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Mercer et al.

[11] **3,775,930**

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[54] **PAPER PULP BALING METHOD AND APPARATUS**

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Related U.S. Application Data

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[52] **U.S. Cl.** **53/32,** 53/209, 53/218, 53/387

[51] **Int. Cl.** **B65b 11/02,** B65b 11/08

[58] **Field of Search** 53/32, 209, 218, 53/383, 387

[56] **References Cited**

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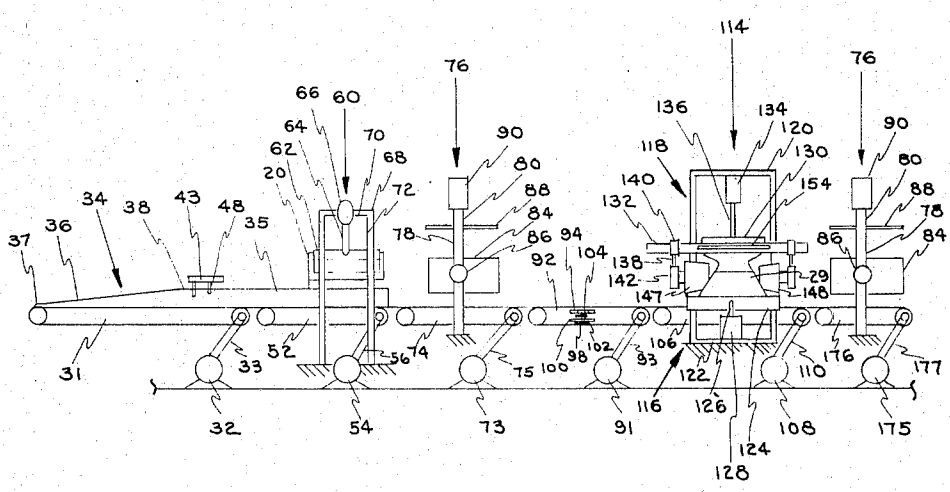
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[57] **ABSTRACT**

Method of baling bundles of paper pulp comprising overwrapping the bundle with top and bottom wrapper sheets, and thereafter forming side seams and end flaps about the bale by applying a repulpable adhesive to overlapping areas of the wrapper sheets and exerting a compressive force on these adhesive-carrying areas so as to obtain bonded side seams and end flaps. Apparatus is disclosed for baling bundles of paper pulp, including means for applying a repulpable adhesive to overlapping areas of the wrapper sheets, means for forming side seams and end flaps, and means for exerting a compressive force on the side seams and end flaps.

12 Claims, 5 Drawing Figures



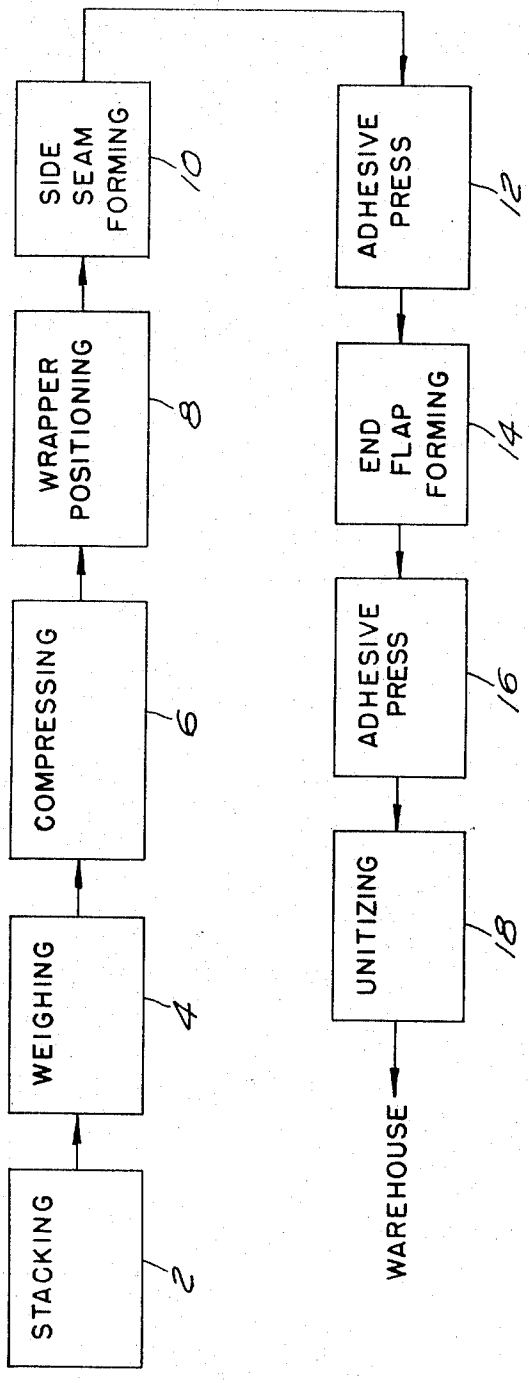


Fig. 1

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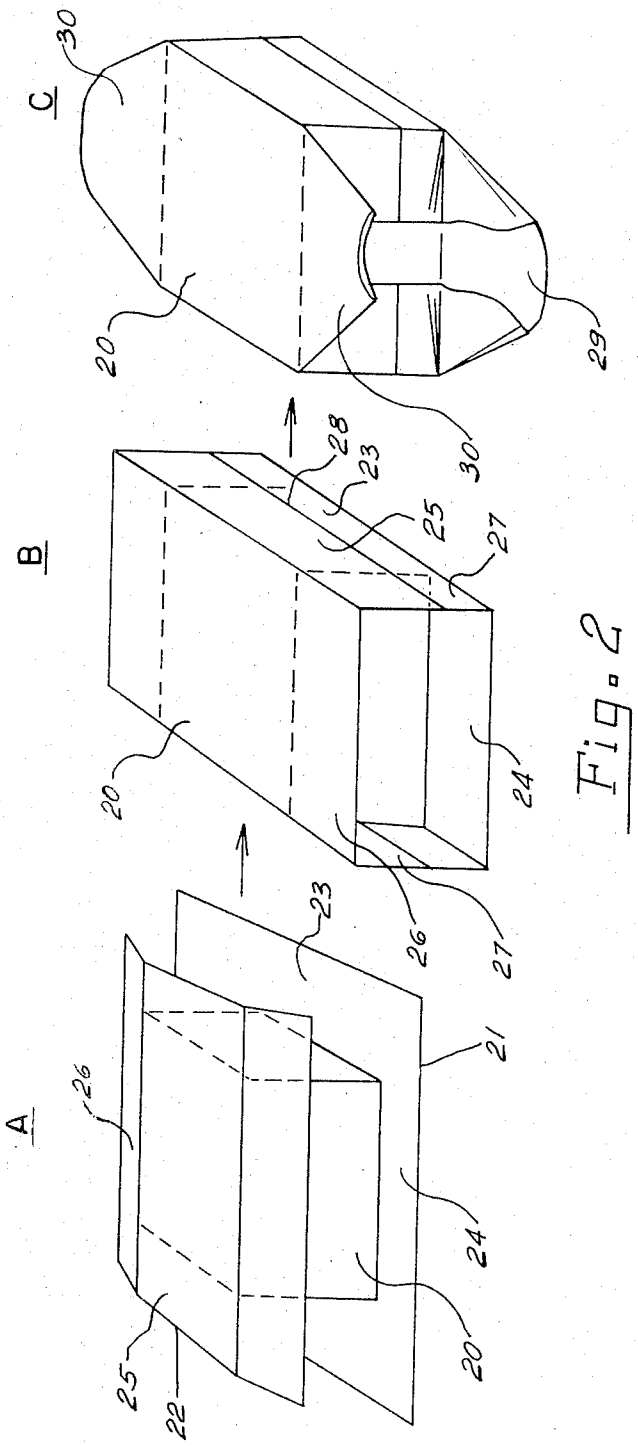


