Dec. 8, 1970 F. L. CALIFANO ET AL 3,546,045

AUTOMATIC STACKING AND TAPING MACHINE

Filed July 28, 1967 5 Sheets-Sheet 1

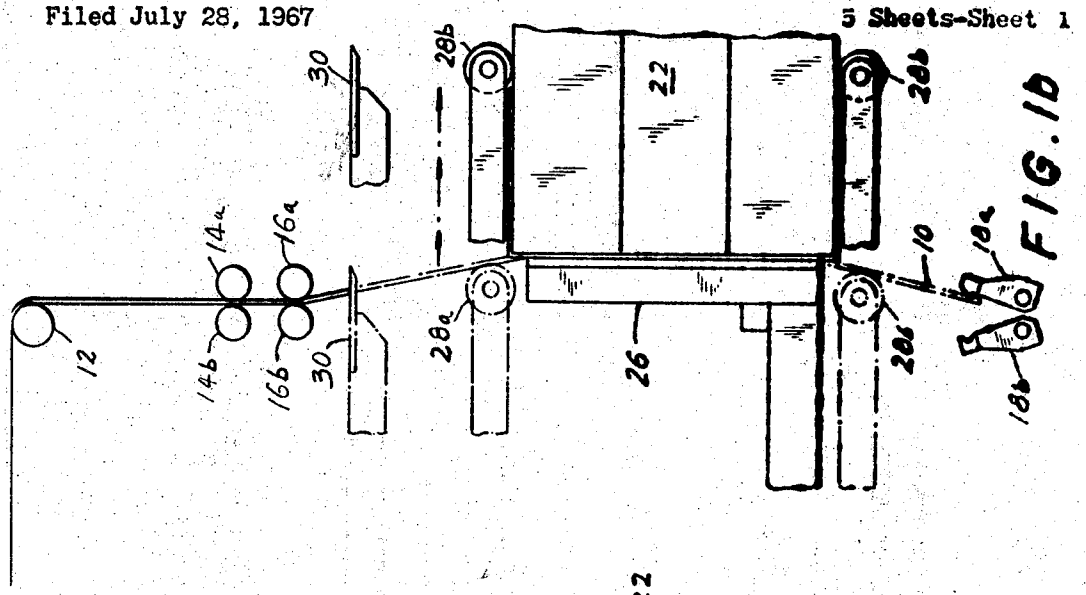


FIG. 1b

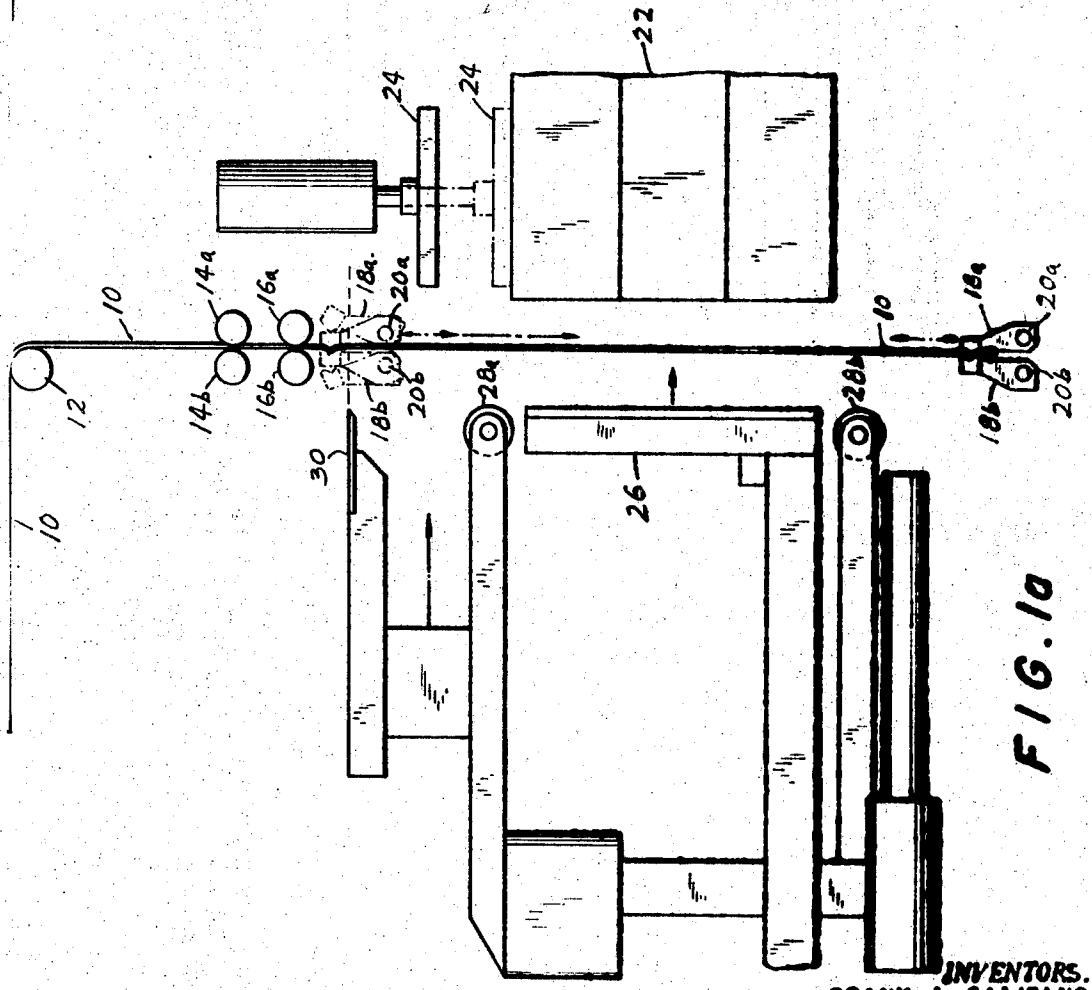


FIG. 1a

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Dec. 8, 1970 F. L. CALIFANO ET AL 3,546,045

