

[72]	Inventors	Roderick L. Brenneman Corvallis; Daniel M. McLean, Independence, both of Oreg.
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[73]	Assignee	Georgia-Pacific Corporation Portland, Oreg.

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Primary Examiner—Carl D. Quarforth

Assistant Examiner—Gary G. Solyst

Attorney—Eugene D. Farley

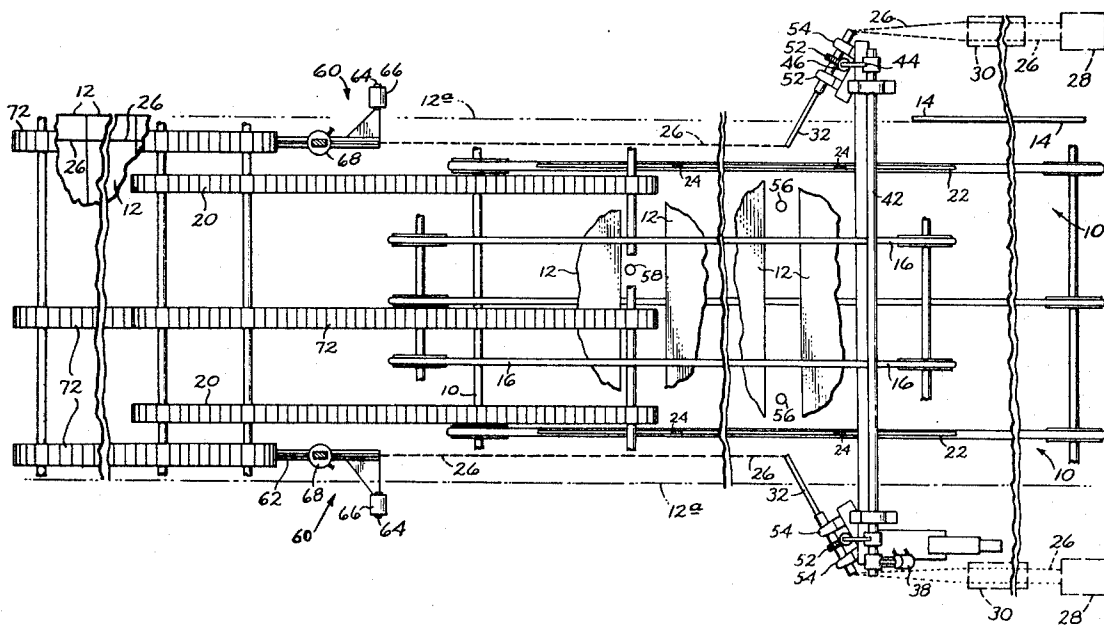
**[54] APPARATUS FOR FASTENING SLATS
TOGETHER EDGE-TO-EDGE
8 Claims, 3 Drawing Figs.**