Fig. 2

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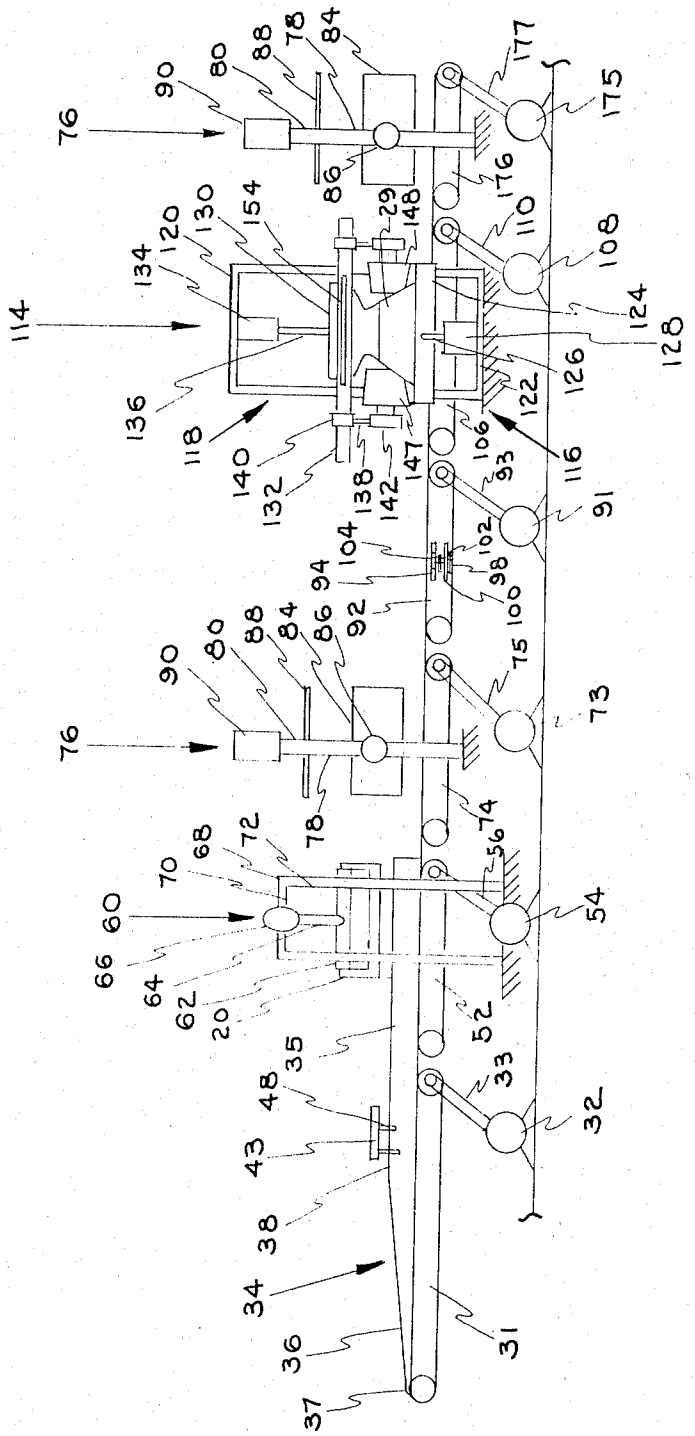


FIG. 3

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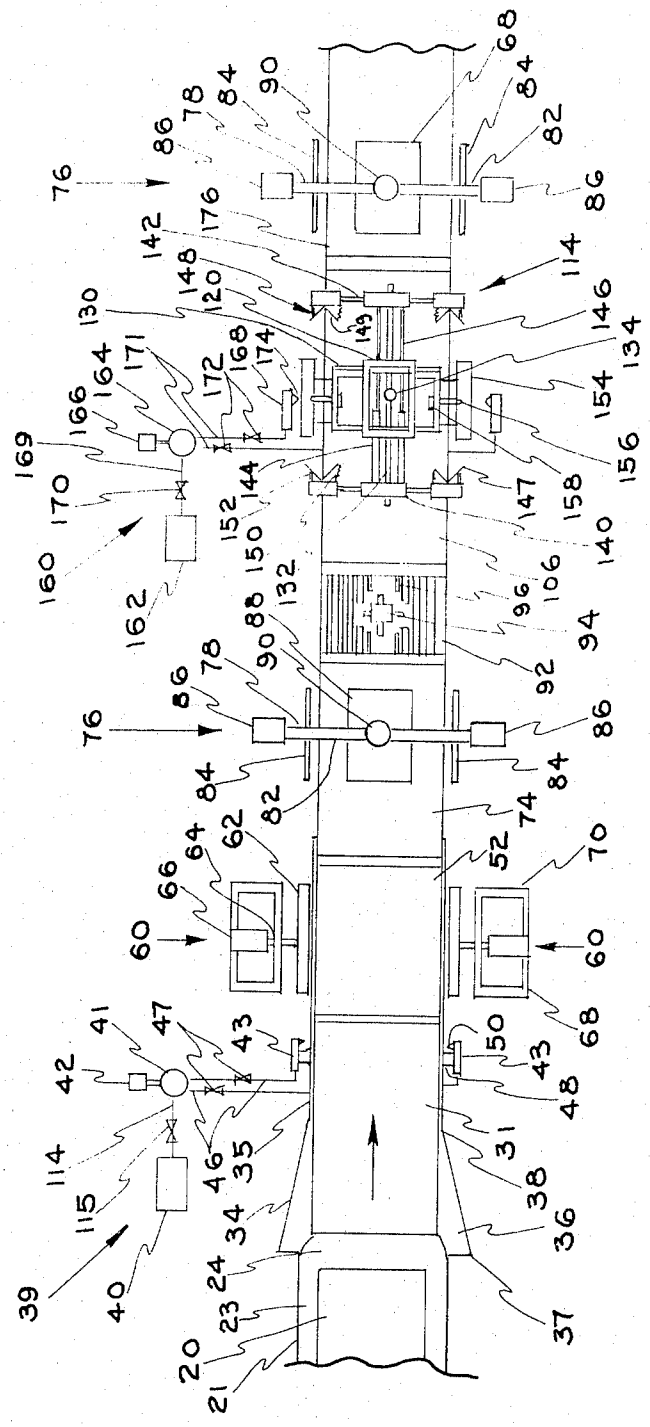


