

[54] APPARATUS FOR PILING UP SHEETS

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[51] Int. Cl. B65h 31/00

[58] Field of Search 271/68, 86

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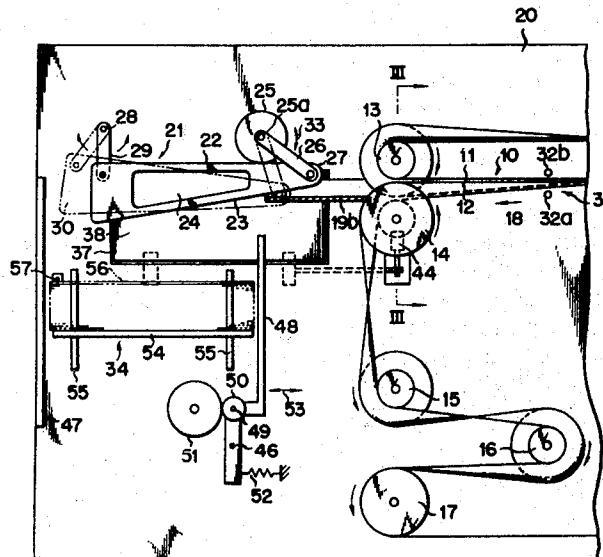
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Attorney—Robert D. Flynn, Leonard Holtz et al.

[57] ABSTRACT

In apparatus for piling up sheets such as post cards, paper monies or the like of the type comprising a conveyor for successively conveying a number of sheets, horizontal guide means for successively guiding the sheets discharged from the discharge end of the conveyor in a direction substantially in alignment with the conveyor and for forcing the sheets downwardly, and a sheet receiver located below the horizontal guide means for successively piling up the sheets therein, there is provided bending means close to the discharge end of the conveyor for bending the sheets in a direction perpendicular to the direction of movement thereof.

