates while prior art mechanism requires slow back and forth motions of relatively heavy flip-over devices. Consequently, substantial cost savings in the operation of the stacking apparatus as compared to the prior art is possible.

Furthermore, the physical dimensions of the stacking apparatus are substantially less than those of prior art devices. This results in a substantial reduction in the need for valuable floor space for the stacking apparatus. Additionally, the smaller physical extent of the apparatus lessens the distance sheets must be moved whereby complicated holding and

transport devices which are relatively expensive to install and require substantial maintenance are eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevational representation of a sheet printer provided with stacking apparatus constructed in accordance with the present invention;

FIG. 2 is a side elevational view of the downstream end of a sheet printing apparatus and of the stacking apparatus of the present invention;

FIG. 3 is a side elevational view, on a reduced scale, similar to FIG. 2 but shows the transfer mechanism of the stacking apparatus in another position during the transfer of sheets onto a stack;

FIG. 4 is an enlarged side elevational view, in section, of a transfer roll constructed in accordance with the present invention;

FIG. 5 is a fragmentary front elevational view and is taken on Line 5—5 of FIG. 4;

FIG. 6 is a fragmentary rear elevational view and is taken on Line 6—6 of FIG. 4;

FIG. 7 is a fragmentary front elevational view of the transfer mechanism and drive means therefore;

FIG. 8 is a side elevational view of the drive mechanism and is taken on Line 8—8 of FIG. 7; and

FIG. 9 is a schematic diagram illustrating the pneumatic system for vacuumizing and pressurizing chamber in the transfer mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a typical glue line printing apparatus used in the manufacture of honeycomb sheets for webs rotatably supports rolls 11 and 12 of web material and continuous sheets or webs 13 and 14 are directed via supporting and drive rollers to a point adjacent a rotary or shear cutter 16. Web 14 is passed adjacent adhesive sources 17 and 18 which respectively place longitudinally extending, wet lines of glue (not separately shown) on the reverse and obverse sides of web 14 at staggered, spaced apart points. Sheet or web 13 is forced into contact with sheet 14 adjacent glue applicator 18 which causes the obverse side of sheet 13 to adhere to the spaced apart glue lines on the reverse side of sheet 14 to form a composite web 15. Other known methods of applying glue lines can be employed instead of the above described two-side printing method.

The composite web thereafter passes over a support roller 19 which cooperates with a notched or serrated driver roller 21 to move the web past shear roller 16. Drive roller 21 is of preselected diameter and is notched at transversely spaced points along its periphery to prevent contact between the longitudinal wet glue lines previously applied to the obverse side of sheet 14 by glue source 18 and the periphery of the drive roller.

Rotary cutter 16 is driven at a speed so that blade 22 cuts composite sheet or web sections 20 of a preselected length. As the web moves past the cutter a transfer mechanism or device 24 is rotatably mounted below rotary cutter 16 so that web material contacts the transfer device.

Before cutter 16 severs the sheet section the transfer device grasps a portion of the section by contacting it with a vacuum chamber 28. The lateral position of the sheet section is thereby determined by the lateral position of the web. Since the web material rolls 11, 12 are relatively exactly positioned and the web moves between the rolls and the cutter in a substantially straight line so that it exhibits little or no lateral deviations in its position, or in the alternative, since the lateral position of the web is controlled by suitable guide rollers (not separately shown), the lateral position of the sheet section when grasped by the transfer device remains practically constant throughout the operation of the apparatus. A suitable vacuum pump 30 is connected to chamber 28 and a valve 32 is actuated after the rotary cutter severs the sheet section and the transfer device aligns the sheet section with stack 26 to place the section thereon.

The stack itself is carried by a lift table 52 and after the desired number of sheets to make up a stack has been deposited thereon, the stack is removed for further processing such as curing the glue lines, and trimming, cutting and finally expanding the stack into honeycomb cores.

