United States Patent [19]

Anastasio et al.

[11] **3,776,404**

[45] **Dec. 4, 1973**

[54] **METHOD OF HANDLING BOOKS**

[75] Inventors: **Frank J. Anastasio**, Paramus; **Clinton F. Brundage**, Mahwah, both of N.J.; **Clarence P. Strakosch**, Tappan, N.Y.

[73] Assignee: **Rockwell International Corporation**, Pittsburgh, Pa.

[22] Filed: **Mar. 26, 1971**

[21] Appl. No.: **128,505**

Related U.S. Application Data

[62] Division of Ser. No. 833,985, June 17, 1969, Pat. No. 3,640,407.

[52] **U.S. Cl.** ..... **214/152**, 198/33 AC, 214/6 H

[51] **Int. Cl.** **B65g 57/08**

[58] **Field of Search** ..... 214/6.5, 6 S, 6 P, 214/6 H, 6 DK, 152; 198/33 AC

[56] **References Cited**

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3,501,036 3/1970 Calistrat ..... 214/6 S

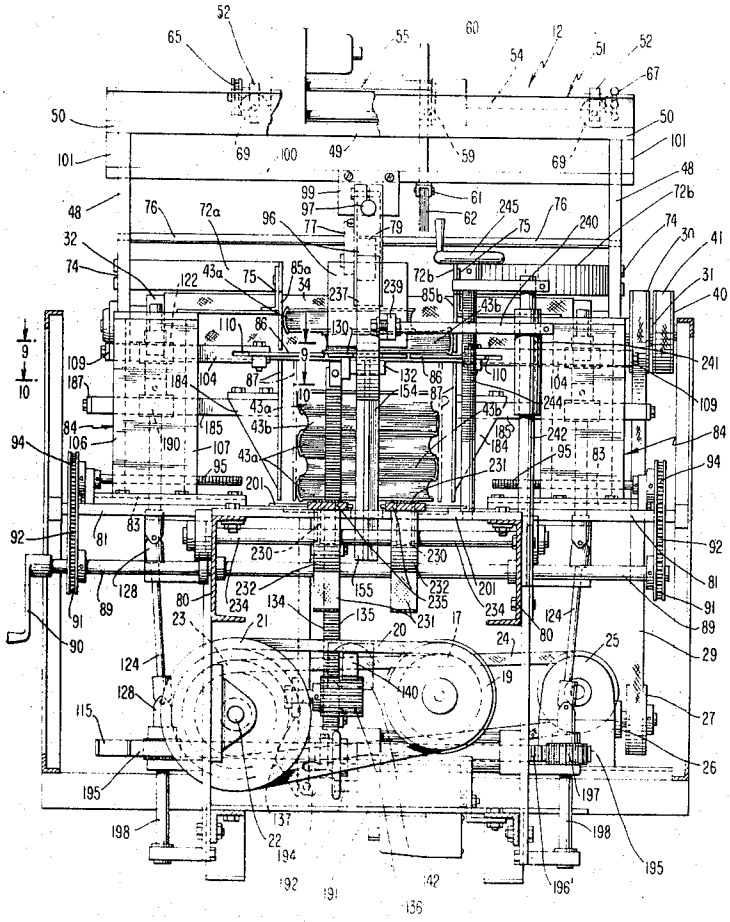
Primary Examiner—Robert J. Spar

Attorney—Dale A. Bauer et al.

[57] **ABSTRACT**

Method and apparatus whereby books delivered on-edge, spine-up, as by a building-in machine, are alternately, tipped in opposite directions on a continuously operating belt conveyor, funnelled into alignment and then stacked with the spine joints of adjacent books at opposite sides of the stack and offset to prevent crushing thereof. The progressively formed stacks are progressively lowered on a photocell-controlled elevator, jogged, and then removed to a delivery conveyor while the building of the succeeding stack is begun on an auxiliary retractable platform for subsequent transfer to the elevator.