30 Claims, 9 Drawing Figures



F I G. 2

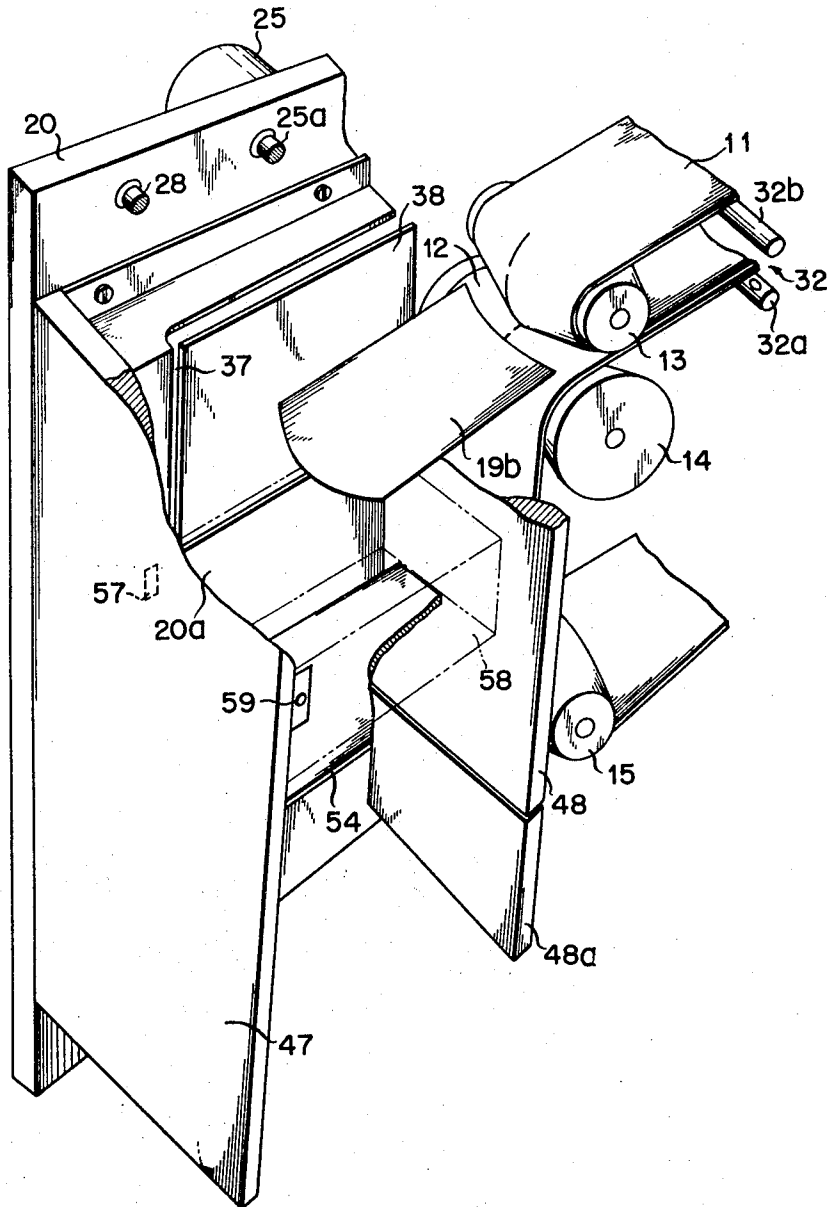


FIG. 5

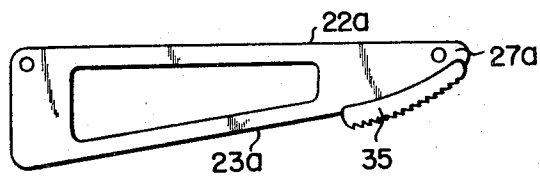


FIG. 6

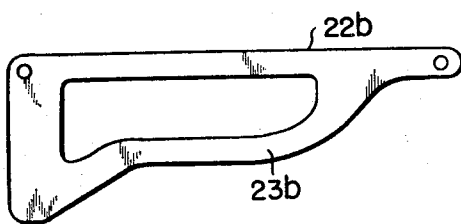
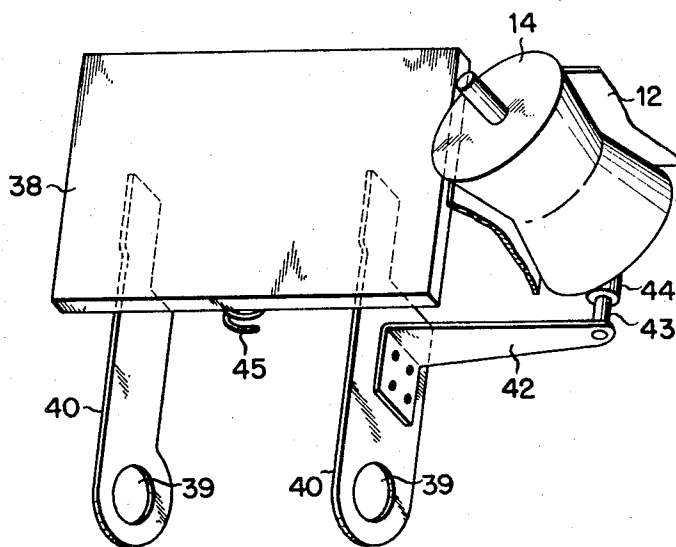
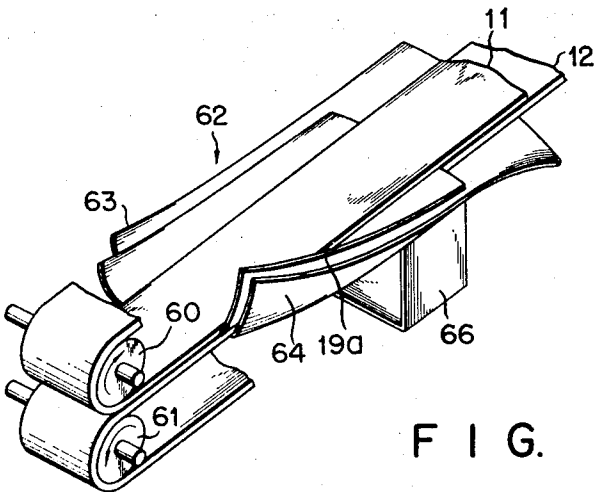
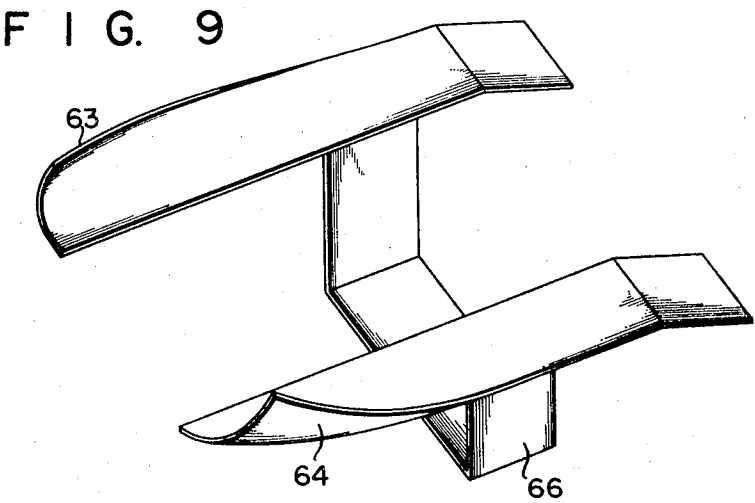


