United States Patent [19]

Wright et al.

[11] **3,762,309**

[45] **Oct. 2, 1973**

[54] **METHOD OF COMPRESSING PAPER PRODUCTS**

[75] Inventors: **Colin S. Wright**, Fort Lauderdale, Fla.; **Robert E. Fogelsong**, Ann Arbor, Mich.; **Jerold W. Johnson**; **Teja S. Jouhal**, both of Cordele, Ga.

[73] Assignee: **American Hoist & Derrick Company**, St. Paul, Minn.

[22] Filed: **Feb. 8, 1971**

[21] Appl. No.: **113,746**

Related U.S. Application Data

[62] Division of Ser. No. 30,837, April 22, 1970, Pat. No. 3,613,556.

[52] **U.S. Cl.** **100/3**

[51] **Int. Cl.** **B65b 13/02**

[58] **Field of Search** 100/9, 99, 3, 7, 100/25, 26, 188, 218, 232

[56] **References Cited**

UNITED STATES PATENTS

583,462	6/1897	Dederick	100/9
646,520	4/1900	Dederick	100/99
679,732	8/1901	Dederick	100/9
3,088,499	5/1963	Rieger	100/218 X
2,984,172	5/1961	Roberts et al.	100/218 X
2,500,819	3/1950	Hall et al.	100/218 X
2,780,989	2/1957	Guy	100/218

FOREIGN PATENTS OR APPLICATIONS

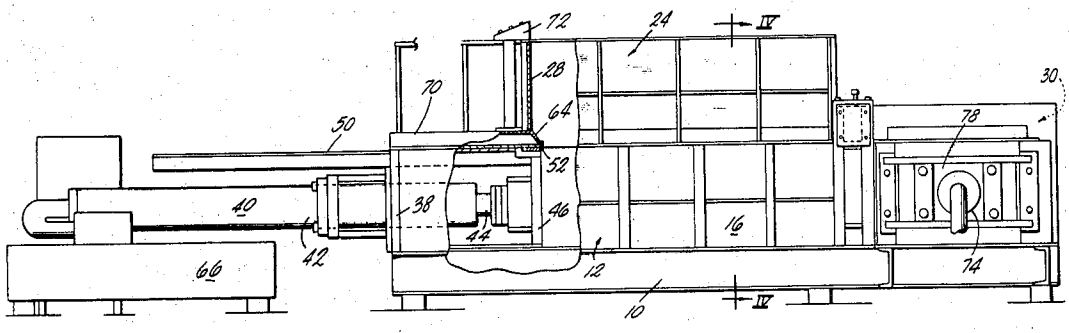
965,906	8/1964	Great Britain	100/3

Primary Examiner—Billy J. Wilhite
Attorney—Beaman & Beaman

[57] **ABSTRACT**

A horizontal baler for baling paper products incorporating a horizontally disposed gathering and compression chamber having an open upper portion communicating with a hopper wherein the paper to be compressed is directly introduced into the hopper and a gatherer and compression ram transfers the paper into a compression chamber to form a parcel of layered compressed material. The paper may be continuously introduced into the hopper as the gatherer ram cycles and a cover plate on the ram receives the paper when the ram is extended, wiping the paper from the cover plate as the ram retracts. Cycling of the gatherer ram continues until a parcel of predetermined compression is achieved, whereupon an ejector or transfer ram perpendicularly disposed to the gatherer ram intermittently transfers the compressed parcel in the direction of the formed compressed parcel layers through automatic strapping apparatus which straps the parcel in a direction perpendicular to the formed layers to define a bale. Gathering, compressing and transferring occurs at substantially the same horizontal orientation, and automatic control means are utilized to permit automatic operation of the apparatus cycle.