18 Claims, 10 Drawing Figures



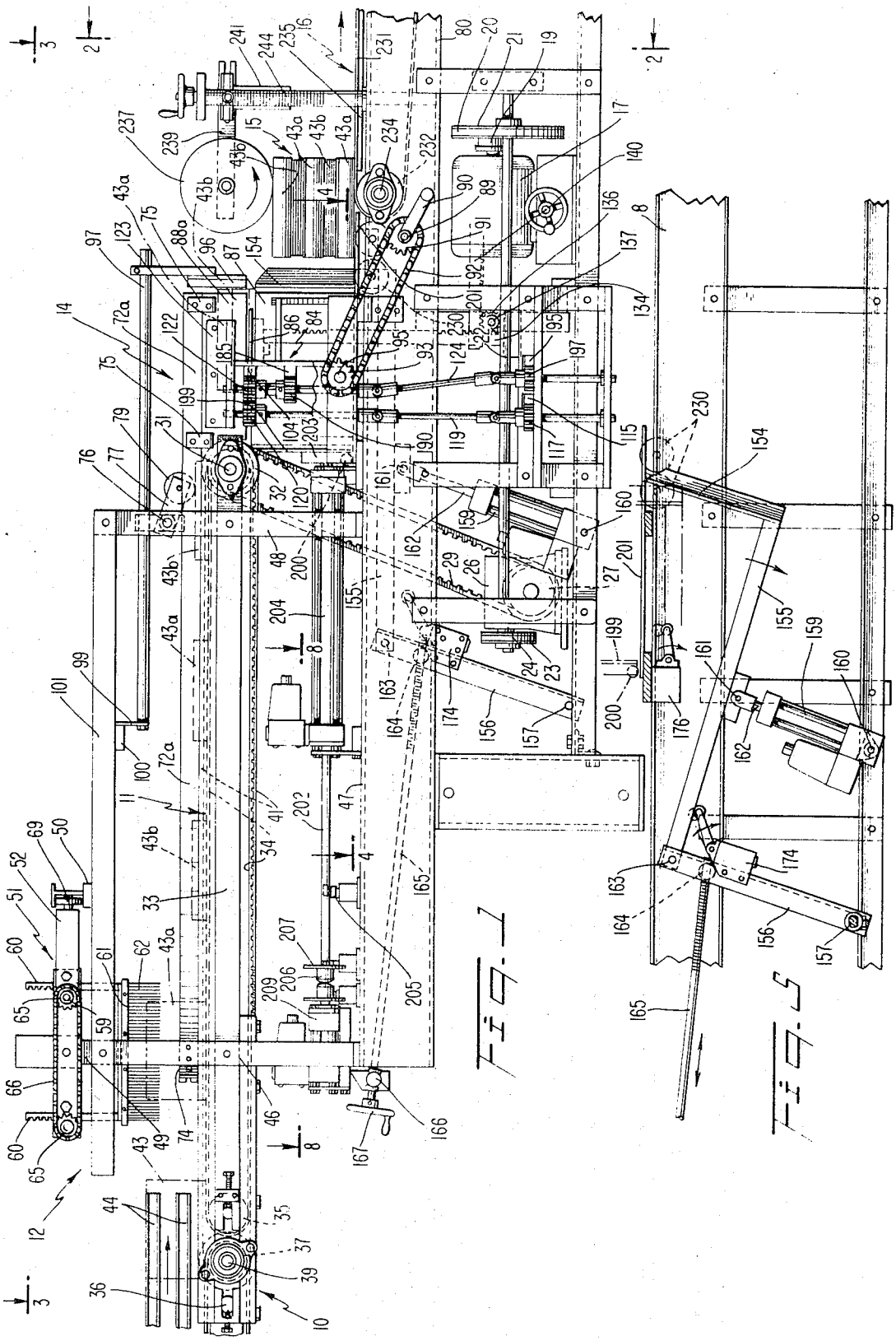


FIG. 1

FIG. 5

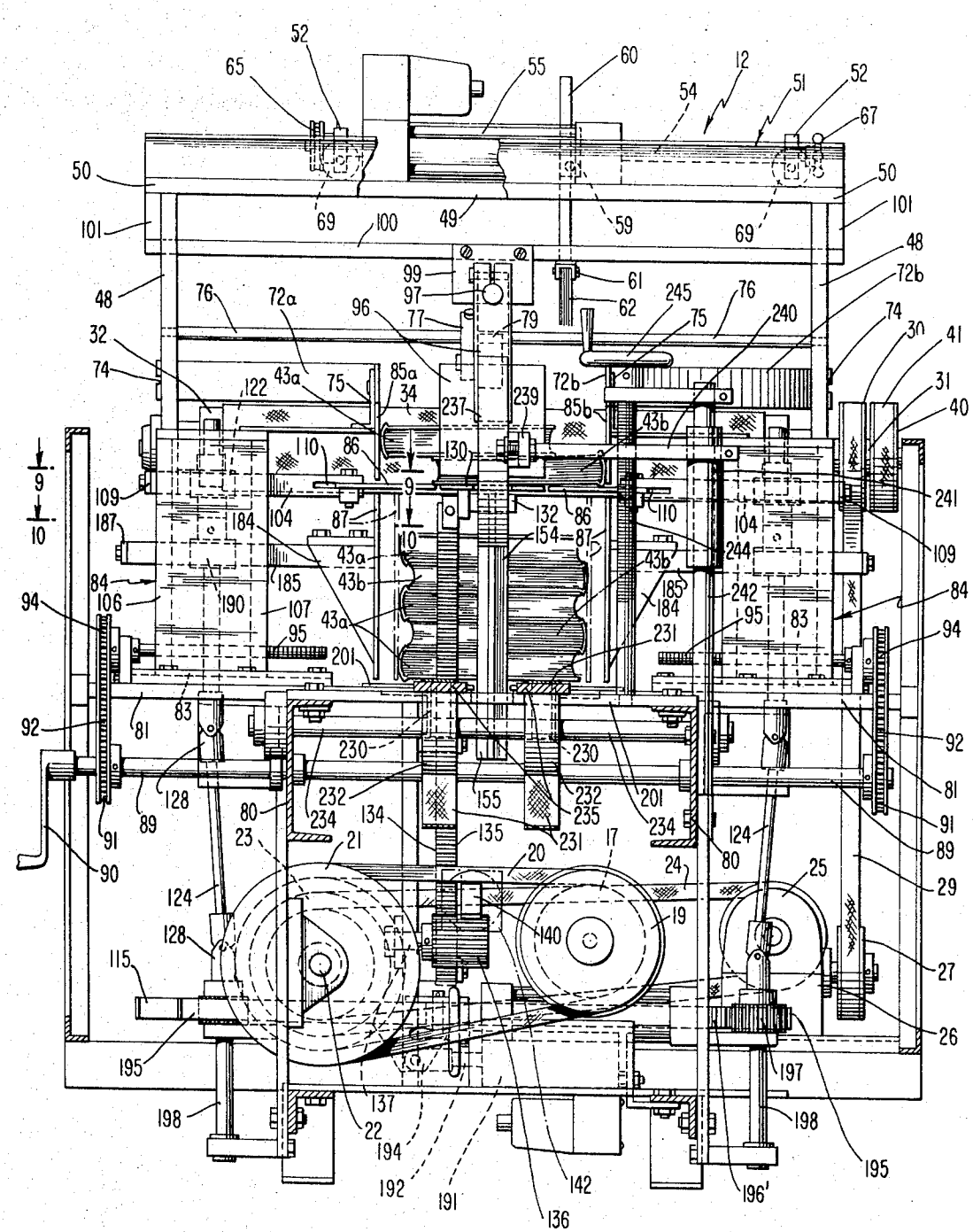


Fig. 2

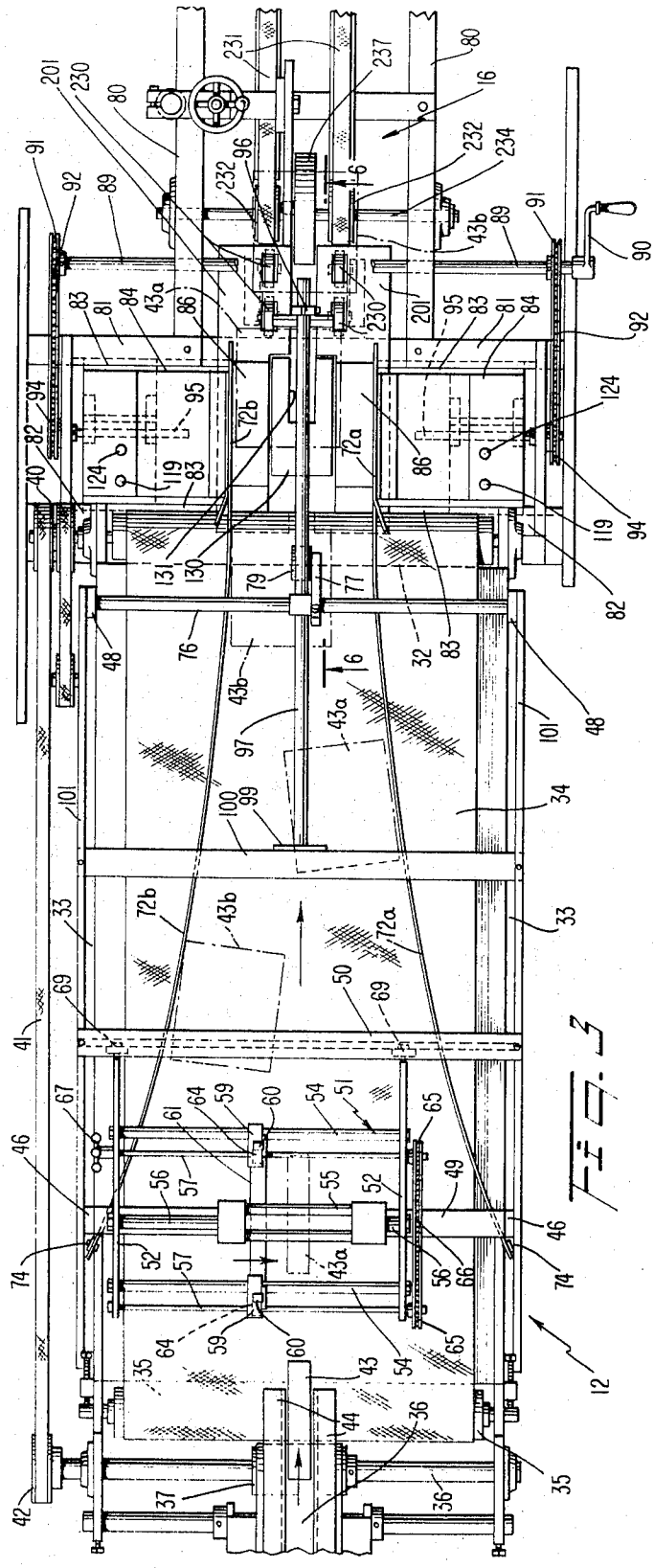


FIG. 3

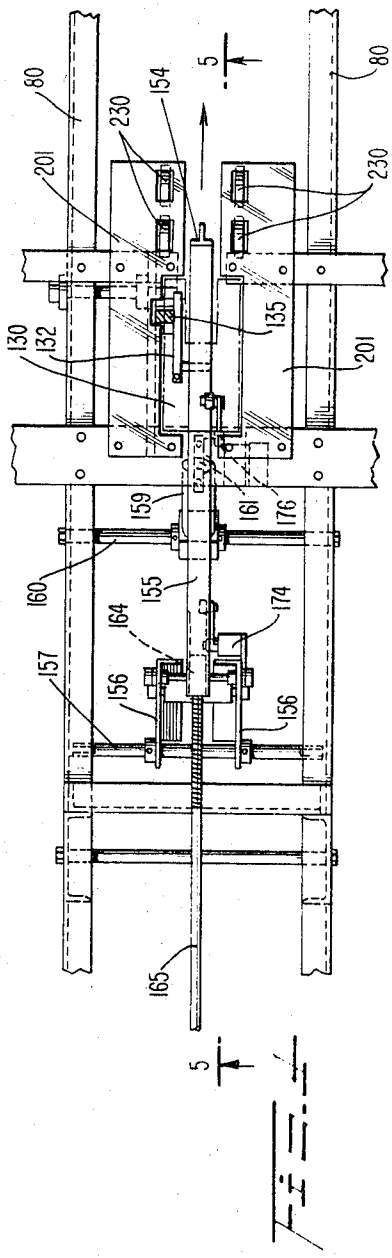
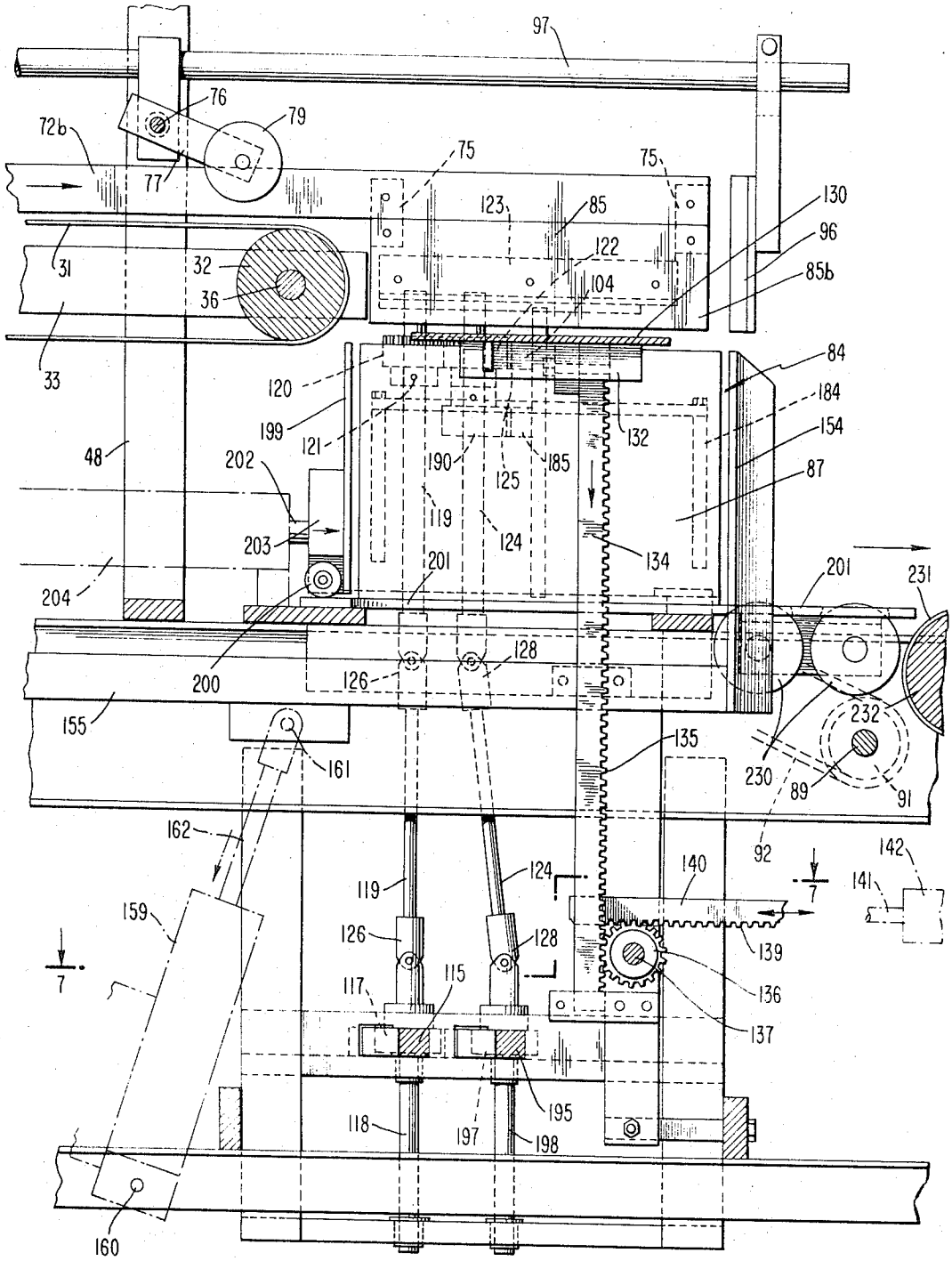