Referring now to FIGS. 2 and 3, the operation of the transfer device 24 and the stacking of the sheets is described in greater detail. The composite web 15 is moved forwardly in a straight line by drive roll 21. Rotary cutter 16 is driven in synchronism with the drive roll so that blade 22 contacts the web at predetermined intervals and severs sheet sections 20 of predetermined and identical lengths in cooperation with a bed knife 34. Thus, web material is constantly being discharged from between the rotary cutter and the bed knife and its length increases until the sheet section is severed.

While sheet section 20 still forms a part of composite web 15 transfer device 24 grasps it to laterally locate the section by taking advantage of the predetermined and substantially constant lateral position of the moving composite web.

The transfer device comprises the aforementioned vacuum chamber 28 which is defined by a box member 36 that has length so that it extends past the widest webs on which glue lines can be printed by the printing apparatus. The box member has a vacuum opening 38 which communicates the chamber with the exterior and which lies on a circularly arcuate support surface 40 extending to both sides of the opening. A shaft 42 rotatably supports the transfer device on a support structure 44. The transfer device is so positioned with respect to rotary cutter 16 that the arcuate support surface 40 is in close proximity to the loosely hanging web end when the cutter is at about the position it is illustrated in in FIG. 3. Atmospheric pressure acting on the loose web end thereby biases it against the vacuum opening 38 whereby the loose web end is grasped. From that moment on the lateral position of the web is determined.

The lengthwise positioning of the free web end for alignment of the subsequent severed sheet section with the sheet stack is performed by the rotating transfer device.

Drive means, not illustrated in FIGS. 2 and 3, is provided to synchronize the transfer device movements with those of the rotary cutter 16. The drive means rotates the vacuum chamber in a clockwise direction (as viewed in FIGS. 2 and 3) from the 6 o'clock position of the vacuum opening 38 so that the peripheral speed of arcuate surface 40 exceeds the speed with which web 15 is fed past cutter 16 when the vacuum opening is about to first contact the free web end in the vicinity of its 2 o'clock position (not shown). The peripheral speed of the vacuum opening continues to exceed the transport speed of the web until a leading edge 46 of the vacuum opening is aligned with a leading edge 48 of the web material or sheet section. At that point the peripheral speed of the arcuate surface equals the transport speed of the web material. The drive means continues to slow the rotational speed of the vacuum chamber and the arcuate surface so that excess sheet material builds up. Resilient rods 58, mounted to the arcuate surface as more fully set forth hereinafter, maintain light weight sheets between leading edge 48 and cutter 16 taut while gravity and centrifugal forces acting on the arcuately moving sheet maintain heavy weight sheets, such as 99 lb. paper, taut as long as the sheet depends in a generally vertical direction from web 15. Leading edges 46 and 48 of the vacuum opening 38 and sheet material 20 now remain aligned and move in synchronism from the point of coincidence of the speeds of sheet 20 and the vacuum chamber (at about the 4 to 5 o'clock position) until the leading edge of the vacuum opening arrives at the 6 o'clock position. The leading edge of the sheet is now aligned with the corresponding side 50 of stack 26 and cutter 16 severs sheet 20 from web 15.

When leading edge 48 of sheet section 20 is aligned with stack 26, and thus leading edge 46 of opening 38 is at the 6 0'-clock position, the drive means for the transfer device main-

tain the device almost stationary. While the device is almost stationary valve **32** (shown in FIG. **1**) releases the vacuum in the chamber to thereby place the sheet on top of the stack.

To prevent an interference between the rotating transfer mechanism **24** and the top of stack **26** or, alternatively, the need for dropping the severed sheet section **20** over a substantial height as long as the stack is relatively low, the stack is mounted on a lift table **52** which maintains the relative height of the upper surface of the stack constant, e.g. one quarter of an inch below vacuum opening **38** and arcuate support surface **40**. The lifter as such is of a conventional construction and it is therefore not further described herein. Sensing and lift table actuating means **54** are mounted to support structure **44** for monitoring the height of the stack and lowering the table as the stack builds up.