FIG. 7





APPARATUS FOR PILING UP SHEETS

This invention relates to apparatus for piling up sheets of a definite configuration in a predetermined position which are conveyed intermittently, and more particularly to apparatus for neatly piling up sheets having a tendency to fold back upon themselves.

Many types of classification and detecting apparatus have been developed wherein a plurality of relatively thin and pliable sheets such as slips, paper monies, post cards, checks, stock-certificates and the like (for brevity, hereinafter merely called sheet or sheets) are successively conveyed, and the sheets are classified, counted or checked whether they are genuine or not. Thereafter the sheets are piled up or collected at predetermined positions or in suitable receiver. Since these sheets are classified or checked while they are conveyed at a high speed, they are discharged from the end of the conveyor also at a high speed.

Where the sheets are very thin, or where the paper monies have been used long time and hence have been folded many times, they tend to bend to fold upon themselves as soon as they are discharged from the conveyor. This tendency is accelerated when the sheets collide upon the wall of the receiver. Accordingly, it is very difficult to neatly pile up the sheets in the receiver.

Although this difficulty can be overcome by decreasing the conveyor speed, this measure alone can not solve the problem. Rather the efficiency of counting or checking is decreased.

It is an object of this invention to provide improved apparatus which can successively convey thin sheets at a high speed and can pile up the sheets while preventing their tendency of folding back upon themselves.

Another object of this invention is to provide improved apparatus for piling up a number of sheets with their side edges and ends neatly aligned in the vertical direction.

Still another object of this invention is to provide an improved apparatus for piling up a number of sheets including guide means for guiding the sheets discharged from a conveyor generally along the passage thereof and at the same time braking and forcing the sheets downwardly into a receiver located beneath the guide means.

SUMMARY OF THE INVENTION

According to the invention, in apparatus for piling up sheets of the type comprising a conveyor for successively conveying a number of sheets, horizontal guide means for successively guiding the sheets discharged from the discharge end of the conveyor in a direction substantially in alignment with the conveyor and for forcing the sheets downwardly, and a sheet receiver located below the horizontal guide means for successively piling up the sheets in the sheet receiver, there is provided bending means close to the discharge end of the conveyor for bending upwardly the sheets in a direction perpendicular to the direction of movement thereof.

Bending of the sheets may be accomplished by the guide rollers of the conveyor belts or another means independent of such rollers. When bent in the transverse direction sheets of thin gauge or having a tendency to fold back upon themselves are reinforced so that it is possible to neatly pile up them in the receiver. Braking means may be provided for the horizontal guide means

for decelerating the sheets supplied thereto at a high speed thereby enabling to neatly pile up the sheets in the receiver. If desired, vibrations may be applied to the side edges and/or one end of the sheets to align them in the vertical direction. Further, means for maintaining the level of the piled up sheets at a predetermined value may be provided.