FIG. 4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76
79
72b
77
75
75
123
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130
96
85b
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36
33
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184
154
87
199
121
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125
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132
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202
119
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200
126
128
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161
135
232
230
89
91
162
92
142
140
124
119
7
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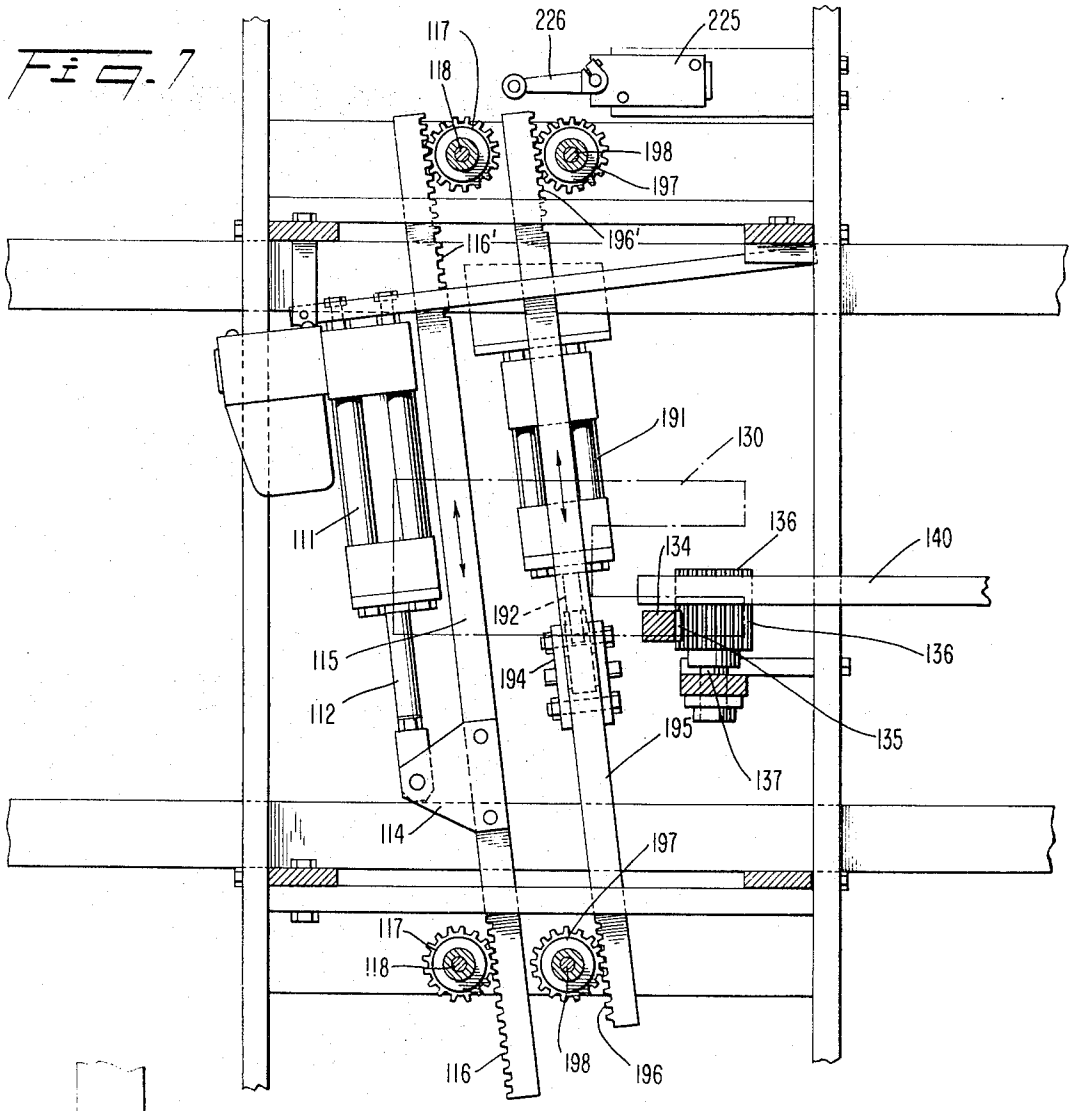
7
115
136
117
137
195
118
197
198
160

Fig. 6

Fig. 7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226
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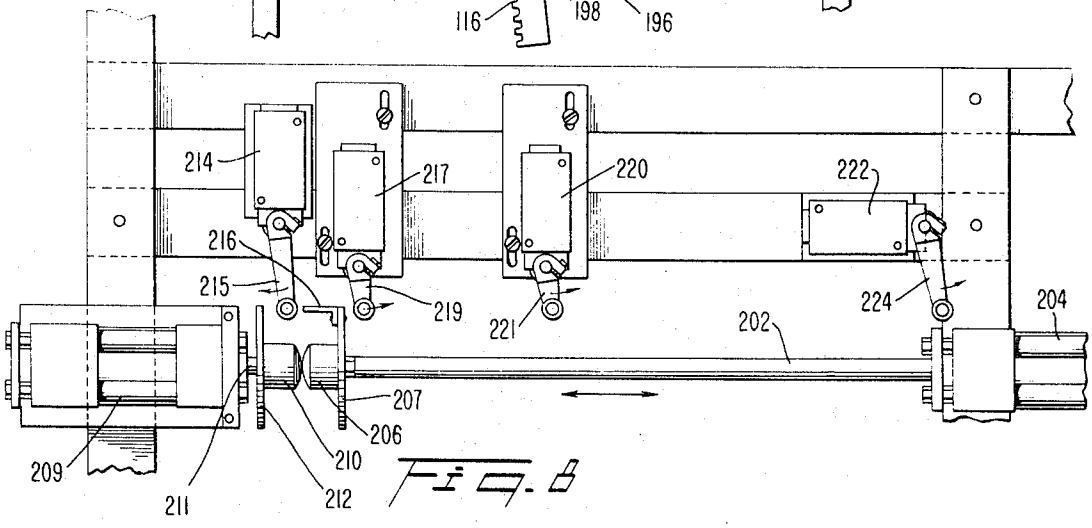
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Fig. 8