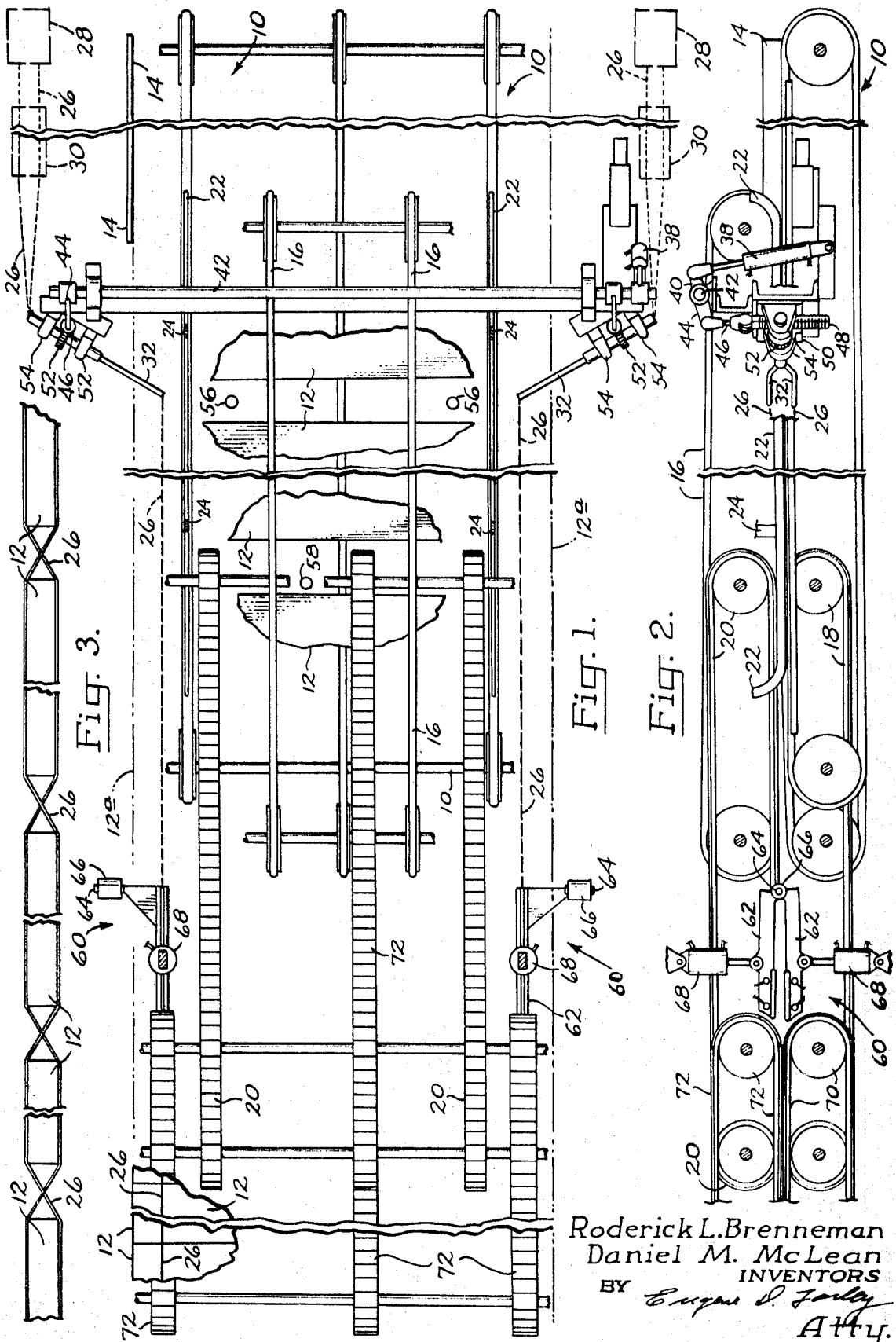
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ABSTRACT: Substantially rectangular sheets are fastened together edge-to-edge by arranging the sheets in spaced relation, arranging a pair of continuous strings, one above and one below the sheets, traversing the strings and the spaced sheets relative to each other, crisscrossing the strings sequentially at each between-sheet space, crowding the sheets together edgewise, and fastening the crisscrossed strings to the sheets, thereby fastening the sheets together in a continuous strip.





Roderick L. Brenneman
 Daniel M. McLean
 INVENTORS
 BY *Eugene D. Jolley*
 ATT'Y.

APPARATUS FOR FASTENING SLATS TOGETHER EDGE-TO-EDGE

This invention relates to an apparatus for fastening together substantially rectangular sheets in edge-to-edge relation. It pertains particularly to method and apparatus for fastening together random width plywood veneers in edge-to-edge relation to form a continuous strip of veneer composited from the individual sheets, which strip may be clipped into plywood sheet size and used to advantage in the manufacture of plywood panels.

In the conventional procedure for manufacturing plywood, full-sized back veneers are conveyed to an assembly station at which glue-coated pieces of core veneer of random width are laid across them, edge-to-edge, in number sufficient to composite a core layer. A face veneer then is superimposed upon the partially completed assembly. This procedure is repeated until a final assembly of the desired number of laminae has been composited. The assembly then is transferred to the press and consolidated to set the glue and form the plywood panel.