Due to the large surface area and relatively light weight of sheet section **20** it moves relatively slow under gravity even through short distances such as the above mentioned one quarter of an inch or less between the transfer device and the top surface of the stack. This limits the maximum operating speed of the device unless the sheet is biased towards and onto the stack. For this purpose and to assure a virtually instantaneous collapse of the vacuum in chamber **38** it is presently preferred to connect pump **30** (shown in FIG. **1**) via suitable valving, more fully described hereinafter, to pressurize vacuum chamber **28** when leading vacuum opening edge **46** is at its 6 o'clock position and thus assure a quick release of the forward portion of the sheet and a bias onto stack **26**. Alternative mechanical means can be substituted for the pneumatic device described above. Furthermore, rods **58** bias the remainder of the sheet towards the stack as more fully described below.

If the sheet material is heavy weight, such as 99 lb. paper, the biasing means referred to in the preceding paragraph are no longer necessary provided the sheet is so positioned with respect to the cutter **16**, arcuate surface **40** and stack **26** that it is gravitationally placed on top of the stack.

The trailing portion **56** of the sheet section is also biased towards stack **26** by resilient, elongate rods **58**. The rods have one end secured to transfer device **24** adjacent box member **36** and they extend outwardly substantially tangentially to arcuate surface **40**. Their internal resiliency tends to straighten the rods whereby they bias the trailing sheet section portion downwardly onto stack **26**. As more fully described hereinafter, the rods are disposed in grooves (not shown in FIGS. **2** and **3**) in arcuate surface **40** and while vacuum opening **38** moves between about the 9 o'clock and the 3 o'clock positions an arcuate guide plate **60** which extends closely around the arcuate surface **40** as that surface rotates, biases the rods into the grooves until the rods pass a mouth **62** of the guide plate and again contact the next sheet section for maintaining that section taut and for biasing it onto stack **26**.

Still referring to FIGS. **2** and **3**, in production runs it is preferred to place stack **26** on a pallet **64** or the like which is initially placed on inwardly extended pneumatically actuated, retractable members **68** mounted to a horizontally disposed support beam **66** extending from adjacent the 6 o'clock position of the transfer device to the right as illustrated in FIG. **2**. Upon commencement of the stacking operation the severed sheet sections **20** are initially placed on top of the pallet. Thereafter, lift table **52** is raised to engage the underside of the pallet, lift it off hydraulic actuators **68**, and the actuators are retracted to permit a lowering of the pallet and the stack as the stack builds up. Upon reaching the desired height the stack is rapidly lowered to clear the hydraulic actuators which are again extended inwardly for supporting another pallet and enabling the continuous operation of the printing and stacking machine.

In the meantime, a roller conveyor **70** or the like disposed beneath beam **66** and constructed to permit passage of the lift table while engaging the pallet provides for the efficient removal of the just completed stack from the vicinity of the apparatus to the next processing station, e.g. the curing press. Thereafter the table is raised again for engaging the pallet and lowering it as the new stack builds up.

Referring to FIGS. **4** through **7**, the structural features of the present invention, particularly the construction of the transfer mechanism and the drive means therefore, is set forth in greater detail. The box member **36** defining vacuum chamber **28** preferably has a generally L-shaped cross section, as best seen in FIG. **4**, and, interiorally thereof, mounts a tubular member or pipe **72** which extends over the full length of the box member and protrudes past one end thereof for extension into a sealing journal block **74** mounted to support structure **44**. Mounted interiorally of the journal block is a soft, resilient seal ring, such as a felt ring **76**, which is pressed against the pipe by a flanged connection **78** bolted to the side of the journal block facing away from box member **36**. A rubber hose **80** or the like is suitably coupled to the free end of the flanged connection and communicates the interior of pipe **72** with the vacuum source (not shown in FIGS. **4** through **7**). The portion of pipe **72** disposed interiorally of box member **36** is provided with a plurality of apertures **82** so that the application of a vacuum to the pipe evacuates chamber **28**.

The other end of the box member rigidly mounts a drive shaft **84** journaled in a bearing **86** and driven by the aforementioned drive mechanism **88**.