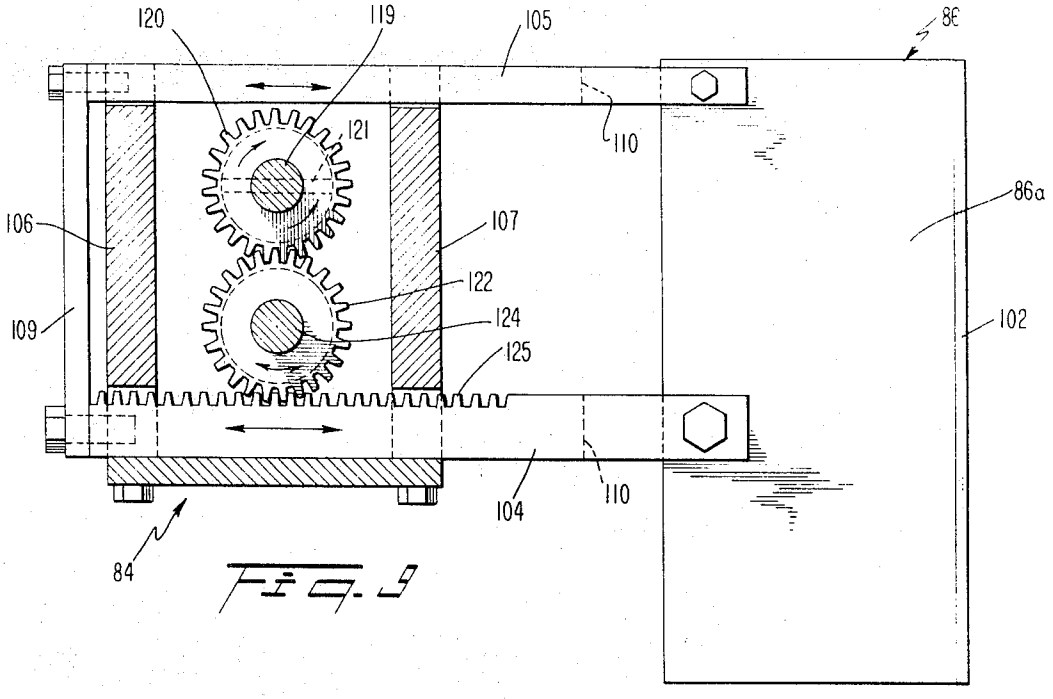
120
119
105
86
121
110
106
107
86a
122
109
124
102
125
104
110
84

Fig. 9

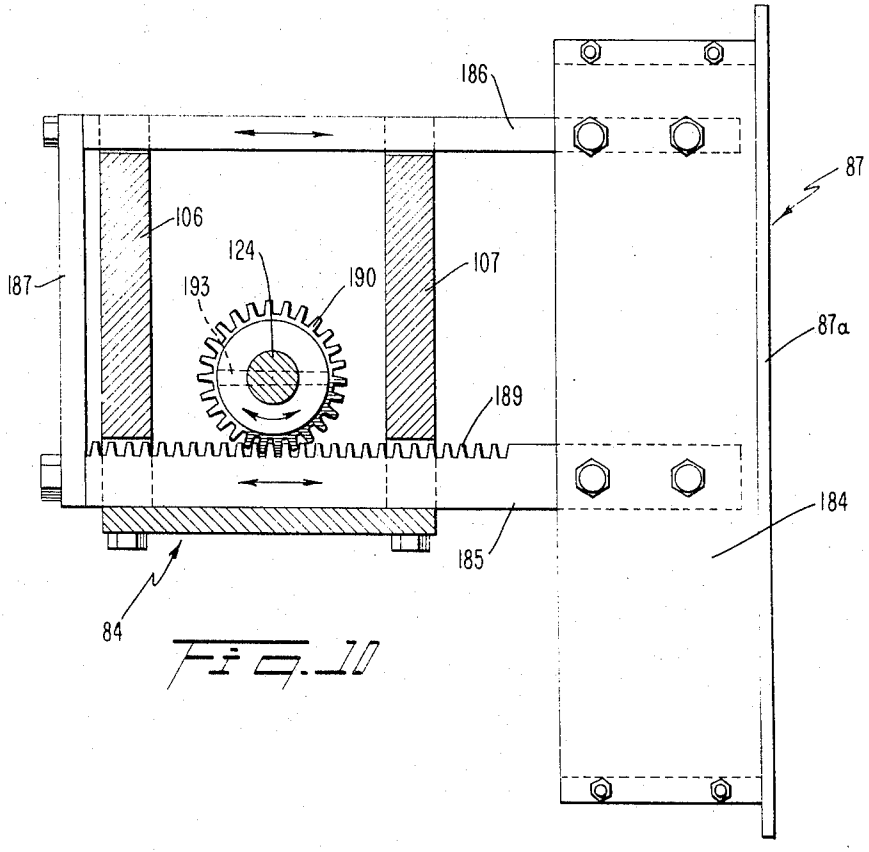
186
87
106
124
107
187
193
190
87a
189
184
185
84

Fig. 10

METHOD OF HANDLING BOOKS

This application is a division of application Ser. No. 833,985, filed June 17, 1969 now U.S. Pat. No. 3,640,407, issued on 2-8-72, for "Method of and Apparatus for Handling Books."

This invention relates to a method of and an apparatus for stacking books.

The invention is particularly useful in the stacking of books which are thicker at their backbone or spine joints than throughout the remainder of the area of their covers or case boards. An example of books of this type is that wherein the spine of gathered signatures forming the body or filler of the book is rounded and backed, and the hinges or spine joints between the spine of the case or cover applied to such book body extend somewhat outwardly of the plane of the outer surfaces of the front and back case boards.

The invention has among its objects the provision of a novel method for the stacking of books.

Another object of the invention is to provide a novel apparatus for the stacking of books.

A further object is the provision of a method of and an apparatus for producing stacks of books wherein the spines of alternate books in the stack lie on opposite sides of the stack and offset slightly in the direction of the spines from the next adjacent book or books.

A still further object of the invention is the provision of a method of and an apparatus for rapidly and accurately producing stacks of books wherein the possibility of crushing the joints between the backbone and case boards is eliminated.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views.

FIG. 1 is a view in side elevation of the book alternator and stacker of the invention, the conveyors for carrying single books in sequence to the alternator and stacker station and for carrying stacks of books away from such station being fragmentarily shown;

FIG. 2 is a view in end elevation of the apparatus shown in FIG. 1, the view being taken from the line 2—2 of FIG. 1, the parts of the stacker being shown in the positions which they occupy after a stack, shown in phantom, pushed from the stacker onto the delivery conveyor and the stack elevator and front stop have been returned to their upper positions, but before retraction of the auxiliary platform;

FIG. 3 is a view in plan of the apparatus shown in FIG. 1, the view being taken from the line 3—3 of FIG. 1;

FIG. 4 is a fragmentary view in horizontal section through the alternator and stacker, the section being taken along the line 4—4 of FIG. 1, the view particularly showing the retractable end stop for the book stacker in retracted position and the mechanism for operating such stop;

FIG. 5 is a fragmentary view in vertical longitudinal section through the alternator and stacker, the section being taken along the line 5—5 of FIG. 4;

FIG. 6 is a fragmentary view in vertical longitudinal section through the stack-forming portion of the apparatus, the section being taken generally along the line 6—6 of FIG. 3, certain of the parts being omitted and others being shown in phantom lines;

FIG. 7 is a view in horizontal section through the lower portion of the apparatus shown in FIG. 6, the section being taken along the line 7—7 of FIG. 6;

FIG. 8 is a fragmentary plan view takey along the line 8—8 of FIG. 1;

FIG. 9 is a fragmentary horizontal section through the stack-forming portion of the apparatus above a partial book-stack-supporting separator or platform blade, the section being taken along the line 9—9 of FIG. 2; and

FIG. 10 is a fragmentary horizontal section through the stack-forming portion of the apparatus above a side presser or jogger for a completed stack of books, the section being taken along the line 10—10 of FIG. 2.

The book alternator and stacker of the invention may be used, for example, at the delivery end of a book-forming or building-in machine from which books are delivered in upright position with the spines uppermost. As delivered to the alternator and stacker, the books shown have had the backbones thereof rounded and backed and have been cased-in in a known manner. In such books the hinged joints between the spine and the case boards or covers thereof protrude outwardly somewhat beyond the outer surfaces of the front and back case boards. It is therefore desirable, in forming stacks of such books, that alternate books be so offset that the case boards of one book do not overlie the protruding spine joints of the next adjacent book or books. The apparatus of the invention forms stacks of books while offsetting adjacent books so that the spine joints of one are not contacted by the case boards of the other. As will become apparent hereinafter, the method and apparatus of the invention are useful also in stacking books of other types.