AUTOMATIC STACKING AND TAPING MACHINE

Filed July 28, 1967 5 Sheets-Sheet 2

FIG. 7

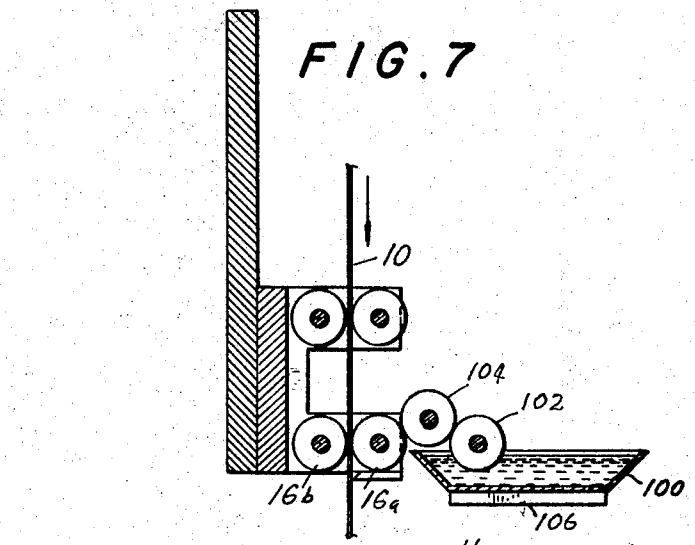


FIG. 2

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AUTOMATIC STACKING AND TAPING MACHINE

Filed July 28, 1967 5 Sheets-Sheet 3

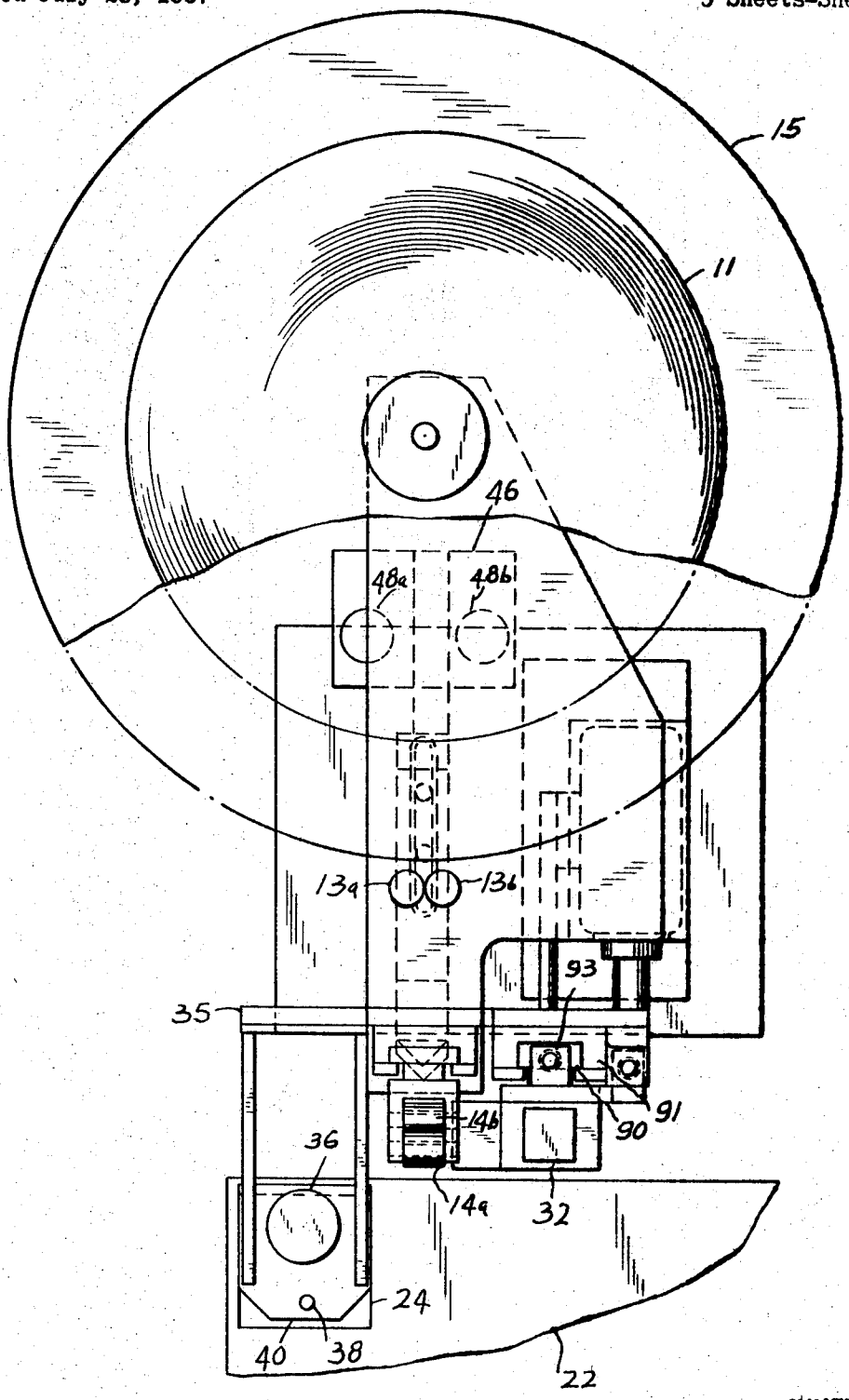


FIG. 3

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AUTOMATIC STACKING AND TAPING MACHINE