Vacuum opening **38** of vacuum chamber **28** is defined by the end of the narrow portion of box member **36** and an insert **90** which has a circularly arcuate surface concentric and aligned with circularly arcuate surface **40**, a plurality of laterally spaced grooves **92** extending over the length of the insert and disposed on the exterior side of the insert, and a longitudinally extending groove **94** disposed on the interior side of the insert and having a sufficient depth to intersect laterally spaced grooves **92** to provide fluid communication between the vacuum chamber and the exterior. Exterior grooves **92** are provided to apply the vacuum over several inches of the length of sheet section **20** for a firm grip thereof. Webs **91** between the grooves prevent excessive deformation or even damage to the sheet section which can occur if the vacuum opening were a single, large aperture. In addition, the provision of a single, large vacuum aperture can cause relative movements of the sheet section and a loss of the alignment thereof due to the large unsupported surface areas.

Although the transfer device can be constructed in the form of a full cylinder, to reduce its weight and inertia which is of importance due to the repeated and high rates of acceleration and deceleration during each revolution of the device, it is presently preferred to provide a plurality of ribs **96** which are spaced over the length of box member **36** and which have circularly arcuate peripheries defining the circularly arcuate support surfaces **40** of the transfer device. For maximum weight reduction the ribs are relatively narrow except for intermittent wider ribs **98** which include grooves **100** for mounting the resilient rods **58** in the above described manner.

It is further preferred to provide the transfer device with a secondary vacuum chamber **102** disposed forward of the main chamber for grasping the forwardmost portion of the sheet section (illustrated in phantom lines in FIG. **4**) as vacuum opening **38** moves relative to the section until leading vacuum opening edge **46** is aligned with leading sheet section edge **48** as described above.

Referring briefly to FIG. **3**, if the secondary vacuum chamber and a second sheet grasping opening is not provided a relatively high speed of operation can cause a forwardmost portion of the sheet to flap or bend backwardly, in the direction of movement of the sheet, of arcuate surface **40** and vacuum opening **38** as illustrated in phantom lines at **103** in FIG. **3**, before vacuum opening **38** engages that portion. The folded over sheet portion **101** then contacts the top of stack **26**, becomes creased, and would remain permanently in the sheet thus rendering that portion of the stack unusable. Moreover, since the folded over portion **101** cannot be readily engaged by vacuum opening **38** the sheet section is no longer securely grasped during the last part of its movement to align

it with the stack and stacks of grossly misaligned sheets can result.

Referring again to FIGS. 4 through 7, the second vacuum chamber is defined by a portion of box member **36**, an end plate **107** extending over the length of the box member obtrusively away therefrom. The free end of the plate mounts an insert **108** that is sealed against end plate **107** and box member **36**. The insert also has a circularly arcuate exterior surface concentric and aligned with arcuate surface **40** and includes a plurality of apertures **110** spaced apart over the length of the insert and communicating the interior of the chamber with the exterior. Adjacent each aperture there are a plurality of laterally spaced exterior grooves **112** to provide an enlarged holding area for the sheet sections.

Additionally, in one embodiment of the invention the second vacuum chamber includes valve means **114** which automatically closes an aperture **116** communicating the two vacuum chambers **28** and **102** when the forward sheet portion **106** no longer covers aperture **110**. The valve means comprise a V-shaped clapper **118** that is secured to a wall **120** of box member **36** with a piano hinge **122** or the like so that one of the legs of the clapper extends forwardly (in the direction of rotation of the transfer device) and slightly upwardly when leading edge **46** of vacuum opening **38** is at the 6 o'clock position. The forwardly and upwardly extending leg of the clapper mounts a plurality of weights **124** spaced over the length of the clapper. The weights are movable towards and away from the long leg of the clapper to thereby change the center of gravity of the clapper and cause the closure of aperture **116** at adjustable angular positions of box member wall **120**. Presently the weights are positioned so that aperture **116** is closed when the leading opening edge **46** is about 15° to 20° before its 6 o'clock position.