Turning now to the drawings, there is shown in FIGS. 1 and 3 a book alternator and stacker 12, 14 which receives spaced books (generally designated 43) in sequence from a first conveyor 10, forms stacks of such books in the manner above generally described, and delivers such stacks 15 to a further conveyor 16. The infeed conveyor 10 may be, for example, the delivery conveyor of a book building-in machine; the conveyor 16 may forward the book stacks 15 to suitable wrapping and strapping apparatus (not shown). The conveyor 10, which is relatively narrow, carries books 43 longitudinally in an upright, on-edge position in the direction of their general plane and deposits them in such position upon a second, wide conveyor 11 disposed in central alignment with conveyor 10. Disposed at the entering end of the continuously operating conveyor 11 there is a book alternator which tips or lays down successive books in opposite lateral directions. As shown in FIGS. 1 and 3, books which have been tipped toward the reader in FIG. 1 are designated 43a and those which have been tipped away from the reader in such figure are designated 43b. The thus tipped books, one-half of which now lie on their front covers and the other half of which lie on their back covers, are fed forwardly by conveyor 11 and are funnelled by fixed guides, to be described, toward the center line of the conveyor and a book stacking mechanism 14 disposed in central alignment with conveyor 11 and fed thereby. At the

stacker **14** the books are formed into a pile or stack; the stack is progressively lowered as books are added thereto. After being lowered the books are jogged laterally inwardly in opposite directions to edge align the sets of alternate books in the stack while leaving one such set laterally offset somewhat from the other set, and all books in the stack are end aligned. The thus treated book stack **15** is then discharged from the stacker to the delivery conveyor **16.**

The stacker **14** is so constructed and arranged as to provide normally vertically aligned upper and lower book receiving channels, the upper channel being periodically separated from the lower channel by laterally-reciprocable, vertically-fixed book supporting or separator blades **86.** This permits the upper channel continuously to receive books delivered thereto from the book alternator conveyor **11** while a completed stack of books **15** in the lower channel is lowered by a vertically-reciprocable book supporting elevator or platform **130** in such lower channel, is edge and end aligned while supported by the platform, and is discharged from the stacker. Upon discharge of the stack, the platform **130** rises, the separator blades **86** are retracted, and the support of the partial book stack in the upper channel is thus transferred to the elevator platform **130.** The cycle is then repeated.

THE MECHANICAL DRIVE

The conveyors **10** and **11** are driven by a motor **17** as shown in FIGS. **1** and **2.** A motor drive pulley **19** is connected by a belt **20** to a large driven pulley **21** affixed to the forward end of a countershaft **22** which extends longitudinally of the stations **12, 14.** A pulley **23** is affixed to the rear end of shaft **22,** such pulley driving a speed reducer **26** (FIG. **2**) through the medium of a Timing belt **24** which is entrained over the pulley **23** and a pulley **25** on the speed reducer. The speed reducer **26** in turn drives the conveyor **11** through the medium of a Timing belt sprocket **27** on the output shaft of the speed reducer, and a Timing belt **29** entrained over a sprocket **30** on the shaft **31** which carries the forward elongated drive pulley or roll **32** of the conveyor **11.** Conveyor **11** has a wide belt **34** which runs over the roll **32** and a roll **35** at the rear end thereof as shown in FIGS. **1** and **3,** the rolls **32** and **35** being journalled upon spaced parallel side frame members **33.**

The infeed conveyor **10** has a narrow belt **36** (FIG. **3**) which runs over a forward drive pulley **37** on a shaft **39** and over a similar pulley (not shown) at the rear of the belt. Belt **36** is driven in synchronism with and at the same speed as the belt **34** of conveyor **11** through the medium of a pulley **40,** affixed to shaft **31** of conveyor **11,** and a longitudinally extending Timing belt **41** which extends to a pulley **42** on the shaft **39** of conveyor **10.** The books **43** are carried by conveyor **10** in upright, spine-up position between opposed side guides **44** which may be adjusted by means not shown to accommodate books of different thicknesses. Books **43,** still in upright position, enter upon the conveyor **11** whereby they are carried to the alternator **12** free from lateral guidance. After the books have been tipped or laid down by the book alternator **12** in a manner to be next described, conveyor **11** carries them to the book stacker **14.**

THE BOOK ALTERNATOR 12

The side frame members **33** of the conveyor **11** are carried by opposed rear and forward upright frame members **46** and **48,** respectively, such uprights in turn being mounted upon a longitudinal frame **47.** The upper ends of uprights **46** are connected by a horizontal cross frame member **49;** member **49** and a similar forward cross member **50** connected to upper frame members **101** serve to support and guide a laterally reciprocable frame **51** of the alternator **12.** Frame **51** has similar spaced parallel, longitudinally-extending side members **52** which are connected and spaced by tie rods **54.** A double acting reciprocable fluid motor **55** having the cylinder thereof disposed above and connected to the cross member **49** has a piston rod **56** which extends through the opposite ends of the cylinder, the outer ends of rod **56** being connected to members **52** as shown. The reciprocable frame **51** is partially supported by the double-ended piston rod **56** and is also partially supported by and guided by channel-shaped cross member **50,** there being rollers **69** journalled on the forward ends of the side frame members **52** which ride in the channel of member **50** as shown in FIGS. **1** to **3.** It will be apparent that upon the alternate admission of fluid under pressure to the opposite ends of the motor **55** and the exhausting of fluid from the other, the piston rod **56** and the frame **51** reciprocate in a direction transverse to the lengths of the conveyors **10** and **11.**

Mounted upon the frame **51** substantially midway between the side members **52** thereof, there is a horizontal longitudinally extending support member **61** from which brush **62** or comparable means depends. The brush holder **61** and brush **62** are so located that when the piston rod **56** of the motor **55** is at one end of its stroke the brush lies on one side of the path of books delivered to the alternator **12** on the conveyor **11** and that when the piston rod **56** is at the other end of its stroke the brush **62** lies on the other side of books delivered to the alternator **12.** The brush holder **61** and brush **62** are vertically positioned as shown in FIG. **1** so that the brush, when reciprocated laterally, may engage the books below the spines thereof. It will be apparent that successive books pivot about the lower laterally outer edge of their respective opposite lower edges so as to fall in opposite directions depending upon the side thereof engaged by the moving brush.

The brush holder **61** and brush **62** are vertically adjustable to cooperate with books of different widths, that is, heights as the books **43** are presented thereto. Parallel longitudinally spaced shafts **57** span the opposite side members **52** of frame **51** and are journalled therein (FIG. **3**). Mounted upon the respective tie rods **54** and shafts **57** are housings **59** within which similar vertical racks **60** are guided, there being a pinion **64** in each of the housings keyed to its shaft **57** and similarly meshing with the teeth on the respective racks **60.** Shafts **57** are drivingly connected by a chain **66** which runs over similar sprockets **65** on corresponding ends of the shafts; the shafts **57** are turned in the same direction and in equal amounts simultaneously to adjust the racks **60** vertically in the same amount by means of a hand wheel **67** attached to one end of a shaft **57.**

The motor **55** for reciprocating the frame **51** and brush **62** is under the control of a photocell (not shown) which may be disposed on one side of the path of travel of books as they emerge from the conveyor **10.** When the photocell is darkened by a book travelling between it and its light source, the motor **55** is en-

ergized so as to travel into a terminal position opposite from that which it then occupies. In so doing, the brush **62** engages the book, designated **43***a* in FIG. **3**, which is then passing so that such book is tipped toward the reader in FIG. **1**. The next book **43***b* emerging from conveyor **10** again darkens the photocell and causes the motor **55** to operate in the reverse direction so that successive books **43***a* and **43***b* are alternately tipped or laid down in opposite directions by brush **62**.

As the tipped books **43***a* and **43***b* are carried forwardly by belt **34** of conveyor **11**, their backbones or spines engage the inner vertical surfaces of respective smoothly converging but oppositely disposed similar longitudinal guide members **72***a* and **72***b* which lie above the upper run of the belt **34**. Guides **72***a* and **72***b* are made of somewhat flexible self-sustaining strip metal, the rear ends of the guides being connected at **74** to uprights **46** and the forward ends thereof being connected by straps **75** to side guide members **85** at the opposite sides of the stacker **14** shown in FIG. **2**. Members **85**, to be more specifically described hereinafter, define the side walls of an upper channel in stacker **14**, and may be adjusted laterally toward and away from each other in order to accommodate books of different widths. Since the forward ends of the flexible guides **72***a* and **72***b* are connected to the respective members **85***a* and **85***b*, the forward ends of the guides are correspondingly laterally adjusted.

It will be apparent that as the conveyor belt **34** carries books **43***a* and **43***b* forwardly, the forward laterally outer corners of the books **43***a*, **43***b* engage the respective guides **72***a*, **72***b*; the books are progressively thrust sidewardly or funnelled by such guides toward the longitudinal center line of the belt **34** so that they enter the upper end of the stack defining means, made up in part of the forward ends of guides **72***a*, **72***b* and side wall members **85***a*, **85***b*. Such members and the forward ends of said guides are disposed at equal distances on opposite sides of the longitudinal center line of conveyor **11** and are spaced apart a distance which appreciably exceeds the widths of the books being stacked; as a result, sets of alternate ones of the books in the upper channel portion of the stacker lie laterally offset in opposite directions an appreciable distance with respect to the longitudinal center line of the conveyor **11** and of said channel portion, as illustrated in FIG. **2**.

THE STACKER 14

As the books **43***a*, **43***b* travel forwardly upon conveyor **11**, their upper surfaces are engaged by a gravity actuated presser roll **79** which is journalled on the free end of a lever **77** pivotally mounted on a fitting secured to a cross bar **76** mounted on the upper ends of the uprights **48**. Roll **79** holds the books down against the conveyor belt **34** and prevents premature tilting thereof over the end of belt **34** to insure their most desirable entry into the stacker channel onto the supporting platform, or the book stack. The stacker **14** is mounted upon fixed framework including members **47** disposed beneath the conveyor **11** and further less widely spaced frame members **80** forwardly of the stacker which underlie and support the conveyor **16**. Frame members **47** and **80** are connected by cross frame members **81** which lie forwardly of the stacker and by similar transverse frame members **82** which are spaced rearwardly from members **81** at the rear of the stacker. Transversely extending guideways **83** are provided upon the upper surfaces of members **81** and **82** on both sides of the stacker. Similar but oppositely disposed carriages **84** are supported for lateral adjustment upon and guided by the guideways **83**. Frames or carriages **84** support the above-mentioned upper side wall members **85**.