Filed July 28, 1967 5 Sheets-Sheet 4

FIG. 4

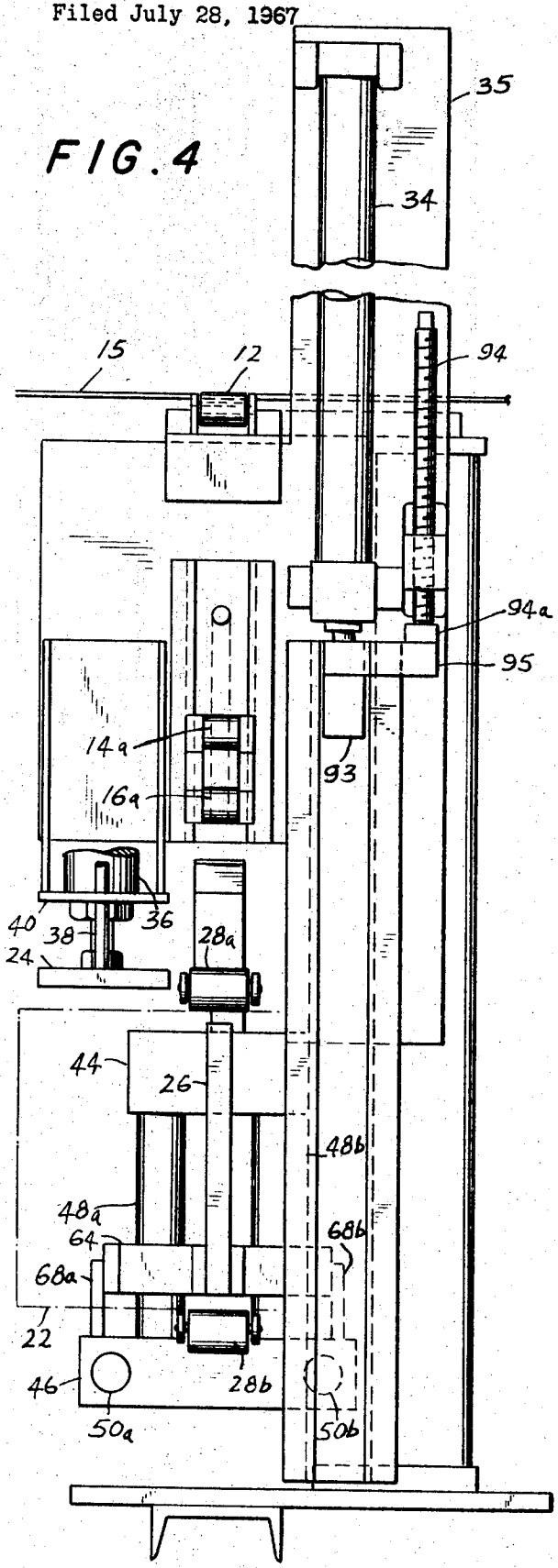


FIG. 6

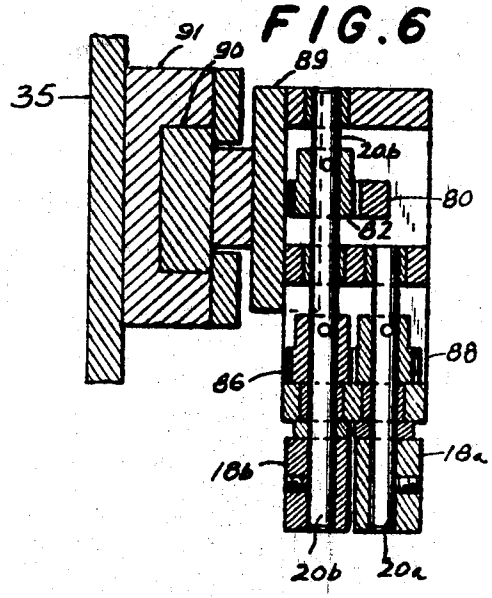
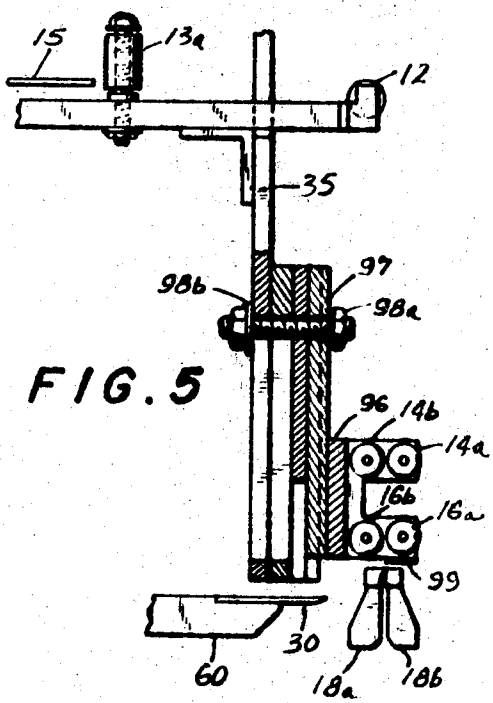


FIG. 5



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AUTOMATIC STACKING AND TAPING MACHINE