Compositing the core layer in the manner described above has two principal disadvantages. First it is time-consuming and laborious, reducing the output of the plywood line increasing the cost of the finished product.

Second, even though the small pieces of veneer from which the core layer is composited are clipped, edge irregularities occasionally are present. In addition, the workmen laying up the core work at high speed and occasionally do not abut the side edges of the veneer pieces with the precision required to form a continuous core layer. Either contingency results in the production of voids in the finished plywood panel. These in turn constitute an imperfection which degrades the product.

Various expedients heretofore have been employed to overcome this problem.

The core veneer pieces have been edge glued to form a full-size core which then is handled as a unit. This method requires special, expensive apparatus, is essentially a piece work operation and adds materially to the cost of the product.

Also, the core veneer pieces have been composited into a full-size core by laying them edge-to-edge and fastening them together on one side with adhesive-impregnated string. However, since the string is applied to one side only, flexing of the resulting panel pops off the string and disintegrates the panel.

It is the object of the present invention to provide an apparatus for fastening together sheet material edge-to-edge, particularly wood veneers edge-to-edge, by a procedure which is rapid, economical, adaptable to inclusion in the conventional plywood line and which leads to the formation of a composite product, the component sheets of which are firmly secured together so that they may be handled safely and fabricated into full-sized panels without disintegrating during the manufacturing processes employed.

The manner in which the foregoing and other objects of this invention are accomplished will be evident from a consideration of the accompanying specification and claims, in the light of the illustrative drawings, wherein:

FIG. 1 is a somewhat schematic plan view of apparatus for fastening together sheets in edge-to-edge relation by the present invention;

FIG. 2 is a view in side elevation of the apparatus of FIG. 1; and

FIG. 3 is a schematic view of a series of the sheets in an intermediate stage of the method.

Generally stated, the herein described apparatus for fastening together sheets in edge-to-edge relation comprises the following steps:

1. Arranging substantially rectangular sheets side-by-side, spaced laterally from each other with their adjacent side edges substantially parallel;
2. Arranging a pair of continuous strings, one above and one below the sheets substantially normal to the side edges of the sheets a spaced distance inwardly from the end edges thereof;
3. Traversing the strings and the spaced sheets relative to each other.

4. Crisscrossing the strings sequentially at each between-sheet space.

5. Thereafter crowding the leading edge of each trailing sheet against the trailing edge of the adjacent leading sheet to form a continuous composite sheet; and

6. Securing the strings to the sheets to maintain them in their closely juxtaposed position.

Considering the foregoing in greater detail and with particular reference to the drawings:

- 10 As illustrated in FIGS. 1 and 2, the apparatus employed in executing the herein described method includes a traveling conveyor 10, the working stretch of which is driven to the left as viewed in the drawings. This conveyor may be long, e.g. 80 feet or more in length in a plywood installation. A layup station is located beside the conveyor. At this station small sheets of rectangular material such as plywood veneers 12 of random width, are placed side-by-side on the conveyor with their adjacent side edges substantially parallel and with the sheets spaced laterally from each other a predetermined minimum distance. A backstop 14 assists the operator in laying the sheets along a uniform line indicated at 12a in FIG. 1.

- Cooperating with conveyor 10 are holddown belts 16. These hold down the sheet material, which may have a tendency to bow. The downstream ends of the two conveyors converge slightly, as is apparent in FIG. 2. This assists in delivering the veneers to the crowding conveyors which work immediately downstream.

- The latter conveyors comprise lower endless chain assemblies 18 and cooperating upper endless chain assemblies 20. The claims employed are conventional in character and belong to the class comprising flat links which bear firmly against the faces of the sheets, holding them securely and preventing them from slipping.

- Motor means, not illustrated, are provided for driving conveyor pairs 10, 16 continuously at a predetermined rate, and crowder chain pairs 18, 20 intermittently at the desired rate. Holddown shoes 22 supported on frame member 24, assist in holding down the veneers and maintaining them properly spaced at the critical interval of transfer from conveyors pairs 10, 16 to crowder chains 18, 20.