Beneath the lower edges of the side wall plates **85** there are disposed horizontal separator blades **86** which are laterally reciprocable and extend into the book receiving channel when the parts are disposed as shown in FIGS. **2** and **3**. When thus disposed, the blades **86** constitute an auxiliary or temporary support or platform for several books in the upper end of the stacker channel. The sides of the lower portion of the book-receiving channel of the stacker, below the level of the separator blades **86**, are formed by spaced side guide or jogger plates **87**, which are moved inwardly or jogged in order to dispose the books in the lower end of the stack with the desired degree of lateral offset from the longitudinal central vertical plane of the stack, before the discharge of the stack from the stacker.

As above explained, the carriages **84** are laterally adjustable in opposite but equal distances from the longitudinal central vertical plane of the conveyor **11** and the stacker so that the stacker may accommodate books of different widths. A cross shaft **89** (FIGS. **1** and **3**) suitably journalled in the frame members **80**, may be turned by a crank **90** affixed to one end thereof (FIGS. **1** and **3**). The opposite ends of the shaft **89** have similar sprockets **91** affixed thereto, there being chains **92** connecting the respective sprockets **91** to sprockets **94** on the outer ends of oppositely disposed horizontal adjusting screws **95** of opposite hand. The outer ends of such screws are journalled in the fixed frame of the apparatus, whereas the laterally inner threaded portions thereof are threadedly received in nuts affixed to each of the respective carriages **84**. It will be seen that the turning of the crank **90** in one direction adjusts the carriages **84** toward each other, whereas the turning of the shaft in the opposite direction further separates the carriages.

Centrally above the book receiving channel of the stacker **14** there is a horizontal longitudinally extending rod **97** which is suitably supported upon the fixed frame structure of the apparatus. One such support for the rod includes a brakcet **99** affixed to the rear end thereof, the bracket being secured to a cross member **100** affixed to the longitudinal frame members **101**. Another support for rod **97** is the bar **76**. The forward end of rod **97** carries a transversely extending vertical plate **96**, the lower edge of which lies substantially coplanar with the upper surface of blades **86**. Member **96** forms an end stop for books fed into the upper portion of the book receiving channel of the stacker as shown in FIG. **2**. When the separator blades **86** are in their inner position as shown in FIG. **2**, books **43***a*, **43***b* are deposited into the upper end of the channel by the belt **34**, the forward end of which lies slightly to the rear of the rear end of such channel. The thus deposited books fall into the channel, the lowermost one of such books lying upon the blades **86**. The blades **86** lie a sufficient distance below the upper surface of the conveyor belt **34** so that the upper portion of the channel can accommodate a plurality of books. In the embodiment shown, the upper portion of the channel, above the blades **86**, is capable of receiving at least three relatively thick

books. As above indicated, during the time that such three books are being deposited upon the blades **86**, a previously deposited stack of books in the lower portion of the channel of the stacker on elevator platform **130** are sidewardly aligned, end aligned, and discharged as a neat stack **15** from the stacker, and elevator **130** is returned to its elevated position (FIGS. **2** and **6**).

THE SEPARATOR BLADES 86

The separator blades **86** are particulary shown in FIGS. **2**, **3**, and **9**. As shown in FIG. **9**, which is a section through the left-hand (FIG. **2**) carriage **84**, such blades have broad horizontal extents, the upper laterally inner edges of the blades being bevelled at **102**. Secured to blade **86** are a horizontally reciprocable rack bar **104** and a parallel guide bar **105**, such bars having their outer ends extending through guiding slots and holes in vertical parallel frame members **106** and **107** of the carriages **84**. The outer ends of bars **104** and **105** are connected by a longitudinally extending strap member **109**. The blade **86** is secured to the inner ends of bars **104** and **105** by being received within slots **110** therein and bolted thereto as shown.

The separator blades **86** are moveable from their laterally inner position shown in FIGS. **2** and **3**, wherein they are shown supporting books in the upper portion of the stacker channel, to an outwardly retracted position in which their inner edges **102** lie at least slightly outwardly beyond the inner faces of the side guide members **85**. The separator blades are moved between such positions by a reciprocable fluid motor **111** (FIG. **7**) which is disposed horizontally beneath the stacker **14**. Motor **111** has a piston rod **112** which is connected to a horizontally reciprocable rack bar **115** by a bracket **114**. The rack bar **115** has a rearwardly facing rack gear **116** on one end thereof and a similar but oppositely facing rack gear **116'** on the other end. Rach gear **116** meshes with a pinion **117** which is connected to a vertical stub shaft **118** which is journalled in the fixed frame of the apparatus. A generally vertically extending shaft **119** which includes two universal joints **126** therein rises from the pinion **117** as shown in FIG. **6**. The upper end of shaft **119** is journalled in and supported by a bracket **123** which is secured to the upper portion of carriage **84**. Fixedly secured by a cross pin **121** to the upper end of shaft **119** beneath the bracket **123** is a pinion **120**. It will be seen that as the piston of motor **111** moves in opposite directions the pinion **120** is turned in opposite directions.

The pinion **120** meshes with a pinion **122** which is journalled upon and freely rotatable with respect to the upper end of a shaft **124** which is mounted parallel to the upper ene of shaft **119**. The pinion **122** meshes with a rack gear **125** on the rack bar **104**. The driving connection between the rack gear **116'** and the separator blade **86** mounted on the right-hand (FIG. **2**) carriage **84** of the stacker is the same as that above described the exception of the reversal of positions of the rack gears **116, 116'** with respect to pinions **117** to cause the opposed separator blades **86** to move simultaneously in opposite directions.

THE BOOK STACK ELEVATOR

Fitting between the inner edges **102** of the opposed separator blades **86** when such blades are in their laterally inner positions as shown in FIG. **3** is a horizontal elevator platform **130**. Such platform has a central forwardly open notch **131** therein which freely receives a retractible end stop **154** which may be swung downwardly from the position thereof shown in FIG. **1** to that shown in FIG. **5**. The platform **130** has a bracket fitting **132** secured to the bottom thereof, the fitting serving to connect the upper end of a vertically reciprocable elevator rack bar **134** to the platform, as shown more particularly in FIG. **6**. The bar **134** has a forwardly facing rack gear **135** thereon, such rack gear meshing with a rotatable pinion **136** which is mounted on a horizontal stub shaft **137**. Pinion **136** also meshes with a rack gear **139** on a horizontally reciprocable rack bar **140** which is connected to the piston rod **141** of a double acting reciprocable fluid motor **142** as indicated in FIGS. **2** and **6**. It will be apparent that upon the thrusting of the piston rod **141** and bar **140** to the left in FIG. **6** the elevator platform **130** is lowered and that upon the travel of such piston rod to the right the elevator platform is raised. The actuation of piston rod **141** is automatically controlled in a manner to be hereinafter described to insure proper timing and sequencing with other parts of the apparatus. In general, after retraction of auxiliary platform **86**, **86** elevator **130** is moved down step-by-step as books are added to the stack until the desired number are present. The elevator is then moved down quickly to unloading position (FIG. **2**), unloaded in a manner to be described, and returned quickly by motor **142** to its raised position (FIG. **6**).

RETRACTIBLE BOOK STOP 154

As illustrated in FIG. **1**, the end stop **154** is disposed with its rear face coplanar with and beneath the rear face of fixed end stop **96**. After the desired number of books have been formed into a stack on elevator **130**, as detected by suitable known counting means, such stack of books is thrust forwardly by a vertical plunger plate **199** through a small distance so that their forward ends engage the stop **154**, thereby vertically aligning the ends of the books. Immediately thereafter, the opposed side guide or jogger plates **87** which defines the sides of the lower portion of the channel of the stacker **14** are thrust laterally inwardly through a small distance to vertically align the spines of alternate books and bring the stack to the condition shown in FIG. **2**. All of such functions are effected by suitable known types of detection means and sequencing controls.

The retractible end stop **154** is mounted upon the forward end of an elongated generally longitudinally extending lever arm **155** which lies substantially horizontal when the parts are in the position of FIG. **1**. The rear end of the lever arm **155** is secured to an upwardly and forwardly inclined lever composed of two similar parallel levers **156** (FIG. **4**), the lower ends of which are pivotally mounted to the fixed frame of the apparatus at **157**. Adjustment of the angularity of the lever **156**, in a manner to be described, permits adjustment of the stop **154** in a direction longitudinally of the stacker for books of different lengths so that crushing of the books by plunger **199** will be avoided. The upper book stop **96** is releasably clamped on rod **97** for similar adjustment (FIG. **2**). The lever arm **155** and the stop **154** are oscillated from their elevated position of FIG. **1** to their retracted or lowered position of FIG. **5** by a double acting reciprocating fluid motor **159**. The lower end of such motor is pivotally mounted to the

frame at 160, the piston rod 162 of the motor being pivotally connected at 161 to an intermediate portion of the lever 155.