Filed July 28, 1967 5 Sheets-Sheet 5

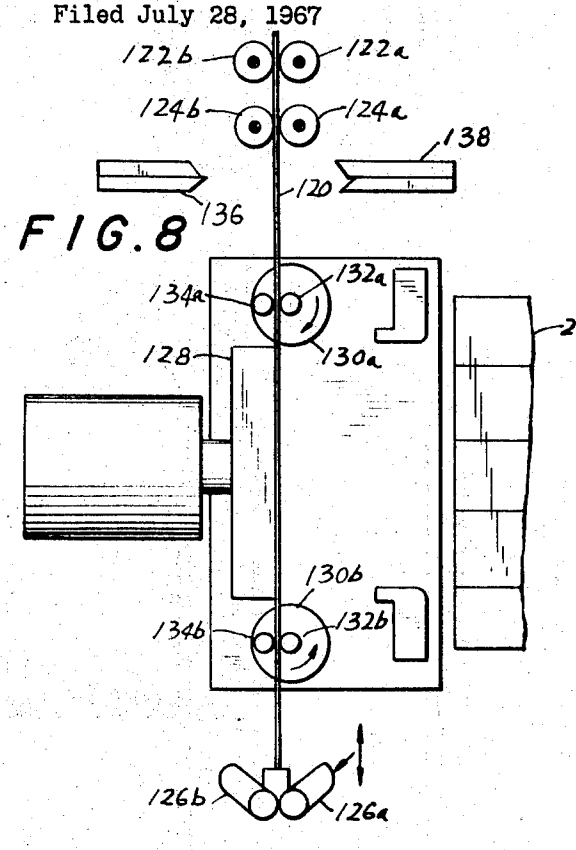


FIG. 8

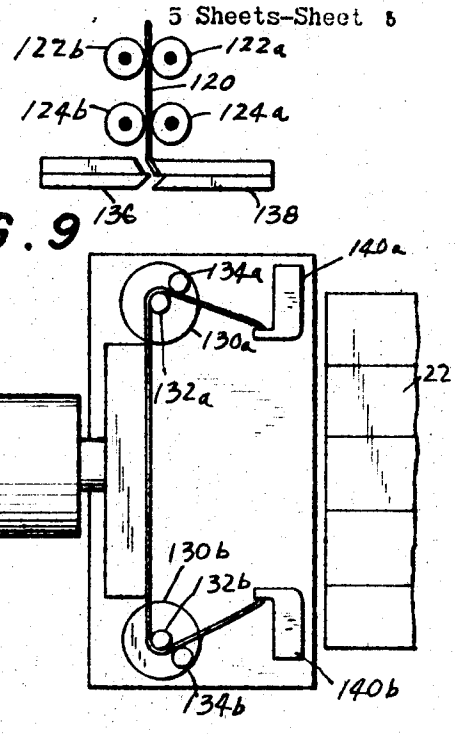


FIG. 9

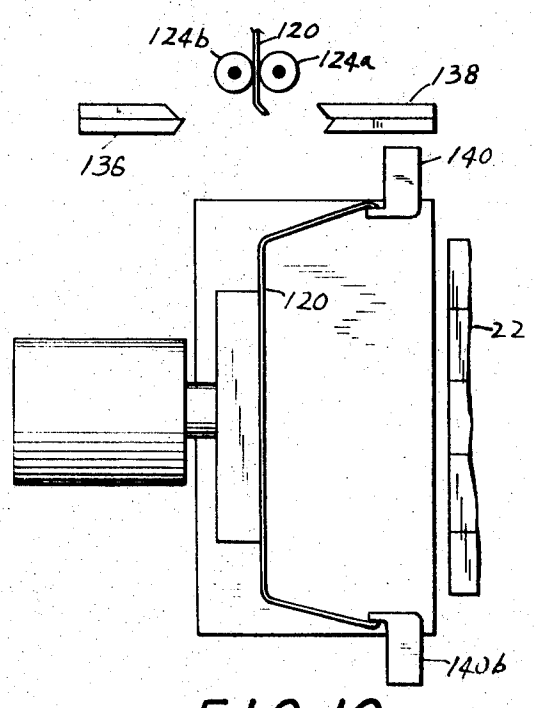


FIG. 10

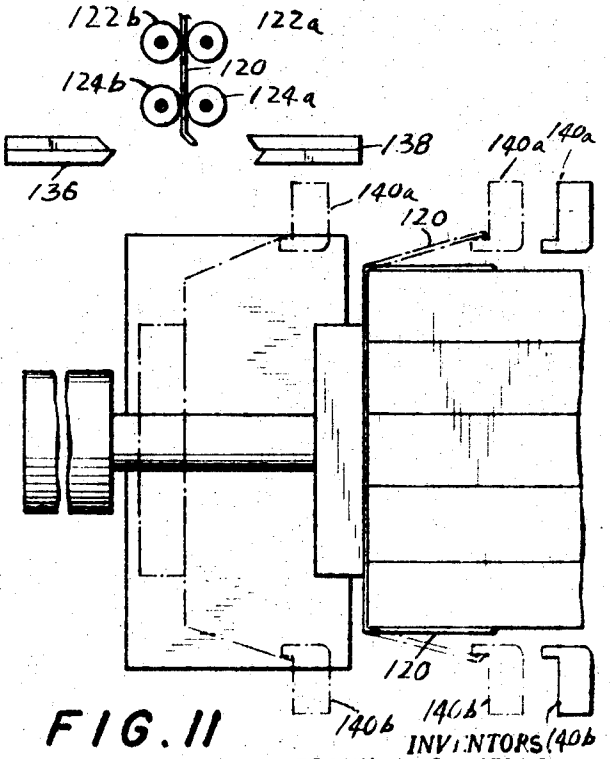


FIG. 11

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United States Patent Office

3,546,045

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3,546,045

AUTOMATIC STACKING AND TAPING MACHINE

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Int. Cl. B32b *31/04*; B65c *9/36*

U.S. Cl. 156—486 14 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for binding stacks of sheet material wherein a suitable length of binding material is applied to a compressed stack of the sheet material and is firmly adhered to the compressed stack of sheet material to form a compact bundle.

The present invention relates, in general, to machinery for binding together stacks of sheet material, such as plywood, gypsum board, insulation board and the like and, in particular, to equipment for applying tape, metal straps, wire and other binding materials to such stacks.