FIG. 4

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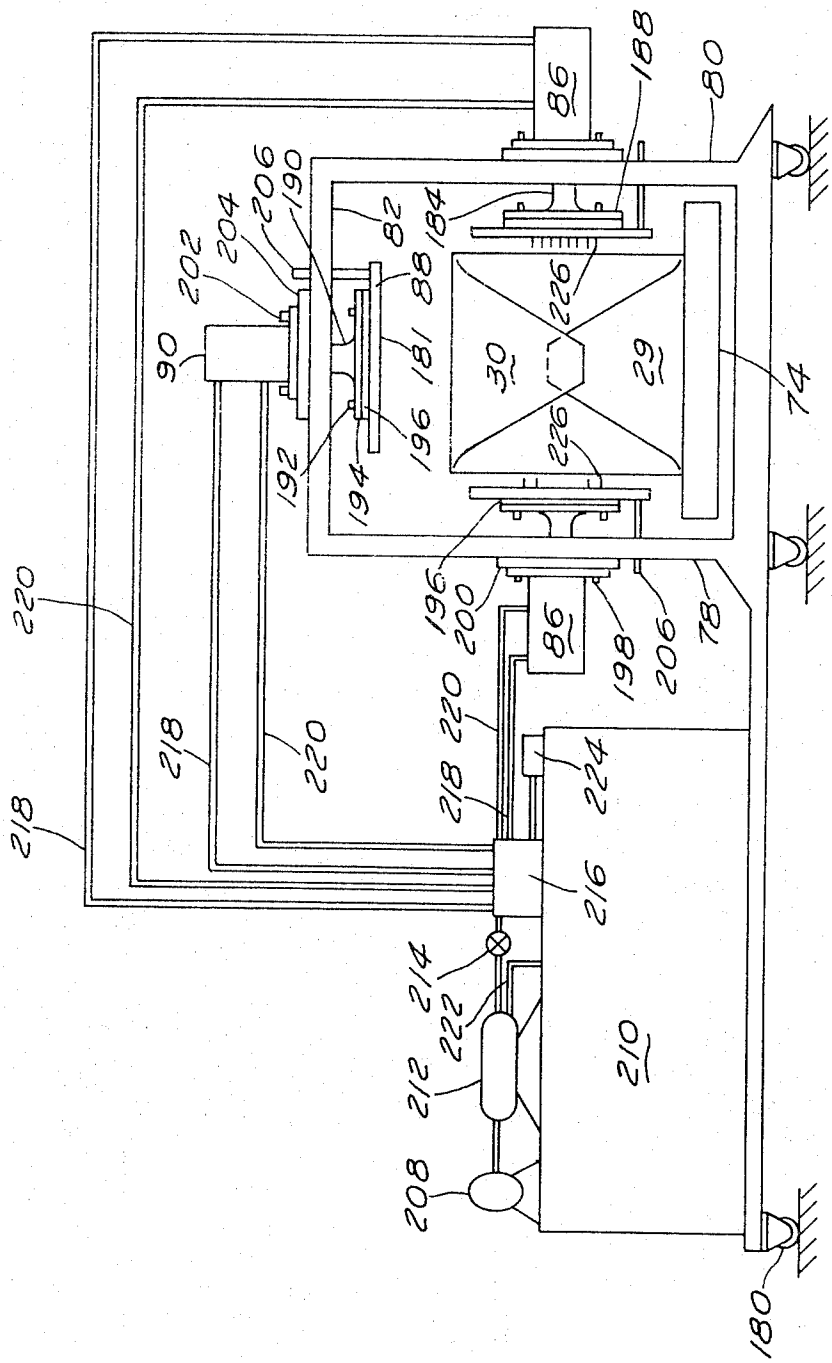


Fig. 5

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PAPER PULP BALING METHOD AND APPARATUS

This is a continuation, of application Ser. No. 153,669, filed 6/16/71, which in turn is a continuation-in-part of copending application Ser. No. 50,837, filed June 29, 1970.

The present invention relates to an improved method for baling bundles of paper pulp and to improve apparatus suitable to carry out said method of baling. More particularly, the present invention relates to a method and apparatus for baling bundles of paper pulp overwrapped with top and bottom wrapper sheets by applying an adhesive to overlapping portions of the wrapper sheets and then applying a compressive force to these overlapping portions.

Generally, paper pulp is manufactured in sheet form at mills close to a source of supply of timber. Often however, no paper mills are located at the same site as the pulp mills, and therefore the pulp must be baled and then shipped to paper mills or other customers.

At the pulp mill, timber is processed into a continuous sheet of paper pulp comprising cellulose fibers. The pulp sheet is passed through a dryer in order to obtain a product of desired solids content, usually between about 80 percent and 100 percent. Once the continuous pulp sheet is formed and dried, it is automatically cut into rectangular sheets, and these sheets are stacked and weighed to obtain a unit weight stack. Top and bottom pulp wrappers are then loosely positioned above and below the stack. Consumer paper mills generally require the pulp stack to be wrapped in these pulp sheets in order to protect the bale contents from dirt and moisture, the wrapper sheets being eventually repulped by the consumer paper mill. The stack is then transferred to a hydraulic press which exerts a tremendous downward pressure on the stack in order to effect a compact bundle. This compression step reduces the height of the stack, correspondingly reducing the stack volume and resulting in a compact unit which can be more easily baled.

Baling is accomplished in the paper pulp art by folding the wrapper sheets about all six sides of the pulp bundle, and then tying steel wires or straps transversely and longitudinally about the bundle. One wire may be secured lengthwise and one wire widthwise, or two or more wires may be tied about each dimension. This operation is performed automatically by wire tying machines especially adapted for the baling of paper pulp. A description of one of the more popular wire tying machines is found in U. S. Pat. No. 3,179,037 to Cranston, et al. The wire tying machine automaticaly encircles a bundle of pulp with a strand of wire supplied by a continuous spool, ties the wire securely, and then snips the wire from the spool. The machine can be adapted to tie several wires at different increments of length or width along the bale. Before the bundle proceeds to the tying machines however, the top and bottom wrappers must be folded about the bundle so as to form side seams and end flaps. Generally, side seams are formed first along the length of the bundle by automatically or manually overlapping the top and bottom wrappers. The bundle is then fed into a tying machine to effect a transverse wire tie about the side seams. The partially formed bale is rotated 90°, and the end flanges are automatically tucked in to form end flaps. The bale is then conveyed to a second wire tying machine which will secure one or more wires longitudinally about the end flaps.

The baling of paper pulp with steel wire has created serious problems which plague both the pulp industury and the paper industry. For example, at the pulp mills, the use of wire presents a considerable expense. The cost of wire per bale may range from a few cents up to more than 20 cents, depending on the number of wires placed about each bale. When it is considered that a medium to large paper pulp mill may manufacture from 500 to 1,500 tons of pulp per day (about 2,000 to 6,000 bales per day), it can be seen that the cost of wire constitutes a major expense. Moreover, the complexity of the wire tying machines causes frequent mechanical problems which may require shutdown of the whole baling line, thus lowering daily production levels.

When the wire-baled pulp reaches a paper mill, even greater problems are involved. For example, removal of the wire from the bales is difficult and time-consuming. Also, removal of the wire often causes injury to employes, such as eye injury, due to the elastic spring of the sharp wire when it is cut from the bale. The most serious problem is that pieces of the wire sometime get into the paper beaters, scoring the rollers and cutting through the felts so as to cause costly equipment damage. Moreover, disposal of the wire once it has been removed from the bale is a problem inasmuch as the wire has essentially no scrap value.