The present invention can be more fully understood from the following detailed description when taken in connection with the accompanying drawings, in which:

FIG. 1 is a diagrammatic side view of one embodiment of this invention;

FIG. 2 is a perspective view of a modification of the embodiment shown in FIG. 1;

FIG. 3 shows a section of bending rollers taken along a line III — III in FIG. 1;

FIG. 4 is a perspective view showing the manner of bending a sheet;

FIG. 5 is an elevational view of a modification of the horizontal guide member shown in FIG. 1;

FIG. 6 is a similar view of another modification of the horizontal guide member;

FIG. 7 is a perspective view showing the relationship between a vibrating plate for vertically aligning the ends of the sheets lying in parallel with the direction of conveyance and the vibrating device; and

FIGS. 8 and 9 show another example of the bending device.

The preferred embodiment of this invention shown in FIG. 1 comprises a conveyor 10 including a first belt 11 and a second belt 12. First belt 11 is driven by a convex guide roller 13 (shown in FIG. 2) rotated in the direction of an arrow whereas second belt 12 is driven by a concave guide roller 14 rotated in the opposite direction to the direction in which the roller 13 is rotated. The second belt 12 further passes around other convex guide rollers 15 and 16 and a cylindrical roller 17 whereby the belt 12 is prevented from disengaging concave roller 14. Individual sheets are clamped between belts 11 and 12 and are successively conveyed in the direction of arrow 18 to be discharged toward left as viewed in FIG. 1 at the discharge end of the conveyor at a given speed.

As shown in FIG. 4, the sheet 19a being conveyed has an initial flat and rectangular configuration. However, when the sheet passes through a bending device constituted by a pair of rollers 13 and 14 and conveyor belts 11 and 12 sandwiched therebetween it is bent upwardly in a direction perpendicular to the direction of movement thereof, thus the sheet being reinforced in the direction of movement. Belts 11 and 12 are made of expandable material and pass about rollers (not shown) positioned on the right hand side of FIG. 1, thus forming endless belts. Rollers 11 and 12 are rotatably supported by vertical side plates 20. Before reaching the discharge end (left hand end), the sheet 19a has already been counted or checked whether it is genuine or not, in a manner well known in the art.

There is provided a horizontal guide device 21 for the discharged sheet 19b including a horizontal guide member 22 disposed substantially along the path of movement of the discharged sheet 19b. The guide member 22 is mounted such that the right hand end, or the end close to the discharge end, of its lower inclined edge 23 is positioned above its left hand end, or the end remote from the discharge end. Further, the guide member 22 is provided with a relatively large window

24 for the purpose of decreasing its weight to minimize its moment of inertia. Accordingly, the movement of the discharged sheet is decelerated when its leading edge engages the lower edge 23. Mounted on the side plate 20 is a rotary member or a rotary solenoid 25. One end of the first link 26 is connected to the shaft 25a of rotary solenoid 25 while the opposite end is pivotally connected to one end 27 of guide member 22 such that it can rotate through a predetermined angle less than one complete revolution. One end of the second link 29 is pivotally connected to the side plate 20 by means of a pin 28, whereas the opposite end is pivotally connected to the rear end 30 of guide member 22.

A detector 32 comprising a source of light 32a and a photoelectric converting element 32b is associated with the conveyor 10 for generating an electrical signal in response to the leading edge of the sheet when it passes through detector 3. After being delayed a predetermined time if desired, this signal is applied to rotary solenoid 25. Accordingly, the shaft 25a of the rotary solenoid 25 is rotated in the direction of a double headed arrow 33 in synchronism with the position of each sheet. As the link 26 is rotated in the clockwise direction, the discharged sheet 19b is guided to the left but depressed downwardly whereby the horizontal movement of the sheet is braked. As a result, the sheet falls down and collected or piled up in a receiver 34 to be described later in more detail. The length of the first link 26 which is driven by the rotary solenoid is made longer than the second link 29 so that the leading end 27 of guide member 22 is caused to move downwardly over a distance larger than that of the trailing end 30. Consequently, the discharged sheet is depressed strongly at its trailing end (the end close to the discharge end of the conveyor 10). Thus, the sheet is decelerated and is extended by the movement of inertia of its leading end, thus decreasing its tendency of folding back. The displaced position of the guide member 22 is shown by dotted lines. In response to the signal generated by the detector 32, the rotary solenoid 25 quickly rotates the shaft 25a to displace the first link 26 clockwise, thus causing the sheet to be decelerated by the guide member 22 fall in the receiver. The sheets are aligned in the vertical direction by the action of side plates 20. For this reason, it is possible to neatly pile up the sheets in receiver 34 without the necessity of utilizing a vibrating plate 38 to be described later.