At the completion of the manufacture of sheet materials such as those mentioned above, the sheets are stacked and bound in bundles for shipment. Usually, the particular binding material which is employed is dependent upon the type of sheet material being bundled. In some manufacturing facilities, the bundles are bound manually, while in others automatic machinery is employed for this purpose. The normal problems of manual operation, for example high costs, low speed, etc., common to other manufacturing steps also are present in the bundling of sheet material. Accordingly, the preferred practice at the present time is to employ automatic machinery for binding together bundles of sheet material. However, none of the equipment presently available satisfies concurrently the usual requirements of modern-day machines. Among the more common problems of automatic bundling machines being employed at the present time are lack of reliability, frequent breakdowns, slow speed, and hazardous working conditions. In addition, these machines, generally, are very expensive to assemble and they lack versatility in handling different sheet materials and different size bundles.

Accordingly, it is an object of the present invention to provide new and improved machinery for bundling sheet materials.

It is another object of the present invention to provide such machinery which is not subject to the shortcomings and limitations of comparable equipment presently in use.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Referring to the drawings:

FIGS. 1*a* and 1*b* are schematic diagrams which illustrate the operation of a bundling machine constructed in accordance with the present invention which employs a tape having a pressure sensitive adhesive surface as the binding material.

FIG. 2 is a side elevation view of a bundling machine depicted schematically by FIGS. 1*a* and 1*b*;

FIG. 3 is a top view of the bundling machine of FIG. 2;

FIG. 4 is a front elevation view of the bundling machine of FIG. 2;

FIGS. 5 and 6 illustrate, on an enlarged scale, portions of the bundling machine of FIG. 2;

FIG. 7 illustrates the manner in which the bundling machine of FIG. 2 may be adapted to employ a tape to which an adhesive is added or a tape having a water soluble adhesive surface; and

FIGS. 8, 9, 10 and 11 are schematic diagrams which illustrate the operation of a bundling machine constructed in accordance with the present invention which employs metal straps or wire as the binding material.

FIGS. 1*a* and 1*b* are schematic diagrams which illustrate the operation of a bundling machine constructed in accordance with the present invention. A tape **10**, supplied from a roll (not shown), is passed around a roller **12** and between two pairs of rollers **14***a*, **14***b* and **16***a*, **16***b*. Tape **10** has a bare surface which contacts rollers **12**, **14***b* and **16***b*, while the other surface of the tape is provided with a pressure sensitive adhesive. The free end of tape **10** is grasped by a pair of tape clamps **18***a* and **18***b* positioned initially just below rollers **16***a* and **16***b*. Tape clamps **18***a* and **18***b* are secured to shafts **20***a* and **20***b*, respectively, which are arranged for opposed pivotal movements. Initially, tape clamps **18***a* and **18***b* are spread in the manner indicated by the dotted lines so that the free end of tape **10** may be grasped by the tape clamps. Once tape **10** is positioned between tape clamps **18***a* and **18***b*, the tape clamps are pivoted with their respective shafts **20***a* and **20***b* toward each other to the positions illustrated by the dot-dash lines in FIG. 1*a*. These movements of tape clamps **18***a* and **18***b* result in tape **10** being grasped firmly by the tape clamps.

Next, tape clamps **18***a* and **18***b* are moved downward together to the positions shown by the solid lines, whereby tape **10** is drawn past a stack **22** which is to be taped. Positioned above stack **22** is a compressing plate **24** which is arranged to move downward from its position illustrated by the solid lines to its position illustrated by the dot-dash lines. This downward movement of compressing plate **24** results in a compression of stack **22** prior to the application of tape **10** to the stack.

After stack **22** is compressed, a tape press **26** and a pair of tape buffer rollers **28***a* and **28***b* are moved horizontally from their respective positions in FIG. 1*a* to the positions in FIG. 1*b*. In particular, tape press **26**, disposed vertically, moves against the bare surface of tape **10** pressing the adhesive surface of the tape against the end of stack **22**. At the same time tape buffer rollers **28***a* and **28***b* move to the positions illustrated by the dot-dash lines in FIG. 1*b* contacting the bare surfaces of tape **10** above and below stack **22**. After the tape buffer rollers reach these positions, tape clamps **18***a* and **18***b* separate to release the free end of tape **10**. A knife **30**, moving horizontally with tape buffer rollers **28***a* and **28***b*, is arranged to cut tape **10** at a point just below rollers **16***a* and **16***b* by movement from its position in FIG. 1*a* to its position illustrated by the dot-dash lines in FIG. 1*b*. The elevation at which the tape is cut corresponds to the initial or upper position of tape clamps **18***a* and **18***b* so that the new end of the tape subsequently may be grasped by the tape clamps. Tape buffer rollers **28***a* and **28***b* then are moved further to the right across the top and bottom surfaces, respectively, of stack **22** to wipe the adhesive surface of the tape along these surfaces of the stack. The end positions of tape buffer rollers **28***a* and **28***b* are illustrated by the solid lines in FIG. 1*b*. Although tape **10** already has been cut, knife **30**, moving with the tape buffer rollers moves to its position illustrated by the solid lines in FIG. 1*b*.

After the buffing operation is completed, compressing plate **24**, not being located in the path of movement of tape buffer roller **28***a*, is raised and the tape press, the tape buffer rollers and the knife are retracted to their initial positions. Next, tape clamps **18***a* and **18***b* are elevated to the positions illustrated by the dotted lines in FIG. 1*a* so as to receive the new free end of tape **10**. The cycle of operation just described then is repeated to apply another

strip of tape to the stack at a different point along the length of the stack.