In view of the many serious problems created by the use of wire in baling paper pulp, those skilled in the art have long sought a better method of baling. However, to the best of our knowledge, no feasible alternative has yet been developed. One direction of inquiry by those skilled in the art has been the use of adhesives to bale paper pulp; but such efforts, for various reasons, have not been successful. In U. S. Pat. No. 3,330,409 to Jorgensen, there is disclosed a pulp bale secured by two or more paper pulp bands made endless about the stack of pulp sheets; the bands can be secured at meeting ends by the use of an adhesive such as animal glue. The Jorgensen invention however, does not contemplate the baling of pulp overwrapped with top and bottom wrapper sheets as is the general custom in the art. Moreover, the Jorgensen method requires an adhesive set time of up to 10 minutes in order to obtain a suitable bond, whereas in a typical pulp mill baling line, the bale must be bonded within from about 10 to 20 seconds. For these reasons, the Jorgensen invention does not solve the problems presented by wire-baling of paper pulp.

In U. S. Pat. No. 2,765,838 to Brown, there is disclosed a method and apparatus for packaging a stack of fibrous mats in kraft paper, using a thermosetting adhesive to bond overlapping portions of the paper. The Brown invention however, is not applicable to the problem of baling paper pulp in pulp wrapper sheets. Thermosetting adhesives are generally non-repulpable, i.e., not water soluble or dispersible, and thus would not be amenable to pulp baling because of the need to repulp the wrapper sheets. Thus the Brown invention does not solve the problems inherent in the baling of paper pulp.

It is accordingly a principal object of the present invention to provide an improved method and apparatus for baling paper pulp.

Another object of the present invention is to provide an improved method and apparatus for baling paper pulp without the use of wire.

It is a further object of the present invention to provide an improved method and apparatus for adhesively bonding top and bottom wrapper sheets about the six sides of a bundle of paper pulp.

It is an additional object of the present invention to provide an improved method and apparatus for effecting greater speed and less expense in the baling of paper pulp.

It is also an object of the present invention to provide an improved baling apparatus which is interchangeable with wire tying units in a paper pulp baling line.

Another object of the present invention is to provide an adhesively bonded pulp bale wherein the wrapper sheets are suitable for repulping.

Basically, the present invention contemplates a method of baling a stack of paper pulp wherein the stack is overwrapped with top and bottom wrapper sheets. The wrapper sheets are folded about the bundle of pulp sheets so as to obtain overlapping side and end flanges to which a repulpable adhesive is applied. These adhesive-bearing flanges are then subjected to a high compressive force in order to achieve a rapid, durable bond which retains the wrapper sheets securely about the pulp bundle.

Apparatus for performing this method will comprise, in addition to means for folding the side and end flanges of the wrapper sheets, means for applying adhesive to said flanges, and means for applying a high compressive force to the adhesive-bearing flanges.

Further objects and advantages of the present invention will become clear from the following description of the invention taken in conjunction with the drawings, wherein:

FIG. 1 is a flow diagram of a pulp baling line incorporating the present invention.

FIG. 2 is a diagram illustrating the folding sequence of a paper pulp bale.

FIG. 3 is a side elevation of a portion of a pulp baling line incorporating the present invention.

FIG. 4 is a plan view of a portion of a pulp baling line incorporating the present invention.

FIG. 5 is an end elevation of an adhesive press means.

According to the method of this invention, sheets of paper pulp in the form of a bundle can be securely baled without the use of wire. The method is applicable to pulp prepared from both gymnosperms (softwood) such as spruce, hemlock, fir, pine and cedar, and from angiosperms (hardwood) such as aspen, birch, beech, maple, oak and gum. The pulp may also be prepared from old paper, rags and other fibrous raw material such as straw, esparato, jute, flax, hemp, corn stalks, bagasse and bamboo. Moreover, the inventive method is applicable to pulp prepared by different processes such as mechanical pulping, semichemical pulping, and chemical pulping including the sulfate process, the sulfite process, the soda process, and the kraft process. Of these processes, the sulfate process, and the kraft variation thereof, are probably the most important. The sulfate process is amenable to both softwoods and hardwoods, but is usually used with softwoods because of the long, strong fibers obtained.

After the pump is formed into a continuous sheet and dried, it is automatically cut into rectangular sheets which may range from about 27 to 36 inches in width and from about 3C to 40 inches in length. The sheets are stacked and weighed so as to obtain stacks of unit weight, usually about 500 lbs. each. The stack is then compressed to reduce its volume and form a compact bundle. Thereafter, top and bottom wrapper sheets are loosely positioned above and below the bundle, either automatically or by hand. The wrapper sheets are typically cut from pulp prepared at the mill, but are cut into larger sizes than the normal pulp sheets in order to provide sufficient surface area for the sheets to completely overwrap the pulp bundle. It is important that the wrapper sheets are positioned in register with the stack. That is, there should be substantially equal projections of the wrapper sheets on both sides of the stack, and at both ends thereof, so as to insure that there will be an overlap of the top and bottom wrappers when they are folded. In this way, sufficient surface area is provided where the side and end flanges overlap to allow for adhesive bonding of the top wrapper to the bottom wrapper. It should also be noted that it is possible to use two bottom wrappers with one top wrapper, or two top wrappers with one bottom wrapper, or two of each. Usually however, only one top and one bottom wrapper will be employed.

After the wrapper sheets are positioned in register with the bundle, the side seams are formed and bonded, and then the end flaps are formed and bonded. The side flanges may be folded manually or automatically by lifting the projecting sides of the bottom wrapper upward along the length of the bundle, and forcing the projecting sides of the top wrapper downward along the length of the bundle, and into overlapping relation with the bottom wrapper. The bottom flanges could be made to overlap the top flanges, but it is preferable to overlap the bottom flanges with the top flanges.

Prior to overlapping engagement of the top and bottom wrappers along the length of the bundle, a repulpable adhesive is applied to areas of the wrapper side projections which will overlap. The adhesive may be applied to one wrapper, or both. When the top wrapper is to overlap the upward extending flanges of the bottom wrapper, adhesive may be applied to the outer surface of the bottom wrapper side flanges, or to the inner surface of the top wrapper side flanges, or to both of said areas. The adhesive may be applied before the side flanges are urged upward and downward along the length of the bundle, or the adhesive may be applied to the flanges after they are partially folded upward and downward along the bundle but prior to actual overlapping engagement.

Application of the adhesive may be effected by any convenient means, such as spraying, extrusion, brushing, or rolling. The pattern of adhesive application can be selected as desired, and for example, may constitute a continuous thin film of from about 2–10 inches in width, a continuous bead, or an intermittent pattern. Preferably, the adhesive is sprayed to form a thin continuous band of adhesive about 5 inches in width along the outer surface of the upwardly extending bottom wrapper side flanges on each side of the bale.