- It is during this interval of transfer that the strings, tapes, or other flexible members employed for fastening the sheets together are applied.

- Such strings are indicated at 26. They are laid continuously on both faces of the sheets substantially normal to the side edges thereof and at a spaced distance inwardly from the end edges thereof. The mechanism by which the strings are applied also is illustrated in FIGS. 1 and 2.

- The strings are supplied from a tensioning reel indicated schematically at 28. They pass in pairs through an impregnating vat 30 containing a heat-alterable glue, i.e. one which may be caused to harden or soften by the application of heat. If the former, as in the case of a thermosetting resinous adhesive, the glue is applied in liquid form and subsequently set by the application of heat. If the latter, as in the case of a thermoplastic adhesive, the glue is applied and spread while hot and molten, after which it hardens upon cooling.

- In either case, the liquid glue is contained in vats 30. It is absorbed into strings 26 as the latter pass through the vats. The glue-impregnated strings then are transferred to the apparatus which weaves them around sheets 12.

- A key element of the weaving apparatus comprises a unique, bifurcated string guide 32 comprising a pair of hollow arms communicating with a hollow stem, all dimensioned to receive and guide the strings which pass together through the stem, separate, and come separately one out of each of the arms.

- String guide 32 is maintained in an angular position in which its arms overlie the margin of the line of sheets 12a, projecting inwardly a predetermined distance. The angular position of the guide is correlated with the spacing between the sheets so that as the sheets pass between the arms, the arms are free to rotate 180° in the spaces between the sheets.

Such rotation is accomplished by a suitable drive. That illustrated in the drawings comprises a fluid-operated cylinder, preferably a double acting pneumatic cylinder 38. The piston rod of the cylinder is coupled pivotally to a lever 40. The latter is fixed to a rock shaft 42 to which also is affixed one or a pair of levers 44. The latter are diametrically opposed to lever 40.

Levers 44 pivotally are coupled to a connecting shaft 46, one end of which pivotally is coupled to a vertically arranged rack 48. Rack 48 works in a guideway 50.

A cooperating pinion gear 52 is keyed to the stem of string guide 32. The stem is journaled in bearings 54.

Suitable control means energize cylinder 38 when string guides 32 are positioned in the spaces between adjacent ones of the sheets.

Such means comprise a pair of photoelectric cells 56 which are in an electric circuit with a solenoid valve controlling the operation of double acting cylinder 38. The photoelectric cells preferably are arranged in alignment with string guides 32. There are two such cells in series with each other to insure that the apparatus does not work in the event that one or the other of the adjacent sheets is askew, or improperly spaced.

When string guides 32 are located in a gap between adjacent sheets, the circuit through the photoelectric cells is completed, double acting cylinder 38 is energized and the string guides rotate through 180°. This crisscrosses the strings in the manner illustrated in FIG. 3 so that the strings are woven about the sheets and hold them together.

Cooperating with the string-applying apparatus is apparatus for crowding the adjacent edges of the sheets together so that they lie in closely edge-abutting relation. This is desired, for example, in the compositing of a unitized core veneer.

The crowding apparatus comprises conveyor belts 10, 16 and flat crowder chains 18, 20 above described, coupled with a suitable drive control.

A photoelectric cell 58 again is a key component of this control. The cell is located in the line between shafts 18, 20 in the plane of the axes thereof. It is in an electric circuit with the drive for the chains and is operative to start and stop them.

Thus when the light beam of the cells is intercepted by one of the sheets 12, the drive of the chain is energized. This conveys the sheet in the outfeed direction. However, as soon as the sheet clears the cells, the chain drive stops.

In the meantime, the drive of conveyor belts 10, 16 continues. This moves next adjacent sheet 12 in the direction of the sheet immediately ahead. As soon as the gap between the sheets has closed, the light beam is interrupted and the chain drive again energized. This sequence is repeated over and over with the result that all of sheets 12 are crowded closely together in the desired position.

During the crowding operation, strings 26 remain under the tension applied by the tensioning device 28. Accordingly, any slack resulting from the crowding is taken up, since the adhesive on the strings has not yet set.