FIGS. 2, 3 and 4 are various views of a bundling machine constructed in accordance with the present invention. FIG. 5 shows, on an enlarged scale, the details of the roller assembly through which the tape is guided to the tape clamps. Referring to FIGS. 2–5, inclusive, tape **10** is supplied from a roll **11** which rests upon a turntable **15**. The tape passes a pair of rollers **13***a* and **13***b* and roller **12** about which the tape is twisted as its direction is changed. The tape then passes between the two pairs of rollers **14***a*, **14***b* and **16***a*, **16***b*, located to the left of an air cylinder **32** as viewed in FIG. 3. The free end of the tape is grasped by tape clamps **18***a* and **18***b*. Turntable **15** rotates freely as tape clamps **18***a* and **18***b* move downward and draws the tape off of roll **11**. A limit switch (not shown) is actuated at the end of the downward stroke of the tape clamps to energize an electric brake **17** coupled to turntable **15** and located below the turntable. Brake **17** prevents an over-run of tape **10** by preventing turntable **15** from rotating when the brake is energized. When the tape clamps move upward and toward their initial positions, brake **17** is de-energized and turntable **15** is free to rotate.

Air cylinder **32** controls the opening and closing of tape clamps **18***a* and **18***b* in a manner to be described in detail hereinafter in connection with FIG. 6. Upward and downward movements of the tape clamps **18***a* and **18***b* are effected by a second air cylinder **34** which is secured to a support plate **35**. The operation of air cylinder **34** also will be described in detail hereinafter.

A third air cylinder **36** serves to move compressing plate **24** downward to compress stack **22** prior to being taped and upward after the stack has been taped. The movements of compressing plate **24** are guided by a guide roll **38** which passes through a hole in a plate **40**.

Tape buffer rollers **28***a* and **28***b* are mounted rotatably at the ends of a pair of arms **42***a* and **42***b*, respectively. Upper buffer roller arm **42***a* is secured to an adjustment block **44**, while lower buffer roller arm **42***b* is secured to a sliding block **46**. A pair of posts **48***a* and **48***b*, best shown in FIGS. 3 and 4, are secured at their lower ends to sliding block **46**, while their upper ends are received in a pair of bushed holes in adjustment block **44**. With this arrangement, adjustment block **44** and, therefore, upper buffer roller arm **42***a* may be moved vertically relative to posts **48***a* and **48***b*. This vertical adjustment is provided to accommodate stacks of different height. The particular setting of adjustment block **44** and upper buffer arm **42***a* may be fixed by suitable means, such as one or more thumb screws received by the adjustment block and bearing against one or both of the posts **48***a* and **48***b*. Tape press **26** is also arranged to have a variable height to accommodate different size stacks.

Sliding block **46** is mounted for sliding movement back and forth along a pair of fixed parallel shafts **50***a* and **50***b*. Both of the shafts **50***a* and **50***b* are mounted in a pair of supports **52** and **54**.

The buffer roller assembly, comprising tape buffer rollers **28***a* and **28***b*, buffer roller arms **42***a* and **42***b*, adjustment block **44**, sliding block **46** and posts **48***a* and **48***b*, is moved back and forth horizontally along shafts **50***a* and **50***b* by means of an air cylinder **56**. This air cylinder is anchored at its left-hand end, while the moving rod of the cylinder is secured to sliding block **46**. Movements of the buffer roller assembly toward stack **22** may be controlled either by adjustment of the stroke of air cylinder **56** or by a fixed stop, such as a collar **58** on shaft **50***a*.

A knife holder **60**, which carries knife **30**, is secured to upper buffer roller arm **42***a* through a block **62**. Thus, knife **30** moves vertically with upper buffer roller **28***a* and upper buffer roller arm **42***a* and horizontally with the entire buffer assembly. The position of knife **30** in knife holder **60** is adjustable so that a desired relationship between the cutting of tape **10** and the buffing of the tape may be effected. A preferred mode of operation is to permit a slight amount of buffing to take place before the tape is cut.

Tape press **26** is mounted on a tape press frame **64**. Each of the lateral edges of tape press frame **64** is provided with a horizontally disposed elongated slot **66**. Slots **66** are engaged by a pair of cam followers (not shown) individually mounted on a pair of brackets **68***a* and **68***b*. Brackets **68***a* and **68***b* are secured to sliding block **46** of the buffer roller assembly. Therefore, brackets **68***a* and **68***b* move horizontally with the buffer assembly.

Tape press frame **64** and tape press **26** are moved toward and away from stack **22** by an air cylinder **70**. The left-hand end of air cylinder **70** is anchored in a bracket **72** and the moving rod of this air cylinder is secured to the tape press frame.

The arrangement of the buffer roller assembly and the tape press frame is such that air cylinders **56** and **70** may be actuated simultaneously to move tape press **26** and tape buffer rollers **28***a* and **28***b* simultaneously toward stack **22**. The movement of tape press **26** stops after the adhesive surface of the tape is forced against the end of stack **22**. Air cylinder **56**, still being actuated, drives the buffer roller assembly further toward the right so that tape buffer rollers **28***a* and **28***b* move across the top and bottom surfaces of stack **22** wiping the adhesive surface of the tape above and below the stack onto these surfaces of the stack. The cam followers mounted in brackets **68***a* and **68***b* move within the slots **66**, thereby permitting relative movement between the stationary tape press frame and the buffer roller assembly.

FIG. 6 is a cross-sectional view illustrating the mechanism which opens and closes tape clamps **18***a* and **18***b*. The moving rod of air cylinder **32** is affixed to a rack **80** which is movable vertically (into and out of FIG. 6). Rack **80** engages a gear **82** which is secured to shaft **20***b*. Also secured to shaft **20***b* are a second gear **86** and tape clamp **18***b*. A third gear **88**, secured to shaft **20***a*, meshes with gear **86**. Also secured to shaft **20***a* is tape clamp **18***a*.

As rack **80** is moved vertically, gear **86** turns in one direction, while gear **88** turns in the opposite direction. As a result, tape clamps **18***a* and **18***b* also move in opposite directions, toward and away from one another, dependent upon whether rack **80** is moving upward or downward.