Once the adhesive has been applied to the side flanges, they may be urged into overlapping contact. The adhesive-bearing side seams are then subjected to a powerful compressive force which drives the adhesive into the pulp wrapper sheets. Because of the deep penetration of the adhesive into the pulp wrapper sheet, a very strong bond is obtained, and further, the adhesive will exhibit greater moisture resistance. The amount of pressure required to effect a strong, durable bond is a function of several parameters, including length of time

of compression and type of adhesive used. The upper level of compressive force which may be applied is limited only by that force which causes the bale to buckle and deform. Inasmuch as higher compressive forces make possible a quicker, stronger bond, it is preferable to exert a downward compressive force on the top of the bale in order that buckling and bale deformation can be prevented, while still exerting a high compressive force on the side seams. Generally, it has been found that pressures of greater than about 10 psig are required to effect a sufficient bond. As has been indicated, the upper pressure is limited only by bale deformation, and may be in excess of 350 psig. When no compressive force is exerted on top of the bale to prevent bale deformation, a preferred pressure range for effecting a strong adhesive bond is from about 10 psig to about 30 psig.

However, as already mentioned, the preferred mode of this invention includes the simultaneous application of a compressive force on the top of the bale in order to prevent bale buckling and deformation while the side seams are being bonded. This anti-buckling pressure may range up to 15 psig, and above. A preferred range of anti-buckling pressure is from about 3 psig to about 10 psig. It will be obvious of course, that the greater the anti-buckling pressure, the greater the side seam bonding pressure may be. When an anti-buckling pressure is applied to the top of the pulp bale, the side seam bonding pressure applied will preferably be from about 25 psig to about 75 psig, and most preferably from about 30 psig to about 60 psig.

The compression dwell time may be varied in accordance with the adhesive employed and the compressive force applied to the bale. It must be noted however that the determining factor as to length of compression dwell time is generally the speed of operation of the baling line. Existing automated baling lines generally require that no one operation on a bale have a dwell time of greater than about 30 seconds. Fast baling lines may have a maximum dwell time, for any one operation, of less than about 20 seconds. The present method of adhesive baling is effective to not only meet existing time requirements of baling lines, but also, can substantially reduce the time required for baling. The compression dwell time may be as low as 5 seconds when a high tack, fast dry, adhesive is employed in conjunction with a high compressive force. Preferably however, the time of compression will be greater than about 10 seconds. The upper limit of compression dwell time is limited only by the speed of the baling line, and for example, could be as long as 20 to 30 seconds.

After the side seams have been bonded by application of adhesive and compressive force, the partially baled bundle is ready for formation and bonding of the end flaps. This operation is similar to formation and bonding of the side seams, except that folding the end flaps is somewhat more complex as both a sideways and a vertical fold is required. The folding operation is generally carried out automatically by first folding the projecting side flaps sideways across the end of the bundle, and then folding the top and bottom flaps vertically to overlap the transverse fold. Preferably, the transverse fold is made first, then the bottom flap is folded upwardly, and finally the top flap is folded down over the bottom flap. When the end flaps are to be folded in this manner, adhesive may be applied to the outwardly facing surface of the bottom flap or to the inwardly facing surface of the top flap, or to both of said surfaces. The adhesive may be applied prior to folding the end flaps, or at any time during the folding thereof. As with the side seams, application of adhesive may be by any convenient means such as spraying, extruding, brushing, or rolling; and the pattern of application may be selected as desired, and preferably will be a thin continuous band about 2–10 inches in width.

After adhesive has been applied to the selected surface areas of the end flaps, the flaps are urged into overlapping engagement, and the bale is then ready for the compressive bonding step. Similar to bonding of the side seams, a compressive force of greater than about 10 psig is used to obtain a good bond, with a range of from about 10 psig to about 30 psig being preferable when no downward, anti-buckling compression is utilized. As previously mentioned, the preferred mode of the present invention comprises the simultaneous application of a compressive force to the top of the bale in order to prevent buckling while the end flaps are being bonded. This anti-buckling pressure may range up to 15 psig and higher, and preferably will be from about 3 psig to about 10 psig. When an anti-buckling pressure is applied to the top of the bale, the end flap bonding pressure applied will preferably be from about 25 to about 75 psig, and most preferably from about 30 psig to about 60 psig.

The dwell time for the compression is again dictated by the demands of the particular baling line, and will normally range between about 10 and 30 seconds. Of course, the compression dwell time can be longer than 30 seconds if the baling operation so permits. Times as low as 5 seconds may effect a suitable bond where the compressive force is high and the adhesive has properties of high tack and fast dry.

The adhesive composition utilized in the present method may be any repulpable adhesive which has properties of good tack and fast set time. The adhesive may be a synthetic or natural adhesive derived from plant or animal sources. A preferred class of adhesive compositions is the collagen protein colloids containing from about 30–50 percent collagen protein and from about 50–70 percent water. A second preferred class of adhesives is the polyvinyl acetates containing from about 40–60 percent polyvinyl acetate solids and from about 40–60 percent water. A composition containing 50–55 percent polyvinyl acetate, 40–45 percent water and up to 10 percent of a suitable plasticizer is a particularly good adhesive for baling paper pulp in accordance with this method. Another suitable class of adhesive compositions is the repulpable hot melt adhesives having properties of fast dry and good tack. High solids content dextrine adhesives containing from about 30–50 percent dextrine and 50–70 percent water are also advantageous.

Many other water soluble or water dispersible resins, while not possessing the very rapid dry and high tack characteristics of the above-mentioned adhesives, may be used successfully in slower baling lines. These resins include polyvinyl alcohols, sodium polyacrylate, casein, carrageenin, sodium alginate, methyl cellulose, hydroxyethylcellulose, carboxymethylcellulose, and mixtures thereof. These resins are generally compatible with the collagen protein colloids when in solution, and may be also advantageously combined therewith to provide suitable adhesive compositions for the purposes of this invention.

The adhesive should be repulpable inasmuch as the consumer paper mill will ordinarily want to repulp the wrapper sheets. The presence of a non-repulpable adhesive impregnating the wrapper sheets would render them unsuitable for paper manufacture. By repulpable adhesive is meant an adhesive which is soluble or dispersible in the paper mill pulp beaters, i.e., water soluble or water dispersible. One important advantage of using the protein colloid adhesive described above is that its presence in the final paper product actually enhances the desirable properties of the paper.

It is important to apply the adhesive to the pulp wrapper sheets while in a flowable state, that is, while having a flowable viscosity, such as would be suitable for spraying or extrusion. Thus if the adhesive is normally a solid or a gel at ambient temperatures, as is generally the case with the collagen protein adhesives, it is necessary to first heat the adhesive to reduce its viscosity and thus render it flowable. Application of the adhesive while hot has the further advantage of encouraging rapid migration of the adhesive into the fiber structure of the pulp wrapper sheets during the compressive bonding step. Also, application of the adhesive while hot results in rapid evaporation of solvent, such as water, which may be present in the adhesive, and thus is conducive to quick drying. The lower temperature of application of the adhesive will thus be determined by the point at which it has a flowable viscosity, and will often be room temperature or lower for many adhesives, such as the polyvinyl acetates described above. On the other hand, the collagen protein adhesives will generally be applied at temperatures of greater than about 100° F. The upper temperature of application will be set by the point of thermal deterioration of the particular adhesive employed. Collagen protein adhesives should usually be applied at less than about 180° F., but some hot melt adhesives may be applied at temperatures ranging up to 400° F.

An alternative method of bonding the side seams and end flaps involves perforation of said side seams and end flaps, as by punching small holes therein, during the compressive bonding thereof. In this manner, penetration of the adhesive into the wrapper sheets is greatly enhanced. Moreover, some of the pulp fibers are interlocked during perforation and compression, thus further improving the strength of the bond. These holes should be relatively small and closely spaced. For example, holes of 1/32 inch diameter spaced at one-sixteenth inch or one-fourth inch centers have been found beneficial in achieving good penetration of the adhesive. It is also possible to perforate the projecting sides and ends of the wrapper sheets prior to application of the adhesive.