In order to apply a greater braking force to the trailing end of the sheet it is advantageous to provide a braking member 35 along the lower edge 23a at the front edge of the guide member 22a as shown in FIG. 5. The braking member 35 is made of a substance having a large coefficient of friction such as rubber. The rubber surface may have a lot of projected portions as shown. In order to prevent the leading edge of the discharge sheet 19b from colliding against braking member 35, the timing of the operation of guide member 22a, that is the timing of the downward movement of the front end 27a is adjusted by properly selecting the delay time of the signal generated by detector 32. The guide edge 23 of guide member 22 is not always required to be straight but may be curved as 23b, in a modified guide member 22b shown in FIG. 6. The edge 23b is shaped such that the edge gradually depresses the sheet when it comes to engage guide member 22b but depresses rapidly the sheet as it moves to the left.

In order to neatly align the side edges of the sheets in the vertical direction it is possible to use vertical guide means comprising a vibrating plate 38 which is received in a recess 37 in the side plate 20, and a vibrator to impart a small vibration to vibrating plate 38 in a direction perpendicular to the movement of the sheets. As shown in FIG. 7, the vibrator comprises a pair of spaced apart arms 40 secured to the rear side of vibrating plate 38 for vibrating the same about a stationary shaft (not shown) extending through openings 39 of arms 40, a lever 42 secured to one arm 40, a shaft 43 secured to the outer end of lever 42 and an eccentric roller 44 rotatably mounted on shaft 43. The eccentric roller 44 is resiliently urged against the end surface of concave roller 14 by means of a spring 45 acting on the rear surface of the vibrating plate 38, whereby the eccentric roller 44 is rotated by the rotation of concave roller 14. Accordingly, the vibrating plate 38 is imparted with a vibration of small amplitude in the direction perpendicular to the movement of the sheets so that the side edges of the falling sheets are aligned in the vertical direction.

Further, a vertical guide device may be used for aligning the trailing and leading of the sheets in the vertical direction. This guide device comprises a vertical wall 47 secured to the left hand end (as viewed in FIG. 1) of side plates 20 and constituting a portion of receiver 34 together with side plates 20, a vertical vibrating plate 48, spaced apart from wall 47 a distance a little larger than the length of the sheets and rotatably mounted upon shaft 46 normal to side plates 20, a roller 50 mounted on a stub shaft 49 secured to vibrating plate 48, an eccentric roller 51 supported by side plates 20 to cooperate with roller 50, and a spring 52 for urging roller 50 into engagement with eccentric roller 51. When eccentric roller 51 is driven by a source of drive (not shown) the vibrating plate 48 is vibrated with a small amplitude in the direction indicated by arrow 53 thus aligning the trailing ends of the sheets in the vertical direction. Receiver 34 further includes a horizontal bottom plate 54 for supporting the sheets. The bottom plate is moved in the vertical direction along vertical guide slots 55 by means of a level control device, not shown, so that the level of the piled up sheets is maintained always at a predetermined level. The control device comprises a level detector including a source of light 59 (see FIG. 2) and a photoelectric converting element 57 and an electric motor (not shown) controlled by the level detector for driving bottom plate 54. A predetermined number of sheets are removed from receiver and are then bound into a bundle for further processing.