Tape clamps **18***a* and **18***b* and the associated control mechanism are mounted on a frame **89** which is affixed to a slide block **90**. Block **90** moves vertically within a guide channel **91** which, in turn, is affixed to support plate **35**. The moving rod of air cylinder **34** is fixed to slide block **90** through a bracket **93**. As a result, tape clamps **18***a* and **18***b* are moved upward and downward by air cylinder **34**.

Screw **94**, best shown in FIG. 4, serves to set the length of the stroke of air cylinder **34**, and, therefore, the length of the tape to be cut for a particular stack. A block **95**, secured to bracket **93** through which the moving rod of cylinder **34** is secured to slide block **90**, moves upward and downward with tape clamps **18***a* and **18***b*. Block **95** abuts against end **94***a* of screw **94** to stop its upward movement. Thus, the height of end **94***a* of screw **94** establishes the uppermost position of the tape clamps. As a result, the length of the tape being cut may be set to accommodate different size stacks.

In order to prevent an excessive length of the free end of the tape from dangling, thereby making it difficult for the tape to be grasped by the tape clamps, rollers **16***a* and **16***b* are moved upward and downward so as to be located just above the uppermost position of the tape clamps. As shown most clearly in FIG. 5, the location of these rollers is set by tightening a pair of nuts **98***a* and **98***b* on a bolt **97** to hold a frame **96**, carrying rollers **14***a*, **14***b* and **16***a*, **16***b*, in place.

A shoe **99** is secured to roller frame **96** below roller **16***a* to prevent the adhesive coating on tape **10** from sticking to roller **16***a*. Because the adhesive coating bears

against the narrow edge of shoe **99**, the tendency of the tape to curl around roller **16***a* is eliminated. As a result, the tape hangs downward and is grasped by tape clamps **18***a* and **18***b*.

FIG. 7 illustrates the apparatus which may be employed to adapt the machinery shown in FIGS. 2–6, inclusive, to use a tape having a water soluble adhesive or a tape to which an adhesive coating is added. A tank **100** containing a liquid, for example, water, a wet adhesive or a hot melt adhesive, is positioned in close proximity to roller **16***a*. A roller **102**, positioned so that its periphery will dip into the liquid in tank **100**, carries the liquid out of the tank to another roller **104** which, in turn, transfers the liquid to roller **16***a*. The roller **16***a* applies the liquid to tape **10** as it is drawn between this roller and roller **16***b*.

When tape **10** is provided with a water soluble adhesive, the liquid in tank **100** is water. A wet adhesive or a hot melt adhesive is provided in tank **100** when an adhesive coating is to be applied to the tape. A heater **106** may be located in the bottom of tank **100** when a hot melt adhesive is to be applied to the tape.

FIGS. 8, 9, 10 and 11 are schematic diagrams which illustrate the operation of a bundling machine constructed in accordance with the present invention which employs metal straps or wire as the binding material. The binding material **120**, supplied through two pairs of rollers **122***a*, **122***b* and **124***a*, **124***b*, is drawn downward by a pair of grasping clamps **126***a* and **126***b* between a pusher **128** and a stack **22** which is to be bound. A pair of benders **130***a* and **130***b* move laterally (out of the drawing) into position. Each bender has a central pin **132***a*, **132***b* and an eccentric pin **134***a*, **134***b* which are spaced apart sufficiently to permit binding material **120** to pass between them.

A pair of cutters **136** and **138** move toward each other to the positions illustrated in FIG. 9 and cut a length of the binding material. The cutters **136** and **138** are so shaped that prior to cutting the binding material, the binding material is bent to have a notch. As a result, after the binding material is cut, the ends are crimped due to the bending introduced by the cutters.

Benders **130***a* and **130***b* then are turned in the directions of the arrows on the benders in FIG. 8 to the positions shown in FIG. 9. As a result, the pins **132***a*, **134***a* and **132***b*, **134***b* exceed the elastic limit of the binding material and bend the binding material to the shape of a "C" clip as shown in FIG. 9. The crimped tips of the "C" clip are forced against a pair of spreaders **140***a* and **140***b*. After the "C" clips are formed, the benders **130***a* and **130***b* are retracted (moved into the drawing) to their initial positions.

The nature and characteristics of the binding material are such that when it is bent into the shape shown in FIG. 9 it will tend to retain this shape when the spreaders **140***a* and **140***b* move away from each other to the positions shown in FIG. 10. After the spreaders reach the positions shown in FIG. 10, the pusher **128** and the spreaders move horizontally to the right applying the clip to the stack **22**. In particular, the pusher **128** moves from the position illustrated by the dot-dash lines in FIG. 11 to the position illustrated by the solid lines. The spreaders move from the positions illustrated by the dot-dash lines in FIG. 11 through the positions illustrated by the dotted lines to the positions illustrated by the solid lines. After the spreaders leave the positions illustrated by the dotted lines, the crimp tips of the clip slide off of the spreaders and snap toward the top and bottom surfaces of the stack and dig slightly into these surfaces. By crimping the tips of the clip, the clips are prevented from sliding off of the stack.

While there have been described what are at present considered to be the preferred embodiments of this invention it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. Bundling machinery for sheet materials comprising:

a source of binding material;

releasible grasping means for grasping a free end of said binding material for pulling said binding material from a storage roll and for drawing said binding material past a stack of sheet material which is to be bound together;

said releasible grasping means comprising a pair of opposed pivotally mounted levers adapted to pivot from an open position to a closed position wherein said free end of said binding material is held between said levers;

means for controlling said levers to move said levers from said open position to said closed position to grasp said free end of said binding material and to move said levers from said closed position to said open position after said binding material has been drawn past said stack thereby to release said free end of said binding material;

driving means for moving said grasping means back and forth past said stack at prescribed times;

means located between said source of binding material and said stack for cutting a length of said binding material drawn past said stack;

and means for applying a cut length of said binding material to said stack.

2. Bundling machinery according to claim **1** wherein the binding material is a tape having a pressure sensitive adhesive surface.