The next step in the sequence is to set the adhesive and fix the sheets in their edge-to-edge position.

If a thermoalterable adhesive has been employed to impregnate the strings, it is set or spread by the application of heat through the agency of cooperating pairs of heated presses, indicated generally at 60. Each comprises an electrically heated, elongated pressing element 62 arranged in the feed direction and pivoted on a sort shaft 64 journaled in a bearing 66. Each also is actuated by means of a double-acting, fluid-operated cylinder, preferably an air cylinder 68. The case of cylinder 68 is pivoted to a frame member; its piston rod, to heating element 62 intermediate its ends.

Precautions are taken to insure that during the intermittent operation of crowder chains 18, 20, heating elements 62 are removed from contact with the strings whenever the chains stop. This prevents overheating and burning of the strings.

To this end cylinders 68 are controlled by the action of an electrically operated pneumatic valve, the setting of which is controlled by electric eye 58. These two elements are in an electric circuit with each other and arranged in such a manner

that when electric eye 58 closes the circuit, energizing the drive of crowder chains 18, 20, it closes at the same time a circuit to the solenoid valve which adjusts cylinders 68 to the closed positions of heating elements 62. However, when the beam of electric eye 58 is interrupted, the reverse situation occurs and the cylinders withdraw the heating elements when forward drive of the crowding chains is arrested.

Downstream from heating units 60 are pressing means for pressing the heated strings into the sheets upon which they have been laid. Such means comprise cooperating endless chains 70, 72. Pressing chains 70, 72 include flat links which contact the sheets positively. As a consequence they flatten the strings, insure that the strings contact the sheet surfaces uniformly, and further assist in the setting of the adhesive with which the heated strings are impregnated.

OPERATION

To review the operation of the herein described apparatus:

Plywood core veneers or other sheets are placed on infeed conveyor 10, side-by-side, spaced laterally from each other, and with their adjacent side edges substantially parallel.

The sheets are conveyed to the left as viewed in FIGS. 1 and 2 and are held down both by upper cooperating conveyor belt 16 and holddown shoes 22. As the sheets pass in sequence over electric eyes 56, the eyes energize cylinder 38 at each gap between the sheets. Through the action of rack 48, the cylinder rotates string guide 32 through 180° crisscrossing the two glue-impregnated strings passing through the guide in the manner illustrated in FIG. 3.

As the sheets pass electric eye 58, the eye energizes the drive of crowder chains 18, 20, moving the sheet toward the outfeed end of the apparatus. However, as soon as the sheet clears electric eye 58, the drive is stopped.

Conveyor chains 10, 16, which operate continuously, advance the next succeeding sheet until its leading edge is in tight abutment against the trailing edge of the stationary sheet held between the crowder chains. In this position of the two sheets, the beam of electric eye 58 again is intercepted, initiating the drive of the crowder chains.

As the unitized sheet assembly progresses further, it passes beneath heating elements 60 which are forced against the strings superimposed upon the sheets by the action of cylinder 68. This presses the strings against the sheet surfaces and spreads or sets the adhesive.

Cylinders 68 are controlled by a solenoid-operated valve which also is in a circuit with electric eye 58. It separates heating elements 62 whenever the drive of crowder chains 18, 20 stops. This prevents burning the strings.

The pressing and adhesive setting operation initiated by elements 62 is continued by pressing chains 70, 72 to which the composite sheet next is transferred.

The foregoing sequence results in the production of a continuous sheet of indefinite length. The sheet is made up of small pieces of random width held together securely, even though the sheet is flexed and distorted during subsequent processing operations.

If the sheet comprises a core veneer to be used in the fabrication of plywood, it may be clipped to plywood panel length and the resulting full-sized sheets used in laying up the assemblies to be pressed into plywood.

This eliminates the necessity of laying up a multiplicity of small veneer pieces during the operation of the plywood line, eliminates to a large extent the production of plywood panels having void defects, and makes practical the automation of the plywood layout line.