Weights **124** are positioned so that clapper **118** opens aperture **116** as long as forward portion **106** of sheet section **20** is disposed over insert **108** of the second vacuum chamber **102**. As the leading edge **48** of section **20** and leading edge **46** of the first vacuum chamber approach alignment, and the forward portion **106** (its relative position over the secondary vacuum chamber being illustrated in phantom lines in FIG. 4) of the section moves with respect to insert **108** in a counterclockwise direction, as viewed in FIG. 4, vacuum apertures **110** begin to open. The construction of clapper **118**, and particularly the relative setting of weights **124**, is such that aperture **116** communicating the two vacuum chambers is closed after a substantial portion, e.g. one third to one half, of the area of vacuum apertures **110** is uncovered by the relatively rearwardly moving sheet section. At that point only a short distance remains between the leading edges and even the high speed operation of the transfer device does not cause a downward bending of the forwardmost portion **106** of the sheet section (as illustrated in phantom lines in FIG. 3) so that the above described formation of folds and creases is prevented and a positive alignment of the sheet section as well as a uniform sheet stack **26** is obtained.

Alternatively to the above described valve means for vacuumizing the secondary vacuum chamber **102** an independent second vacuum system can be connected to the secondary chamber only. Such vacuum system eliminates the need for clapper valve means **114** which is subject to centrigual forces that can impair its proper operation during high speed operation of transfer device **24**. Furthermore, the vacuum in the primary chamber **28** is not affected by the presence of the secondary chamber.

Still referring to FIGS. 4 through 7, with the provision of the second vacuum chamber the arcuate support surface **40**, defined by inserts **90** and **108** and by ribs **96** and **98**, extend to both directions of vacuum aperture **38** of first vacuum chamber **28**. In instances in which no secondary vacuum chamber is provided arcuate surface **40** ends just forward of the vacuum opening **38**. Although an arcuate surface forward or to the left of vacuum chamber opening **38** is not necessary for operation of the transfer mechanism so that short, web-shaped shoes or inserts **126** (shown in FIGS. 2 and 3) can be provided, it is preferred to extend the arcuate support surfaces not only substantially past the first vacuum chamber but also substantially past the second chamber as illustrated in FIG. 4. Preferably the arcuate support surface extends over a total of more than **180** degrees with a portion of the surface rearwardly (or to the right, as viewed in FIG. 4) of the first vacuum chamber extending through a sufficient arc so that at the moment the sheet section is severed by rotary cutter **16** the arcuate support surface fully supports the taut sheet section and the section extends tangentially off the arcuate surface towards the rotary cutter. The forward portion of the arcuate surface, that is that portion of the surface to the left of the vacuum chambers, preferably extends through an arc of about 135° from the leading edge of the first vacuum chamber. This provides a support for the forwardmost portion of a new sheet section as soon as that sheet portion leaves mouth **62** of guide **60**. Furthermore, hard impacts between the arcuate surfaces and a relatively long length of sheets depending from bed knife **34**, which can wrinkle the sheet, flip it or even rupture it during high speed operation, are prevented.

Consequently, the transfer device **24** of the present invention also includes second, relatively thin ribs **128** which are preferably aligned with ribs **96** and **98**. The forward ribs have a rearwardly extending protrusion **129** secured to box member wall **120** and provided with cutouts **130** to enable the opening of valve means **114** and to limit the maximum clockwise movement of clapper **118** to the position shown in phantom lines in FIG. 4. The forwardmost portion of the forward ribs further includes a rounded segment **132** to prevent sharp corners and possible damage to the sheet sections, particularly if the forward ribs are relatively short and arrive at the vicinity of guide mouth **62** after the forwardmost portion of a new sheet section has passed the mouth.