It should be noted that the excellent results obtained by the inventive method described herein are totally unexpected in view of the very difficult bonding job required. The bonding job is inherently difficult for at least two reasons; (1) the small amount of time available to obtain a strong bond, and (2) the bulky nature of the pulp wrapper sheets. The pulp wrapper sheets are generally about six times thicker than a sheet of paper, and are coarse and unflexible, thus making the pulp difficult to fold and bond. Surprisingly, practice of the present method entails the use of as little as 1 ounce or less of adhesive per 500 lb. bale in many instances.

Apparatus for carrying out the method of the invention is illustrated in the accompanying drawings. FIG. **1** diagrammatically illustrates a typical pulp baling line into which the present invention has been incorporated. A continuous feed of pulp is cut into rectangular sheets and stacked in piles at stacking station **2.** The stacks are then conveyed to weighing station **4** where unit weight stacks, usually about 500 lbs., are obtained by adding or subtracting pulp sheets. The unit weight stack is compressed at compression station **6** to obtain a compact bundle of paper pulp. Top and bottom wrapper sheets are loosely associated with the bundle at wrapper positioning station **8,** and the bundle is conveyed to side seam forming station **10** where adhesive is applied to projecting sides of the wrapper sheets and these sides are folded into overlapping engagement. The overwrapped bundle is then fed to adhesive press station **12** where a high compressive force is exerted on the side seams to obtain a strong adhesive bond. Thereafter, the bundle passes to end flap forming station **14** where the projecting ends of the wrapper sheets are folded to form end flaps and adhesive is applied thereto. The bundle is conveyed to adhesive press station **16** to provide a high compressive force to the end flaps. The completed bale is subsequently transferred to unitizing station **18** where the bales may be stacked in a vertical pile and unitized by securing the pile with a metal strap. The bales are then ready for shipping and/or storage.

FIG. **2** illustrates a preferred method of folding top and bottom wrapper sheets about a paper pulp bundle. In step A, bundle **20** is loosely underlaid with bottom wrapper **21** and overlaid with top wrapper **22.** Bottom wrapper **21** has projecting sides **23** (also referred to as projecting side flanges) and projecting ends **24** (also referred to as projecting end flanges). Top wrapper **22** has projecting sides or flanges **25** and projecting ends or flanges **26.** In step B, bottom wrapper side flanges **23** have been folded upward against the sides of bale **20,** and top wrapper side flanges **25** have been folded downward to overlap the bottom wrapper, thus forming side flaps **27** and side seams **28.** In step C, the side flaps **27** have been folded transversely across the end of bundle **20,** resulting in the formation of bottom flap **29** and top flap **30.** Folding of this bale is completed by urging bottom flap **29** upward against the end of bale **20,** and subsequently overlapping flap **29** with top flap **30.** Side flaps **27,** along with top and bottom flaps **29** and **30** will be referred to collectively as the end flaps.

Referring to FIGS. **1–5,** pulp bundle **20** is positioned on bottom wrapper **21** and is carried in the direction indicated, by endless feed conveyor **31** which is driven by motor **32** through belt **33.** Bottom wrapper folding means **34,** positioned on each side of conveyor **31,** includes vertical guides **35** and contoured guides **36.** Contoured guides **36** are substantially horizontal at trailing edge **34** but are gradually inclined upwardly to a vertical position at leading edge **38.** In this manner, guides **36** can engage the outwardly projecting side flanges **23** of bottom wrapper **21** and urge said flanges into a substantially vertical position by the time bundle **20** reaches leading edge **38.** A top wrapper **22** will be positioned over bundle **20** at this time if such wrapper has not previously been placed in register therewith.

Adhesive application means, generally **39,** includes adhesive tank **40,** pump **41** driven by motor **42,** and applicator heads **43.** Pump **41** draws adhesive through line **44** and valve **45,** and supplies adhesive to applicator heads **43** through lines **46** and valves **47.** Applicator

heads 43 are stationarily mounted on vertical guides 35 by means of brackets 48, and are equipped with nozzles 50 which are positioned to apply a continuous adhesive band along the outer surface of bottom side flanges 23 as these flanges are conveyed in an upwardly extending position past nozzles 50. Nozzle design and pressure can be varied to achieve different patterns of adhesive application. Pump 41, applicator heads 43, and lines 44, 46 may be heated, as by electrical elements (not shown), in order to retain the adhesive in a heated condition until it is applied. Also, adhesive tank 40 may be heated in any convenient manner, as by steam or electrical heat.

Bale 20 is discharged onto endless machine conveyor 52, driven by motor 54 through belt 56, and positions bale 20 at seam forming station 10. Top wrapper folding means, generally 60, are positioned on each side of conveyor 52 and are operable to fold top wrapper side flanges 25 downward to overlap adhesive carrying bottom side flanges 23. Vertical guides 35 extend along each side of conveyor 52 to retain bottom flanges 23 in a vertically disposed position. When bale 20 is positioned opposite top wrapper folding means 60, pivotally mounted, hinged folding plates 62 are actuated to engage side flanges 25 of top wrapper 22. Folding plates 62 are moved in a downward wiping motion by pivotally attached piston rods 64 actuated by cylinders 66. FIG. 3 illustrates folding plate 62 in its downward position, in which position it is retained until bale 20 is discharged from seam forming station 10. Cylinders 66 are rigidly mounted on frames 68 which include cross members 70 and vertical members 72.

Upon completion of the side flanges folding operation, conveyor 52 discharges bale 20 onto endless adhesive press conveyor 74, driven by motor 73 through belt 75. The adhesive compression means, generally 76, includes frame 78 having vertical members 80 connected by horizontal cross member 82. Transverse compression plates 84 are reciprocably mounted at the ends of pistons 184, and pistons 184 are actuated by compression cylinders 86 mounted on vertical frame members 80. Anti-buckling plates 88 is reciprocably mounted at the end of piston 190 below frame cross member 82. Piston 190 is actuated by cylinder 90 mounted on frame cross member 82. When bale 20 is properly positioned at adhesive press station 12, transverse compression plates 84 and anti-buckling plate 88 are actuated to engage the sides and top of bale 20 respectively. After the desired compressive force has been exerted on the bale side seams, compression plates 84 and anti-buckling plates 88 are retracted.

Bale 20 is discharged by conveyor 74 onto endless turntable conveyor 92 which is driven by motor 91 through belt 93. A turntable 94 is associated with conveyor 92 and is operable to turn a bale resting thereon through a 90° arc. Turntable 94 is positioned in the center of conveyor 92 between conveyor flights 96, and is raised vertically by lift arm 98 bearing on index plate 100 which is rigidly attached to turntable shaft 102. Turntable 94 is rotated through a 90° arc, while in a raised position, by action of drive chain 104 mounted on shaft 102. Rotation of bale 20 through a 90° arc results in the sides of the bale being positioned transversely with respect to the direction of advance of conveyor 92.