Having thus described our invention in preferred embodiment, we claim as new and desire to protect by Letters Patent:

1. Apparatus for fastening together substantially rectangular slat sheets in edge-to-edge relation, the apparatus comprising:

- a. conveyor means for conveying a plurality of sheets side-by-side, spaced laterally from each other with their adjacent side edges substantially parallel,

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- b. string guide means for guiding a pair of continuous strings, one above and one below the sheets, substantially normal to the side edges of the sheet, a spaced distance inwardly from the end edges thereof,
 - c. drive means coupled to the string guide means and operative to crisscross the strings at each between-sheet space,
 - d. crowding means for crowding the sheets together edge-to-edge, and
 - e. bonding means arranged for securing the crisscrossed strings to the sheets in their juxtaposed position.
2. The apparatus of claim 1 wherein the string guide means comprises a hollow bifurcated guide positioned for overlapping the end edges of the sheet.
3. The apparatus of claim 1 wherein the string guide means comprises a hollow bifurcated guide positioned for overlapping the end edges of the sheet and wherein the string guide means drive means comprises rack and pinion means connected to the string guide means for rotating the same.
4. The apparatus of claim 1 including means for impregnating the strings with adhesive and press means downstream from the crowding means arranged to heat and press the strings against the faces of the sheets.
5. Apparatus for fastening together substantially rectangular slat sheets in edge-to-edge relation, the apparatus comprising:
- a. conveyor means for conveying a plurality of sheets side-by-side, spaced laterally from each other with their adjacent side edges substantially parallel,
 - b. string guide means for guiding a pair of continuous strings, one above and one below the sheets, substantially normal to the side edges of the sheet, a spaced distance inwardly from the end edges thereof,
 - c. drive means coupled to the string guide means and operative to crisscross the strings at each between-sheet space,
 - d. crowding means for crowding the sheets together edge-to-edge,
 - e. securing means arranged for securing the crisscrossed strings to the sheets in their juxtaposed position,
 - f. an electric circuit including the string guide drive means, and
 - g. photoelectric cell means mounted adjacent the conveyor means and operative to energize the string guide drive means at each between-sheet space.
6. Apparatus for fastening together substantially rectangular

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- lar sheets in edge-to-edge relation, the apparatus comprising:
- a. conveyor means for conveying a plurality of sheets side-by-side, spaced laterally from each other with their adjacent side edges substantially parallel,
 - b. string guide means for guiding a pair of continuous strings, one above and one below the sheets, substantially normal to the side edges of the sheet, a spaced distance inwardly from the end edges thereof,
 - c. drive means coupled to the string guide means and operative to crisscross the strings at each between-sheet space,
 - d. crowding means for crowding the sheets together edge-to-edge,
 - e. securing means arranged for securing the crisscrossed strings to the sheets in their juxtaposed position, and
 - f. tensioning means feeding the strings through the string guide means and maintaining the strings under longitudinal tension during the sheet crowding operation.
7. Apparatus for fastening together substantially rectangular slat sheets in edge-to-edge relation, the apparatus comprising:
- a. conveyor means for conveying a plurality of sheets side-by-side, spaced laterally from each other with their adjacent side edges substantially parallel,
 - b. string guide means for guiding a pair of continuous strings, one above and one below the sheets, substantially normal to the side edges of the sheet, a spaced distance inwardly from the end edges thereof,
 - c. drive means coupled to the string guide means and operative to crisscross the strings at each between-sheet space,
 - d. crowding means for crowding the sheets together edge-to-edge, the crowding means comprising crowding endless chain means arranged to receive the sheets from the conveyor means, drive means for the crowding chain means, and control means for the crowding chain drive means, the control means being operative to energize the drive means upon close juxtaposition of the leading and trailing sheets and to arrest the drive means when the leading sheet is separated from the next succeeding sheet.
8. The apparatus of claim 7 wherein the crowding chain drive means comprises an electric motor, an electric circuit including the motor, and a photoelectric cell in the electric circuit and arranged to energize the motor when the leading and trailing sheets are juxtaposed, and to arrest it when they are separated.

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