Referring now to FIGS. 7 and 8, drive mechanism **88** for rotating the transfer device **24** principally comprises a driven gear or chain drive wheel **134** mounted to a shaft **136** to which a fly wheel **138** is keyed. The face of the fly wheel mounts a guide bar **140** having a groove **142** which extends in a radial direction across the center of rotation of the fly wheel. A drive arm **144** is affixed to the free end of drive shaft **84** of transfer device **24** and includes a cam follower **146** disposed in groove **142** and engaging the groove walls of guide bar **140**. The center spacing "S" between the axes of shaft **84** and of cam follower **146** is slightly greater, say one eighth to one fourth of an inch, than the center distance "*s*" between the axes of shafts **84** and **136**. Furthermore, the drive arm **144** is mounted to shaft **84** so that when the leading edge **46** (not shown in FIGS. 7 and 8) of vacuum opening **38** is in its 6 o'clock position the axes of shafts **84**, **136** and of cam follower **146** are aligned as illustrated in FIG. 8.

When fly wheel **138** is driven, and starting from the zero position illustrated in FIG. 8, which corresponds to the 6 o'clock position of vacuum opening **38** (see FIG. 2), the angular velocity of drive shaft **84**, and therewith of transfer device **24**, is negligible as compared to the angular velocity of the fly wheel which rotates at a constant rate. Thus, the transfer device is momentarily practically stationary when the vacuum chamber is at the 6 o'clock position. As the fly wheel continues to move drive arm **144** and drive shaft **84** are slowly accelerated until they reach a maximum velocity at **180** degrees from the zero position (illustrated in phantom lines in FIG. 8). Thereafter the drive arm **144** and drive shaft **84** are decelerated, at an increasing rate, until guide bar **140** and the drive arm again reach the zero position.

Referring to FIGS. 7 through 9, to synchronize the formation and release of the vacuum in vacuum chamber **28** with the transfer mechanism drive means **88**, a cam **148** is mounted to the periphery of fly wheel **138** for actuating a four-way valve **32** via suitable actuating linkage **152**. The four ports of the valve are connected to vacuum chamber **28**, the pressure side of a pump **30**, to the atmosphere and to the suction side of the pump so that a vane **156** of the valve can fluidly couple the

pump suction side with the vacuum chamber and the pump pressure side with the atmospheric exhaust when the vane is in the position shown in FIG. 9. By rotating the vane 90° to either side the valve couples the pump pressure side with the vacuum chamber and the suction side with the atmospheric exhaust.

The cam and the linkage are so adjusted that the pump suction side is coupled to the vacuum chamber in sufficient time to grasp and straighten the sheet prior to the time of coincident velocities of the sheet and the drum. The cam and the linkage are further set so that when the vacuum chamber is at the 6 o'clock position and the sheet section is aligned with the stack, vane **156** is rapidly repositioned to couple the pump pressure side with the vacuum chamber. The pressure in the vacuum chamber then blows off the sheet section to quickly deposit it on stack **26**. Since the transfer device **24** and the four-way valve **32** are driven off the same rotating member, namely fly wheel **138**, and further since drive wheel **134** for the fly wheel is coupled to and synchronized with the drive for rotary cutter **16**, a synchronization between the cutter, the transfer device and the vacuum control is achieved. Misalignments of the stacked sheets from even slight synchronisms between these components of the apparatus thereby are prevented. At the same time the simple arrangements of parts and the handling, e.g. the grasping of the sheet, while it is fed through the machine so that upon severance of the sheet section from the web the sheet is almost in its aligned position with the stack on which it is to be placed substantially reduces the necessary handling of the sheet, the components of the machine to perform that handling, and further allows significant reductions in the operating time to stack the sheets. For example, it has been possible to stack large size sheet sections at up to four times the rate at which they could be stacked with prior art equipment.

I claim:

1. A method for stacking sheet sections with parallel lateral and transverse edges which are severed from a length of sheet material having lateral sides which define the lateral edges of the sheet sections, the method comprising the steps of: moving the sheet material at a constant speed parallel to the lateral sides, applying a vacuum over substantially the full transverse extent of the material to at least one side of the sheet material at a point aft of a free end of the sheet material, moving the vacuum in a forward direction with respect to the material towards the free end thereof until a leading edge of the vacuum is aligned with the free end to remove wrinkles, creases and unevenness in the material, thereafter severing the section from the material while the vacuum continues to be applied, and releasing the section onto a stack of sections.