Turntable conveyor 92 discharges bale 20 onto endless end folding conveyor 106 powered by motor 108 through drive belt 110. Conveyor 106 positions bale 20 at end flap forming station 14. End flap folding means, generally 114, is positioned in association with conveyor 106 and is operable to fold bale side flaps 27 sideways and end flaps 29 and 30 vertically. Apparatus which is particularly suitable for this operation is disclosed in U. S. Pat. No. 3,327,452 to Cranston et al. Generally, the end flap folding means 114 includes bottom flap folders 116, and top and side flap folder 118 which is suspended from carriage 120 on overhead tracks (not shown). Bottom flap folders 116 are mounted on each side of conveyor 106 and comprise a frame 122 which carries a pivotally mounted folding paddle 124 thereon. Paddle 124 is normally disposed in a horizontal direction with respect to conveyor 106, but may be swung through a 90° arc to an upright position by means of piston rod 126 which is pivotally connected to paddle 124. Piston 126 is powered by cylinder 128 mounted on frame 122. Actuation of piston 126 swings paddle 124 through the 90° arc, thus urging bottom flap 29 into a substantially vertical position, as shown in FIG. 3.

The top and side flap folder 118 comprises a top frame 130 carrying guide bar 132. Frame 130 and guide bar 132 are moved vertically by vertical cylinder 134 mounted on carriage 120 and connected to frame 130 by piston 136. Vertical hanger bars 138 are downwardly disposed from slides 140 at each end of guide bar 132. Hanger bars 128 carry transverse horizontal cross bars 142 which may be drawn together and spread apart by cylinders 144 and piston rods 146. Cylinders 144 and pistons 146 are connected to slides 140 at each end of guide bar 132.

The ends of transverse cross bars 142 carry L-shaped side flap folders 148 formed by metal plates 147 and 149. Folders 148 are normally resiliently held in a 45° position by springs 150. Stops 152 limit rotation of folders 148 in one direction, but when they engage a corner of bundle 20, they are rotated against the springs 150 such that plates 147 are in a position perpendicular to transverse cross bars 142. In this manner, a sideways fold is effected on side flaps 27, and top and bottom flaps 29 and 30 are formed.

Top folding paddles 154 are pivotally mounted in journaled shafts (not shown) attached on either side of vertically moving frame 130. Top paddles 154 are normally held in a horizontal position but may be actuated downward through a 90° arc into a vertical position by means of pivotally attached piston rods 156 powered by cylinders 158 mounted on frame 130. In this manner, top flaps 30 can be folded downward to overlap bottom flaps 29.

Adhesive application means, generally 160, includes adhesive tank 162, pump 164 driven by motor 166, and applicator heads 168. Pump 164 draws adhesive from tank 162 through line 169 and valve 170, and supplies adhesive to applicator heads 168 through lines 171 and valves 172. Applicator heads 168 are fixedly mounted by brackets (not shown) on each side of conveyor 106 adjacent the bottom flap folders 116. The heads 168 are equipped with nozzles 174 which are operable to apply a suitable adhesive pattern to the end flaps of bale 20. Pump 164, applicator heads 168, and lines 169, 171 may be heated, as by electrical elements (not shown), in order to retain the adhesive in a heated condition until application. Adhesive tank 162 may be heated by any convenient means.

An alternative means of applying adhesive to the end flaps of a bale involves mounting applicator heads **168** on a moving carriage (not shown) which is operable to advance the applicator heads **168** forward and back along a defined path parallel to the direction of advance of pulp bales **20.** The defined path can constitute a track (not shown) extending a distance equivalent to the breadth of one bale. In this manner applicator heads **168** can be synchronized to perform a two-pass application cycle in sequence with the folding of the end flaps. Thus, once folders **148** have effected a sideways fold on flaps **27,** applicator heads **168** will be automatically actuated to travel forward along the defined path, applying a band of adhesive across the folded end flaps **27.** It is preferable to have metal plates **147** cut out in a horseshoe design so as to enable application of the adhesive across the entire width of bale **20.** Thereafter, bottom paddles **124** will be automated to fold bottom flaps **29** upward against the adhesive-bearing, transverse folded side flaps **27.** Subsequently, applicator heads **168** will be actuated to travel backwards along the defined path returning to their initial position, while applying a band of adhesive across upwardly folded bottom flaps **29.** Finally, top folding paddles **154** will be actuated to fold top flaps **30** downward into overlapping engagement with adhesive-bearing bottom flaps **29.**

Bale **20** is subsequently discharged onto bale press conveyor **176,** driven by motor **175** through belt **177,** which positions bale **20** at end flap compression station **16.** The adhesive compression means, generally **76,** has the same construction and operation as heretofore defined in conjunction with the description of the side seam adhesive press. When a bale is properly positioned at press station **16,** transverse compression plates **84** and anti-buckling plate **88** are actuated to engage the ends and top of the bale respectively. Plates **84** and **88** are then retracted and the completed bale is discharged.

Referring to FIG. **5,** and describing adhesive compression means **76** with greater particularity, it will be seen that adhesive press frame **78** may be mounted on swivel casters **180.** One of the advantages of the present invention is that compression means **76** may be easily rolled into and out of a typical pulp baling line. The baling line need not be rebuilt or otherwise rearranged when employing the present adhesive press system. Thus pulp bundles may be alternatively baled with adhesive or with wire by quickly interchanging apparatus.

Transverse compression plates **84** and anti-buckling plate **88** may have Teflon faces **181** in order to prevent tearing of the pulp wrappers during compression of the bale. Plates **84** are actuated by pistons **184** connected to the plates by bolts **186** through piston faces **188.** Likewise, plate **88** is actuated by piston **190** connected to the plate by bolts **192** through piston face **194.** A hard rubber interface **196** may be provided between faces **188, 194** and plates **84, 88.** Hydraulic cylinders **86** are mounted on frame vertical members **80** by means of bolts **202** through metal plate **204.** Stabilizing guide bars **206** extend from compression plates **84, 88** through frame members **80, 82.** Electric motor **208,** positioned on hydraulic tank **210,** drives vane pump **212** which supplies hydraulic fluid through pressure regulator valve **214** to directional solenoid valve **216.** Directional valve **216** regulates flow of hydraulic fluid to and from cylinders **86** and **90,** through hydraulic lines **218** and **220.** Pump **212** draws hydraulic fluid from tank **210** through line **222,** and directional valve **216** discharges fluid to tank **210** through filter **224.**

Perforation needles **226** may be threaded through Teflon faces **181** into tranverse compression plates **84.** The needles **226** are about one-fourth inch long and are spaced closely together, as for example at one-sixteenth inch or one-fourth inch centers. Actuation of the compression plates **84** causes needles **226** to perforate the side seams and end flaps of bale **20,** thus enhancing penetration of adhesive into the wrapper sheets. Retraction of compression plates **84** and needles **226** causes the needles to self-clean during withdrawal.

Although the adhesive compression means **76** has been shown and described as operated by a hydraulic fluid system, it should be understood that a compressed air system could also be employed, especially at lower compression ranges. A hydraulic system has been described because such a system is more versatile within ranges of high compressive force.