As shown in FIG. 4, the lever arms 156 are connected at their upper ends by a cross bar 164. A longitudinally extending threaded adjusting rod 165 has its forward end threadedly received in a fitting mounted on bar 164. The rear end of rod 165 is journalled in the frame of the apparatus at 166. A hand wheel 167 on the rod rearwardly of the bearing 166 permits the rod to be turned in the desired direction relative to said fitting so as to change the angularity of the lever arm 156. As arm 156 is inclined further away from the vertical in FIG. 1, the connection 163 and hence the end stop 154 are moved forwardly; conversely, adjustment of the arm 156 closer to the vertical moves the stop 154 rearwardly. For purposes to appear hereinafter, the movements of the retractible stop 154 into its elevated and retracted positions are relied upon to operate a switch 174 having an operating arm 175 mounted on lever arm 156 and a switch 176 having an operating arm 177 is actuated by the lever 155.

THE SIDE JOGGERS

Since the side jogging plates 87, which are disposed on opposite sides of the lower portion of the book receiving channel of the stacker 14, are similar to each other and are operated by identical mechanism, a specific description of the jogger carried by the left-hand (FIG. 2) carriage 84 will suffice. The side guide plate 87 is mounted in vertical position on a bracket 184 which in turn is secured to the end of a horizontally reciprocable rack bar 185. As shown in FIG. 10 the outer end of the rack bar 185 is guidingly received in passages through the vertical parallel plate members 106, 107 of the carriage 84 (FIG. 10). A guide bar 186 disposed parallel to bar 185 is also secured to the bracket 184 and is guided by the members 106, 107. The outer ends of bars 185, 186 are connected by a strap 187. The plate 87, the bracket 184, and the bars 185, 186 of the opposite carriages 84 are moved laterally inwardly in opposite directions through equal distances at substantially the same time that the book stack 15 is being thrust forward against the stop 154. Immediately thereafter front stop 154 and the plates 87 are retracted and the side aligned books forming the stack 15 are thrust forwardly onto the conveyor 16 by pusher 199.

Each plate 87 of the side jogger means is moved inwardly and outwardly between the full and dotted line positions in FIG. 2 by the following mechanism. A rack gear 189 on bar 185 meshes with a pinion 190 which is affixed to the shaft 124 by a pin 193. The shaft 124 is turned in opposite directions by a double acting fluid operated reciprocable motor 191 (FIG. 7) which is disposed beneath the stacker and close and parallel to the above described motor 111. The piston rod 192 of motor 191 is connected through a fitting 194 to a horizontally reciprocable rack bar 195. The left-hand end of bar 195 as it is shown in FIG. 2 carries a rearwardly facing rack gear 196 whereas the right-hand end of such bar carries a forwardly facing rack gear 196'. Rack gear 196 meshes with a pinion 197 which is journalled on the upper end of a vertical stub shaft 198 (FIG. 6) affixed to the frame parallel to the shaft 118. The lower end of the shaft 124 is connected to the pinion 197. As shown, shaft 124 includes serially disposed universal joints 128 which permit the drive between the pinion 197 and the pinion 190 to be preserved despite lateraly adjustment of the carriage 84. The disposition of the rack gears 196, 196' on opposite sides of bar 195 permits the opposite jogger plates 87 to be moved laterally inwardly toward each other upon movement of the piston rod 192 of motor 191 in one direction and to be retracted outwardly upon movement of such piston rod in the opposite direction.

THE BOOK STACK PUSHER

The vertically disposed pusher platen 199 forms the rear wall of the lower portion of the book receiving stacker channel when the parts of the apparatus are disposed as in FIGS. 1 and 6. Such platen is secured to a carriage 203 which is supported for longitudinal reciprocation by guide wheels 200 which travel along a horizontal supporting plate 201. The carriage 203 is secured to the forward end of the piston rod 202 of a double acting reciprocable fluid motor 204 (FIGS. 1 and 8) which is disposed longitudinally of the apparatus beneath the conveyor 11. Piston rod 202 extends in both directions from the cylinder of the motor 204, the rearwardly extending portion of said piston rod being supported upon a roller guide 205 as shown in FIG. 1. The rear end of piston rod 202 is provided with an abutment cap 206 (FIG. 8), such cap being provided with a flange 207 on its forward end. A further, relatively short, fixed stroke double acting reciprocable fluid motor 209 is disposed rearwardly of and in alignment with the motor 204. The piston rod 211 of motor 209 has an abutment cap 210 thereon, such cap having a flange 212 on its rear end. When elevator 130 is lowering a completed stack 15 to unloading position ready for vertical alignment as described above, motor 209 is first actuated so as to thrust its piston rod 211 against the abutment cap 206 and thereby to thrust the piston rod 202 of the motor 204 with platen 199 forwardly with sufficient force to override the then opposing fluid pressure in motor 204 to move the stacked books gently against the stop 154 to effect substantial end alignment. Following this and after the stop 154 has been retracted by motor 159 and the side jogger plates 87 have been moved laterally inwardly to side align alternate books, the motor 204 moves the pusher platen 199 further to the right as viewed in FIG. 1 and between jogger plates 87 so that the book stack 15 is fully discharged from the stacker and supported upon the conveyor 16 (FIG. 1). It will be understood that as soon as a completed stack 15 is lowered for jogging and discharge, the auxiliary platform plates 86 are temporarily moved in to catch the next few incoming books from conveyor 11.

The platen 199 pushes the stack of books 15 to the right across the plate 201 and onto rollers 230 which protrude upwardly through slots in said plate to facilitate such travel of the stack. The stack then enters upon laterally spaced similar belts 231 of the conveyor 16, such belts being driven by means not shown. Idle pulleys 232 affixed to a rear shaft 234 of conveyor 16 support the rear ends of the belts 231; similar driven pulleys (not shown) engage and drive the belts 231. Such belts travel across and are supported by longitudinally extending plates 235 which underlie them.

In the initial portion of its travel on the conveyor 16 the stack is engaged at its upper end by a presser roll 237 which is preferably of soft resilient character,

being made, for example, of soft sponge rubber. The roll **237** is mounted upon a longitudinally extending arm **239** (FIG. **1**) which is affixed to a lateral arm **240** to which a vertical sleeve **241** is secured. Sleeve **241** slides upon a fixed vertical post **242.** The arm **240** intermediate the sleeve **241** and the arm **239** has a vertical threaded passage therethrough, such passage threadedly receiving a vertical screw **244** which is journalled at its upper end against vertical motion. A hand wheel **235** on the upper end of screw **244** permits the arms **239, 240** and the sleeve **241** to be adjusted vertically in response to rotation of the screw, thereby permitting the roll **237** to engage the upper end of the stack **15** with the desired amount of pressure so as to press the stack securely against the infeed ends of belts **231** of conveyor **16.**

SEQUENCING CONTROLS

The operating sequence of the various elements of the stacking means of the apparatus is preferably effected by electrical and pneumatic means, the latter being in the form of fluid motors described above. The electrical controls include switches **174** and **176** operable by bar **155** when front stop **154** is in its terminal down and up positions, respectively (FIG. **5**). A switch **214** having an arm **216** is actuated by a bar **212** on the forward stroke of piston rod **211** (FIG. **8**). Switches **217,220** and **224** are operable, for purposes to hereinafter appear, by a bar **207** on piston rod **202,** the flange being adapted to engage the roller equipped arms **219, 221** and **224,** respectively, on said switches. A switch **225** shown in FIG. **7** is operable by bar **195.** Other switches and photocell detection devices of known construction are referred to in the following description of the operation but are not shown in order to avoid necessary complication of the drawing.

MODE OF OPERATION

From the foregoing it will be seen that conveyor belts **34, 43** and **231** are the only parts of the apparatus which are continuously driven by motor **17.** The other operating elements are operated by cylinder and piston fluid motors, such as double acting compressed air motors. The application of pressure in opposite ends of each cylinder may be controlled in a known manner by solenoid actuated valves which may in turn be controlled by suitable relays, switches, photocells and the like which are responsive to the passage of books or movements of the operating elements of the apparatus.

By way of example, book detection means of known type, such as a photocell, may be provided to detect books approaching brush **62** and to control the reciprocation of motor **55** to actuate the brush and tip adjacent books in opposite directions on conveyor **11.** Means well known in the art, such as photocell counter, are also provided for electrically counting the books as the same drop off the end of conveyor **11,** said means being employed to control the operation of auxiliary platform **86,** elevator **130** and end jogging motor **209.** When the first of a series of a selected number of books for a stack passes the counter detector, the motor **111** is energized to move plates **86** into operative position to catch and support a few books, usually about one-third of a full stack. This number may depend on several factors such as the rate of travel and spacing of the books, the thickness of the books, the vertical height of the stacker channel, the time required for the elevator **130** to complete a down-up cycle and others. When the selected number of books have been stacked on plates **86,** as determined by the counter, said plates are retracted by motor **111.** This preliminary number of books now rest on elevator **130** in its up position where they are detected by suitable control means, such as a photocell and light beam, to control the descent of the elevator. Thus, when the photocell, for example, is darkened by the uppermost book on the stack being in the beam, motor **42** is operable to slowly lower the elevator until the photocell is again lighted across the top of the stack. As each book is added, the elevator is progressively lowered. This may be effected by causing motor **42** to operate against a hydraulic dash pot with an escape valve controlled by the photocell and a solenoid. When the counter signals the entry of the final book of a stack the dash pot is rendered ineffective so as to permit the elevator to be moved promptly to fully lowered position. The next book entering the stacker, i.e., the first book of the next stack, is detected by the counter and motor **111** is thereby caused to be energized to again move auxiliary platform plates **86** into operative position as explained above.