2. A method according to claim **1** wherein the step of moving the vacuum comprises the step of moving the vacuum with respect to the material along a circular path.

3. A method for producing unexpanded honeycomb blocks comprising the steps of transporting a long length of sheet material past a cutting mechanism, controlling the lateral position of the sheet material, grasping the sheet material at the cutting mechanism after a leading edge of the material has passed the cutting mechanism and while the leading edge forms an integral part of the sheet material so that the relative lateral position of the grasped sheet material portion remains controlled, grasping the sheet material successively closer to the leading edge until the leading edge and the grasped portion coincide, severing a section of the sheet material including the grasped portion from the length of sheet material, moving the section over a stack, and releasing the section when its sides are aligned with sides of the stack.

4. A method according to claim **3** wherein the step of grasping comprises the step of applying a vacuum to the sheet material which extends over substantially the full lateral extent of the material.

5. A method for building sheet stacks comprising the steps of continuously feeding sheet material off a roll of such material in a forward direction, intermittently moving a vacuum chamber between first and second points at a speed which decreases from the first to the second point and which exceeds the web speed at the first point and which is less than the web speed at the second point, contacting a side of the web aft of a leading edge thereof with the vacuum at about the first point, severing a sheet section from the web when the speed of the web and the speed of the vacuum are substantially equal, and releasing the vacuum at the second point to deposit the web on the stack.

6. Apparatus for stacking honeycomb sheets severed from a long length of sheet material in mutual alignment to form an unexpanded honeycomb block comprising: means for laterally positioning the sheet material, a vacuum chamber including a vacuum opening communicating the chamber interior with the exterior for grasping a side of the sheet material, means for rotating the chamber about an axis thereof, means defining a circularly arcuate support surface disposed about and concentric with the vacuum chamber for supporting the sheet section in spaced relation from the vacuum chamber, means for intermittently severing sections of the sheet material having a predetermined length while the sections are grasped by the vacuum chamber, whereby the rotating chamber carries the section into alignment with edges of a stack of sections, and relatively thin, elongate, flexible members constructed of a resilient material and assuming a normally straight position secured adjacent the support surfaces for biasing the sheet towards the stack.

7. Apparatus according to claim **6** wherein the circularly arcuate support surface is defined by a plurality of axially spaced, relatively thin ribs extending over an arc of less than 360°.

8. Apparatus according to claim **7** wherein the ribs extend from the vacuum chamber in an aft direction with respect to the direction of rotation of the chamber.

9. Apparatus according to claim **8** wherein the ribs also extend from the vacuum chamber in a forward direction.

10. Apparatus for stacking honeycomb sheets severed from long length of sheet material in mutual alignment to form an unexpanded honeycomb block comprising: a forward vacuum chamber and an aft vacuum chamber, each chamber having at least one separate vacuum opening, means for laterally positioning the sheet material adjacent the vacuum openings for grasping the sheet material so that its lateral position with respect to the openings is controlled by the remainder of the sheet material, means for intermittently severing sections of the sheet material while the sections are grasped by the vacuum in the chambers, means for moving the chambers from the severing means to the stack for placing the grasped section on the stack in alignment with edges of the stack, and means for selectively releasing the vacuum in the forward chamber when at least a portion of the opening in the forward chamber is not covered by the sheet section.

11. A sheet transfer mechanism comprising means for advancing a web past a cut-off point, a relatively narrow, elongate vacuum chamber having a length at least about equal to a width of the web, means for rotating the chamber about an axis located adjacent a narrow side of the chamber so that the chamber extends radially away from the axis, vacuum openings in another, opposite narrow side of the chamber, means positioning the chamber so that the vacuum openings pass past the cut-off point closely adjacent the web and thereby engage the web for transfer of the web to a stack of webs along a circular path, and web support surfaces trailing the chamber and the openings defined by a plurality of relatively narrow, axially spaced ribs secured to the chamber and terminating in a circular web support surface to provide web supports spaced intermittently across the width thereof when the vacuum openings draw the web towards the stack whereby web damage during high speed operation is prevented while the transfer mechanism has low mass and inertia.

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