It will of course be understood that the amount of compressive force exerted over the side seams and end flaps of a bale during the adhesive compression step will be a function of (1) the hydraulic or pneumatic pressure directed to the adhesive compression cylinders **86,** (2) the diameter of the pistons **184,** and (3) the surface area of the compression plates **84.**

Excellent results have been obtained by utilizing a 4 inch diameter for pistons **184** (cross sectional area = 12.56 Sq. in.), and using compression plates **84** having dimensions of 30 inches by 14 inches (surface area = 420 sq. in.). With pistons and compression plates of that size, the most preferred range of hydraulic pressure will be from about 1,000 lbs. to about 2,000 lbs., which works out to an actual pressure of 30 to 60 psig across each of the side seams and end flaps of the bale. Actual pressure is calculated by multiplying the hydraulic pressure by the cross-sectional surface area of the piston **184,** and dividing the product by the surface area of compression plate **84.**

Likewise, anti-buckling piston **190** may have a 4 inch dimater (cross-sectional surface area = 12.56 sq. in.). Anti-buckling plate **88** preferably has length and width dimensions slightly greater than that of bale **20;** thus for a 30 by 33 inch bale, plate **88** could have dimensions of 31 by 35 inches (surface area = 1,085 sq. in.). Therefore a hydraulic pressure of 1,000 lbs. applied through piston **190** to plate **88** would generate an actual pressure of about 11.5 psig across the top of bale **20.**

The side flange folding apparatus, end flap folding apparatus, turntable, and adhesive applicator apparatus are preferably operated by a compressed air system. The conveyor system may be operated by electric motors or pneumatic motors as desired. The various pneumatic and hydraulic cylinders are controlled by relay valves which may be actuated either by solenoids in an electric control system or by pneumatic relay valves in a pneumatic control system. In an electrical control system, the various operations and sequences are generally initiated and timed by limit switches actuated by the pulp bale or by moving parts of system, apparatus. In a pneumatic control syste, these functions are generally performed by pilot valves actuated by the bale or by moving parts of the apparatus. The operating and control systems are not illustrated as these are well un-

derstood in the art and the program of operations must serve the varying requirements of each particular pulp baling line. These requirements vary to the extent that no particular control system can be considered as standard. A control system designed for one pulp mill installation would probably not be suitable for another.

Obviously, many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. A method for baling bundles of paper pulp comprising: positioning top and bottom wrapper sheets, having projecting side and end flanges, in register with the top and bottom of a pulp bundle; applying a repulpable adhesive to a portion of the projecting side flanges; forming side seam bonds by folding the side flanges into overlapping relationship, and applying a compressive force of greater than about 10 psig to said overlapping flanges for a time greater than about 5 seconds, while simultaneously applying a downward compressive force to the top of the pulp bundle sufficient to prevent buckling thereof; forming end flaps in the wrapper sheets by folding said projecting end flanges; applying said adhesive to a portion of said end flaps; and forming end flap bonds by applying a compressive force of greater than about 10 psig to said end flaps for a time greater than about 5 seconds, while simultaneously applying a downward compressive force to the top of the pulp bundle sufficient to prevent buckling thereof.

2. The method of claim **1** wherein a compressive force of from about 25 psig to about 75 psig is applied over the side seams and end flaps for from about 10 to 30 seconds.

3. The method of claim **1** wherein the adhesive is applied in a spray pattern and is selected from the group consisting of collagen protein adhesives, polyvinyl acetate adhesives, and hot melt adhesives.

4. The method of claim **1** wherein the side seams and end flaps are perforated during the application of a compressive force thereto.

5. The method of claim **1** wherein a compressive force of from about 30 psig to about 60 psig is applied over the side seams and end flaps for from about 10 to about 20 seconds.

6. The method of claim **2** wherein the adhesive is a collagen protein adhesive and is applied at a temperature of from about 100° F. to about 180° F.

7. The method of claim **5** wherein the adhesive is a polyvinyl acetate adhesive comprising from about 40-60% polyvinyl acetate solids and from about 40-60% water.

8. The method of claim **1** wherein a hydraulic pressure of from about 1,000 lbs. (PSI) to about 2,000 lbs. (PSI) is used to provide the sealing compression force.

9. The method of claim **1** wherein the downward compressive force applied to the top of the pulp bundle is from about 3 to about 15 psig.

10. The method of claim **5** wherein the downward compressive force applied to the top of the pulp bundle is from about 3 to about 10 psig.

11. A system for baling bundles of paper pulp with top and bottom wrapper sheets having projecting side and end flanges and including means for folding the projecting sides of the wrapper sheets along the length of the bundle, and means for forming end flaps from projecting ends of the wrapper sheets, the improvement which comprises: adhesive application means associated with said side folding and end flap forming means for applying adhesive to a portion of the projecting flanges and to the end flaps of said wrapper sheets; and adhesive press means positioned adjacent said side folding means and end flap forming means, said adhesive press means including a conveyor for carrying a paper pulp bundle along a defined path, an anti-buckling compression plate positioned above the conveyor path in a horizontal plane therewith, said anti-buckling plate being reciprocably mounted for vertical movement toward and away from a pulp bundle positioned on said conveyor, and a pair of compression plates vertically disposed on both sides of said conveyor path and reciprocably mounted for horizontal movement towards and away from a pulp bundle positioned on said conveyor.

12. A system for baling bundles of paper pulp with top and bottom wrapping sheets having projecting side and end flanges and including means for folding the projecting sides of the wrapper sheets along the length of the bundle, and means for forming end flaps from projecting ends of the wrapper sheets, and conveyor means for carrying the paper pulp bundle along a defined path, the improvement which comprises: adhesive application means associated with said side folding and end flap forming means for applying adhesive to a portion of the projecting flanges and to the end flaps of said wrapper sheets; and adhesive press means positioned adjacent said side folding means and end flap forming means, said adhesive press means including an anti-buckling compression plate positioned above the conveyor path in a horizontal plane therewith, said anti-buckling plate being reciprocably mounted for vertical movement toward and away from a pulp bundle positioned on said conveyor means, and a pair of compression plates vertically disposed on opposite sides of said conveyor path and reciprocably mounted for horizontal movement towards and away from a pulp bundle positioned on said conveyor means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,775,930 Dated December 4, 1973

Inventor(s) Cecil S. Mercer et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 14, lines 1 and 2, cancel "(PSI)", each occurrence; line 2, "compression" should read -- compressive --.

Signed and sealed this 18th day of February 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,775,930 Dated December 4, 1973

Inventor(s) Cecil S. Mercer, Archibald D. Beveridge, and Frederick A. McDowall

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 5 - after "1970" add --both of which are now abandoned-- ;

Column 3, line 65 - cancel "3C" and substitute therefor --30-- ;

Column 6, line 26 - after "25" add --psig-- ;

Column 8, line 56 - cancel "34" and substitute therefor --37-- ; line 67 - cancel "44" and substitute therefor --114-- ; cancel "45" and substitute therefor --115-- ;

Column 9, line 9 - cancel "44" and substitute therefor --114-- ; line 42 - cancel "plates" and substitute therefor --plate-- ;

Column 10, line 29 - cancel "128" and substitute therefor --138-- ;

Column 11, line 54 - omit "186";

Column 12, line 64 - cancel "system" and substitute therefor --the-- ; line 65 - cancel "syste" and substitute therefor --system-- ;

Column 14, line 33, cancel "wrapping" and substitute therefor -- wrapper --.

Signed and sealed this 24th day of September 1974.

(SEAL)
Attest:

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Attesting Officer

C. MARSHALL DANN
Commissioner of Patents