The operation of the apparatus shown in FIG. 1 can be more fully understood by referring to FIG. 2. The apparatus shown in FIG. 2 is generally identical to that shown in FIG. 1 except that an auxiliary side plate 20a having an operating surface flush with the vibrating plate 48 is secured to one side of plate 20, that a vertical wall 48a is secured to the auxiliary side plate 20a in parallel with vertical wall 47 and in vertical alignment with vibrating plate 48 and that the vibrating device for vibrating plate 48 including elements corresponding to eccentric roller 51 and roller 50 is mounted on the rear side of auxiliary side plate 20a.

In case when the width of the sheets is substantially larger than the width of belts 11 and 12 it is advantageous to use a modified bending device 62 shown in

FIG. 8. Rollers 60 and 61 corresponding to convex roller 13 and concave roller 14, respectively, of FIG. 1 are cylindrical rollers. In this case, rollers 15 and 16 shown in FIG. 1 may be omitted. The opposite side edges of the sheets are bent up by curved guide members 63 and 64 positioned on the opposite sides of conveyor belt 12 and are interconnected by a yoke 66, as shown in FIG. 9. The curvature of the guide members 63 and 64 are increased toward the discharge end of the conveyor 10 so that the cross section of the assembly including guide members 63 and 64 and belt 12 resembles that of a boat. Accordingly, the sheets are bent and reinforced to prevent the tendency of folding back.

What we claim is:

1. Apparatus for piling up sheets comprising:
a conveyor for successively conveying a number of sheets,
bending means located close to the discharge end of said conveyor for bending said sheets upwardly in a direction substantially perpendicular to the direction of movement thereof, said bending means including a convex roller and a concave roller cooperating with said convex roller for bending the sheets therebetween,
horizontal guide means for successively guiding the sheets discharged from said discharge end of said conveyor in a direction substantially in alignment with said conveyor and forcing said sheets downwardly, and
a sheet receiver located below said horizontal guide means for successively piling up said sheets therein.
2. An apparatus according to claim 1 wherein said conveyor includes first and second conveyor belts adapted to clamp said sheets therebetween, said first conveyor belt passing around said convex roller and said second conveyor belt passing around said concave roller.
3. An apparatus according to claim 2 wherein said bending means further comprises a second convex roller positioned close to said concave roller for preventing said second conveyor belt from disengaging from said concave roller.
4. An apparatus according to claim 2 wherein said conveyor belts have a width smaller than the width of said sheets so that the sheets are conveyed with their side edges projected beyond the side edges of said belts, and wherein the curvatures of said rollers gradually increases toward the discharge end of said conveyor, thus bending said sheets in the form of a cross-section of a boat.
5. An apparatus according to claim 1 wherein said horizontal guide means includes a guide member having a lower edge which is inclined downwardly in the direction of movement of the sheets discharged from said conveyor to thereby brake the sheets and urge them downwardly.
6. An apparatus according to claim 1 wherein said horizontal guide means includes a guide member having a lower edge shaped to receive and guide in the horizontal direction the sheets discharged from said conveyor and wherein said apparatus further comprises means located in the passage of said conveyor for producing a signal in response to the sheet conveyed by said conveyor, and means responsive to said signal for driving downwardly said guide member thus forcing downwardly the sheet to be guided by said guide member.

7. An apparatus according to claim 6 wherein said guide member is extending in the direction of movement of said sheets and said second mentioned means comprises a rotary member and a link connecting said rotary member to the end of said guide member close to the discharge end of aid conveyor.

8. An apparatus according to claim 7 wherein said first link is longer than said second link so that said one end of said guide member is moved downwardly with a larger stroke than said opposite end.

9. An apparatus according to claim 6 wherein said second mentioned means comprises a rotary member, one end of said guide member close to the discharge end of said conveyor is connected to said rotary member through a first link and the opposite end of said guide member remote from said discharge end is pivotally mounted on a stationary member through a second link.

10. An apparatus according to claim 6 wherein said rotary member is a rotary solenoid which is rotated in response to said signal generated by said first mentioned means.

11. An apparatus according to claim 6 wherein said one end of said guide member close to the discharge end of said conveyor is provided with a braking member for decelerating said sheets.

12. An apparatus according to claim 1 wherein said receiver comprises a first vertical vibrating plate for aligning in the vertical direction the side edges of said sheets.