3. Bundling machinery according to claim **1** wherein the binding material is a tape having a water soluble adhesive surface.

4. Bundling machinery according to claim **1** wherein the binding material is a tape to which adhesive is applied prior to being drawn past the stack to be bound.

5. Bundling machinery according to claim **1** wherein the binding material is metal straps.

6. Bundling machinery according to claim **1** wherein the binding material is wire.

7. Bundling machinery for sheet materials comprising:

a source of binding material;

releasible grasping means for grasping a free end of said binding material at a first position of said grasping means for pulling said binding material from a storage roll and for drawing said binding material past a stack of sheet material which is to to bound together;

said releasible grasping means comprising a pair of opposed pivotally mounted levers adapted to pivot from an open position to a closed position wherein said free end of said binding material is held between said levers;

means for controlling said levers to move said levers from said open position to said closed position at said first position of said grasping means thereby to grasp said free end of said binding material and to move said levers from said closed position to said open position at a second position of said grasping means after said binding material has been drawn past said stack thereby to release said free end of said binding material;

driving means for moving said grasping means back and forth between said first and said second positions of said grasping means;

means located at said first position of said grasping means and actuated after said grasping means move said free end of said binding material to said second position of said grasping means for cutting a length of said binding material extending between

said first and said second positions of said grasping means;

and means for applying said length of binding material to said stack.

8. Bundling machinery for sheet materials comprising:

a strip of tape having a bare surface and an adhesive surface;

a tape press spaced from a stack of sheet material which is to be bound together and movable horizontally toward a side of said stack, said tape press being disposed vertically and arranged to contact said bare surface of said tape and to force said adhesive surface of said tape against said side of said stack;

a pair of tape grasping clamps together movable between a first position above said tape press and a second position below said tape press for grasping a free end of said tape at said first position and for drawing said free end of said tape downward between said tape press and said stack to said second position;

a first tape buffer roller above said tape press and movable horizontally across the top of said stack, said first tape buffer roller arranged to contact said bare surface of said tape and to wipe said adhesive surface of said tape extending between said top of said stack and said first position of said tape grasping clamps across said top of said stack;

a second tape buffer roller below said tape press and movable horizontally across the bottom of said stack, said second tape buffer roller arranged to contact said bare surface of said tape and to wipe said adhesive surface of said tape extending between said bottom of said stack and said second position of said tape grasping clamps across said bottom of said stack;

a knife blade movable horizontally at the height of said first position of said tape grasping clamps for cutting said tape;

means for moving said tape press horizontally to said side of said stack;

means for moving said first and said second tape buffer rollers horizontally across said top and said bottom, respectively, of said stack;

means for moving said knife blade horizontally through said first position of said tape grasping clamps;

and means for moving said tape grasping clamps between said first and said second positions thereof.

9. Bundling machinery according to claim 8 wherein the knife blade and the first and second tape buffer rollers move together horizontally.

10. Bundling machinery according to claim 9 wherein a first air cylinder is coupled to the tape press to move said tape press horizontally and a second air cylinder is coupled to the knife blade and the first and second tape buffer rollers to move said knife blade and said tape buffer rollers horizontally.

11. Bundling machinery according to claim 8 wherein the tape is supplied from a roll which rests upon a freely rotatable turntable and an electric brake is coupled to said turntable and actuated to prevent rotation of said turntable when the tape grasping clamps reach their second position.

12. Bundling machinery for sheet materials comprising:

a strip of tape having a bare surface and an adhesive surface;

a tape press spaced from a stack of sheet material which is to be bound together and movable horizontally toward a side of said stack, said tape press being disposed vertically and arranged to contact said bare surface of said tape and to force said adhesive surface of said tape against said side of said stack;

a pair of tape grasping clamps together movable between a variable first position above said tape press and a fixed second position below said tape press for grasping a free end of said tape at a selected first position and for drawing said free end of said tape downward between said tape press and said stack to said second position;

a first tape buffer roller above said tape press and movable horizontally across the top of said stack, said first tape buffer roller arranged to contact said bare surface of said tape and to wipe said adhesive surface of said tape extending between said top of said stack and said selected first position of said tape grasping clamps across said top of said stack;

a second tape buffer roller below said tape press and movable horizontally across the bottom of said stack as said first tape buffer roller moves across said top of said stack, said second tape buffer roller arranged to contact said bare surface of said tape and to wipe said adhesive surface of said tape extending between said bottom of said stack and said second position of said tape grasping clamps across said bottom of said stack;

a knife blade coupled to said first tape buffer roller and movable horizontally with said first tape buffer roller for cutting said tape;

coupling means between said first and said second tape buffer rollers for moving said first tape buffer roller and said knife blade vertically relative to said second tape buffer roller to position said knife blade at the height of said selected first position of said tape grasping clamps and to position said first tape buffer roller at the height of said top of said stack;

means for moving said tape press horizontally to said side of said stack;

means for moving said first and said second tape buffer rollers horizontally across said top and said bottom, respectively, of said stack and for moving said knife blade horizontally through said selected first position of said tape grasping clamps;

fixed first stoppage means for limiting downward movements of said tape grasping clamps to said second position thereof;

variable second stoppage means for limiting upward movements of said tape grasping clamps to said selected first position thereof;

and means for moving said tape grasping clamps between said selected first and said fixed second positions thereof.

13. Bundling machinery according to claim 1 wherein said binding material is a metal binding material and wherein said bundling machinery includes means for bending said cut length of said binding material before said length of binding material is applied to said stack into a C clip adapted to tightly engage the top, side and bottom surfaces of said stack; and said means for applying said cut length of binding material to said stack comprises means for applying said C clip to said stack.

14. Bundling machinery according to claim 13 wherein the cutting means bend the metal binding material prior to cutting said binding material so that the tips of the cut binding material are crimped.

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