When the last book of a stack arrives, the counter also disables the dash pot control of motor **142** to permit rapid, continuous descent of the elevator and effects energization of end jogger motor **209** to move pusher **199** to the right (FIG. **1**) to end-align the stack against front stop **154** as explained above. In response to actuation of switch **214** by flange **212,** motor **191** is energized to move side jogger plates **87** inwardly against the stack by actuation of bar **195.** The latter, near the end of its stroke, actuates switch **225** to thereby effect proper energization of motor **159** to lower front stop **154.** As elevator **130** reaches its lowermost position, it actuates a switch (not shown) which, conditioned on the completion of the end jogging signalled by actuation of switch **214** and on the lowering of front stop **154** signalled by actuation of switch **174,** signals the proper energization of motor **204** for actuating pusher **199** to move the jogged book stack from between plates **87** onto conveyor **16.**

The energization of pusher motor **204** for returning pusher **199** is effected when flange **207** actuates switch **222** at the end of the forward stroke of piston rod **202.** On the pusher retraction stroke of piston rod **202,** the switch **221** is actuated by flange **207** to signal the return of front step **154** to raised position by motor **159** and consequent actuation of switch **176.** Near the end of its return stroke, flange **207** momentarily actuates the one-way switch **217** to initiate the raising of elevator **230** which is effected with continuous rapid movement by motor **142.** When the elevator reaches its upper position it actuates a switch, not shown, which reverse energizes motor **142** to apply a lowering force to the elevator under control of the dashpot and stack level detecting means as above described. In the interval thus required for lowering, unloading and returning the elevator several books will have been deposited on platform **86.** When the preselected number of books have been deposited onto plates **86,** as determined by the counter, said plates are retracted and the complete cycle is repeated.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be expressly understood that various changes may be made

therein without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art. Thus, alternate books **43** which have been tipped or laid down in opposite directions upon the belt **34** of the conveyor **11** may be moved laterally so as to enter the stacker **14** in offset position by means other than the opposed curved guides **72***a*, **72***b*. One such alternative means for so doing is in the form of a transversely reciprocable carriage similar to carriage **51** and suspended in a similar manner above the belt **34** downstream of the carriage **51**. Such unillustrated carriage may have horizontal, longitudinal bars rigidly suspended therefrom and positioned above the upper surface of belt **34** but close enough thereto to engage the spines of the books which have been laid down upon the belt. Suitable means such as a photocell and light source are disposed to detect the passage of the laid-down books on the conveyor and to effect proper energization of the carriage motor. In one terminal position of the carriage, the bar on one side thereof is disposed laterally outwardly of the spines of the books which have been laid over in the respective direction; the bar on the other side of the carriage is similarly disposed with respect to the books laid over in the other direction when the carriage is in its other lateral terminal position. As the carriage moves from one terminal position toward the other, one of the bars engages the book which it confronts and carries it laterally inwardly; in the reverse travel of the carriage the other bar carries the book on the other side of the belt **34** laterally inwardly. The books thus carried inwardly are released in such lateral position on the belt that they can enter the upper portion of the channel in the stacker **14** but are laterally offset in the same manner as in the illustrated apparatus.

Although the method and apparatus of the invention have been illustrated in connection with books which have been rounded and backed, and encased, it is to be understood that the invention may be employed to advantage in the stacking of books of other types. Among such other types of books are those in which the front and rear surfaces of the books, including the spine joints, throughout their extent lie substantially in parallel planes, making the offsetting of successive books unnecessary. The apparatus is also useful for stacking books without alternating the position of the spines thereof.

We claim:

1. A method of stacking books which comprises feeding longitudinally a plurality of similar books in succession generally along a path, disposing the books flat in first lateral positions with alternate books substantially offset laterally in opposite directions from the longitudinal center line of such path, moving one set of alternate books as the books travel longitudinally laterally toward the other alternate set of books so that the books lie in second lateral positions wherein there is decreased lateral offset between successive books, and discharging the books in such second lateral positions into an at least generally vertical stack.

2. A method of stacking books as defined in claim **1** comprising moving alternate books as they travel longitudinally laterally inwardly in opposite directions toward the longitudinal center line of said path.

3. A method of stacking books as defined in claim **1** wherein the books are initially disposed vertically in end alignment generally parallel to said path of travel, and wherein the books are disposed in said first lateral positions by tipping alternate books in opposite directions about their lower edges as they travel longitudinally along said path.

4. A method of stacking books as defined in claim **1** wherein both sets of books are progressively moved laterally inwardly toward the center line of said path as the books travel longitudinally.

5. A method of stacking books as defined in claim **1** wherein alternate books are tipped in opposite directions from their initial vertical positions by thrusting a laterally moving member against the opposite sides of the upper portion of successive books as the books travel therepast.

6. A method of stacking books as defined in claim **1** wherein the books have back covers and caseboards connected by spine joints to the back covers, the books in said first lateral positions thereof have the spine joints of alternate books disposed laterally outwardly, and wherein the outer free edges of the caseboards of each book in said second lateral position thereof falls somewhat short of overlying the spine joints of each other book in the stack.

7. A method of stacking books as defined in claim **1** wherein the books in their initial vertical position have their back covers disposed uppermost.

8. A method of stacking books as defined in claim **1** comprising stopping the forward travel of books in their second lateral position, and sequentially adding them to the top of said stack by dropping them onto the stack after their forward travel has been stopped.

9. A method of stacking books as defined in claim **1** comprising retaining the bottom book of the stack at a first, upper fixed level while continuing to pile books on top of such stack, and subsequently progressively lowering the bottom of the stack while piling additional books on the top of the stack.

10. A method of stacking books as defined in claim **1** comprising terminating the lowering of the bottom book in the stack at a second, lower fixed level, and pressing the opposite sides of the thus lowered stack laterally inwardly toward each other to a point at which the alternate books lie in third lateral positions in which the alternate books in one set thereof are slightly offset laterally from the books in the other set thereof.

11. A method of stacking books as defined in claim **1** wherein the books have back covers and caseboards connected by spine joints to the back covers, the back covers of the books in both sets of alternate books lie laterally outwardly of the free edges of the caseboards of the contiguous books in the stack, and comprising terminating the lowering of the bottom book in the stack at a second, lower fixed level, and thereafter pressing the backs of the books on opposite sides of the thus lowered stack laterally inwardly toward each other to a point at which the outer free edges of the caseboards of each book fall slightly short of overlying the spine joints of each contiguous book in the stack.

12. A method of stacking books as defined in claim **1** wherein the books are continuously fed forwardly until stopped to be dropped onto the top of the first recited stack, retaining the bottom book of the first stack at a first, upper fixed level by at least one separator blade while continuing to pile books on the top of the first stack and while lowering a previously formed second stack of books disposed below the first stack on an elevator located below the separator blade to a lowered

position wherein the lowest book of the second stack lies at a second, lower fixed level, discharging the thus lowered second stack of books from beneath the first stack, thereafter raising the elevator to a position close to and below the separator blade, retracting the separator blade to transfer the first stack of books to the elevator where they form the lower portion of a subsequent second stack, continuing to collect books as delivered on the top of the second stack, and after a predetermined desired number of books have been piled on the second stack advancing the separator blade so that subsequent books are supported on the separator blade and form a subsequent first stack.

13. A method of stacking books as defined in claim **12** comprising moving the books in the second stack endwise against stop means so as to end align the books in the second stack in a longitudinal direction.

14. A method of stacking books as defined in claim **13** wherein the end alignment of the books in the second stack takes place as the second stack is being moved to its lowered position.

15. A method of stacking books as defined in claim **12** comprising pressing the opposed side edges of the books in the second stack laterally inwardly toward each other to a point at which the alternate books lie in third lateral positions in which the alternate books in one set thereof are slightly offset laterally outwardly from the books in the other set thereof, so as to align the laterally outer edges of the books in the respective sets thereof.

16. A method of stacking books as defined in claim **15** wherein the edge alignment of the sets of books in the second stack takes place as the second stack is being moved to its lowered position.

17. A method of stacking books as defined in claim **16** comprising end aligning the books in said second stack while such second stack is moving to its lowered position by pressing the forward edges of the books against retractable stop means.

18. A method of stacking books as defined in claim **17** wherein the end alignment of the books and the edge alignment of the sets of books take place in quick succession.

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