13. An apparatus according to claim 12 wherein said first vertical vibrating plate is vibrated in a direction perpendicular to the direction of movement of said sheets by means of an eccentric roller driven by a roller of said conveyor.

14. An apparatus according to claim 1 wherein said receiver comprises a second vertical vibrating plate for aligning in the vertical direction one end of said sheets.

15. An apparatus according to claim 14 wherein said second vertical vibrating plate is positioned at one end of the sheets piled up in said receiver and is vibrated in the direction of movement of said sheets by means of rotary cam means.

16. An apparatus according to claim 1 wherein said receiver includes a movable bottom plate and means responsive to the level of the sheets piled up on said bottom plate for controlling said movable plate so as to maintain the level of said piled sheets at a predetermined value.

17. Apparatus for piling up sheets comprising:
a conveyor for successively conveying a number of sheets,

bending means located close to the discharge end of said conveyor for bending said sheets upwardly in a direction substantially perpendicular to the direction of movement thereof,

horizontal guide means for successively guiding the sheets discharged from said discharge end of said conveyor in a direction substantially in alignment with said conveyor and forcing said sheets downwardly, and

a sheet receiver located below said horizontal guide means for successively piling up said sheets therein, said horizontal guide means including a guide member having a lower edge shaped to receive and guide in the horizontal direction the sheets discharged from said conveyor, first means located in

the passage of said conveyor for producing a signal in response to the sheets conveyed by said conveyor and second means responsive to said signal for driving downwardly said guide member to force downwardly the sheets to be guided by said guide member.

18. An apparatus according to claim 17 wherein said guide member is extending in the direction of movement of said sheets and said second mentioned means comprises a rotary member and a link connecting said rotary member to the end of said guide member close to the discharge end of said conveyor.

19. An apparatus according to claim 17 wherein said second mentioned means comprises a rotary member, one end of said guide member close to the discharge end of said conveyor is connected to said rotary member through a first link and the opposite end of said guide member remote from said discharge end is pivotally mounted on a stationary member through a second link.

20. An apparatus according to claim 19 wherein said first link is longer than said second link so that said one end of said guide member is moved downwardly with a larger stroke than said opposite end.

21. An apparatus according to claim 17 wherein said rotary member is a rotary solenoid which is rotated in response to said signal generated by said first mentioned means.

22. An apparatus according to claim 17 wherein said one end of said guide member close to the discharge end of said conveyor is provided with a braking member for decelerating said sheets.

23. An apparatus according to claim 17 wherein said receiver comprises a first vertical vibrating plate for aligning in the vertical direction the side edges of said sheets.

24. An apparatus according to claim 23 wherein said first vertical vibrating plate is vibrated in a direction

perpendicular to the direction of movement of said sheets by means of an eccentric roller driven by a roller of said conveyor.

25. An apparatus according to claim 17 wherein said receiver comprises a second vertical vibrating plate for aligning in the vertical direction one end of said sheets.

26. An apparatus according to claim 25 wherein said second vertical vibrating plate is positioned at one end of the sheets piled up in said receiver and is vibrated in the direction of movement of said sheets by means of rotary cam means.

27. An apparatus according to claim 17 wherein said receiver includes a movable bottom plate and means responsive to the level of the sheets piled up on said bottom plate for controlling said movable plate so as to maintain the level of said piled up sheets at a predetermined value.

28. An apparatus according to claim 17 wherein said conveyor includes first and second conveyor belts adapted to clamp said sheets therebetween and said bending means comprises a convex roller around which said first belt passes and a concave roller cooperating with said convex roller, said second conveyor belt passing around said concave roller.

29. An apparatus according to claim 28 wherein said bending means further comprises a second convex roller positioned close to said concave roller for preventing said second conveyor belt from disengaging from said concave roller.

30. An apparatus according to claim 28 wherein said conveyor belts have a width smaller than the width of said sheets so that the sheets are conveyed with their side edges projected beyond the side edges of said belts, and wherein the curvatures of said rollers gradually increases toward the discharge end of said conveyor, thus bending said sheets in the form of a cross-section of a boat.

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