2 Claims, 10 Drawing Figures



PATENTED OCT 2 1973

3,762,309

SHEET 1 OF 6

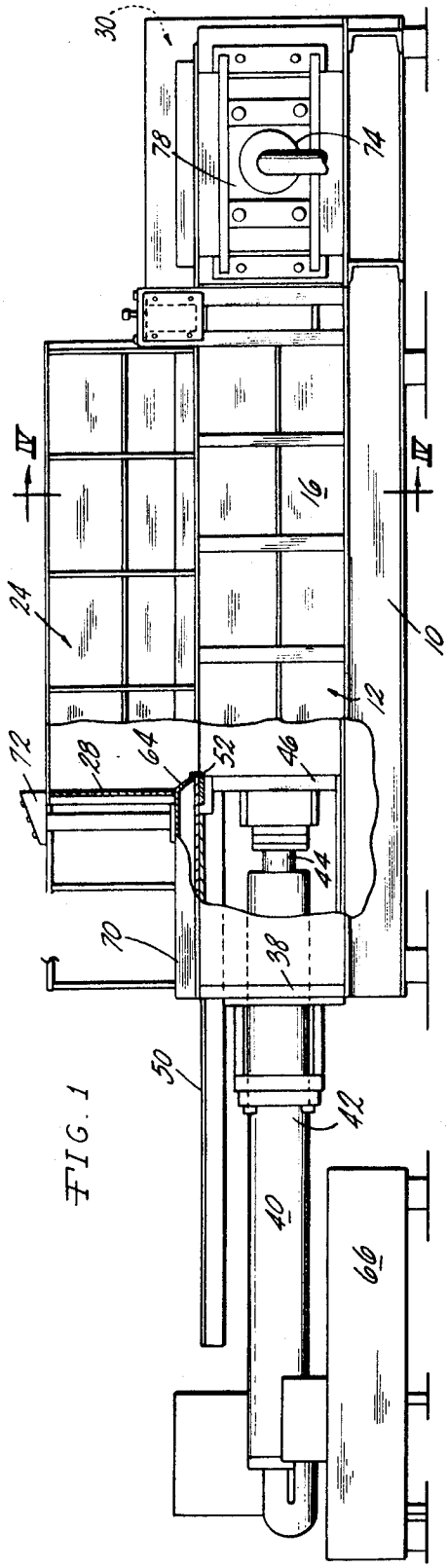


FIG. 1

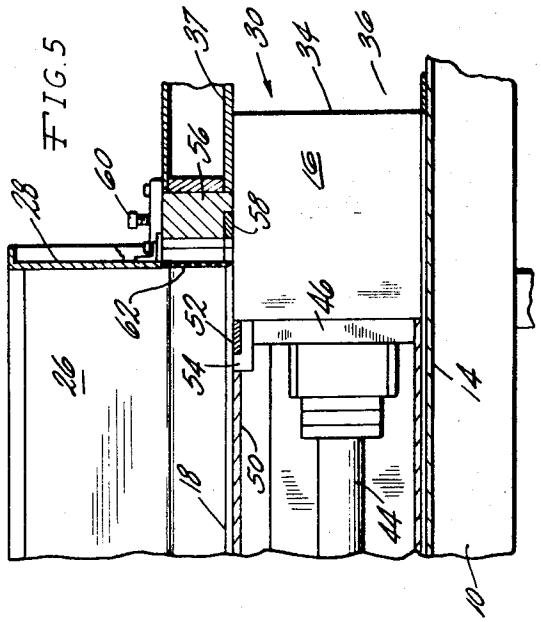


FIG. 5

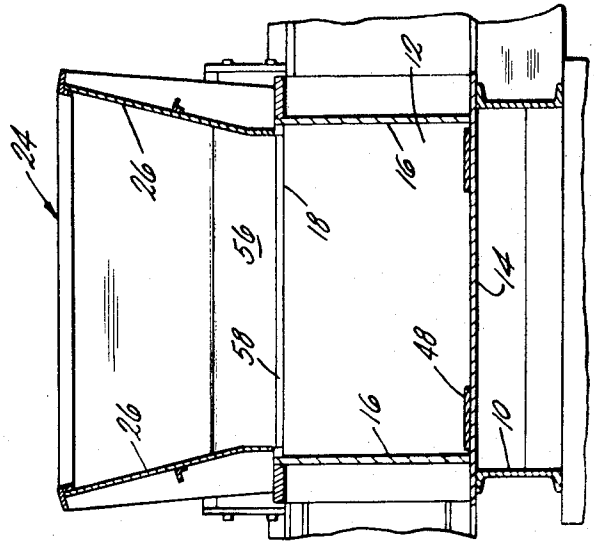


FIG. 4

INVENTORS
COLIN S. WRIGHT
ROBERT E. FOGELSONG
JEROLD W. JOHNSON
TEJA S. JOUHAL
BY Beaman & Beaman
ATTORNEYS

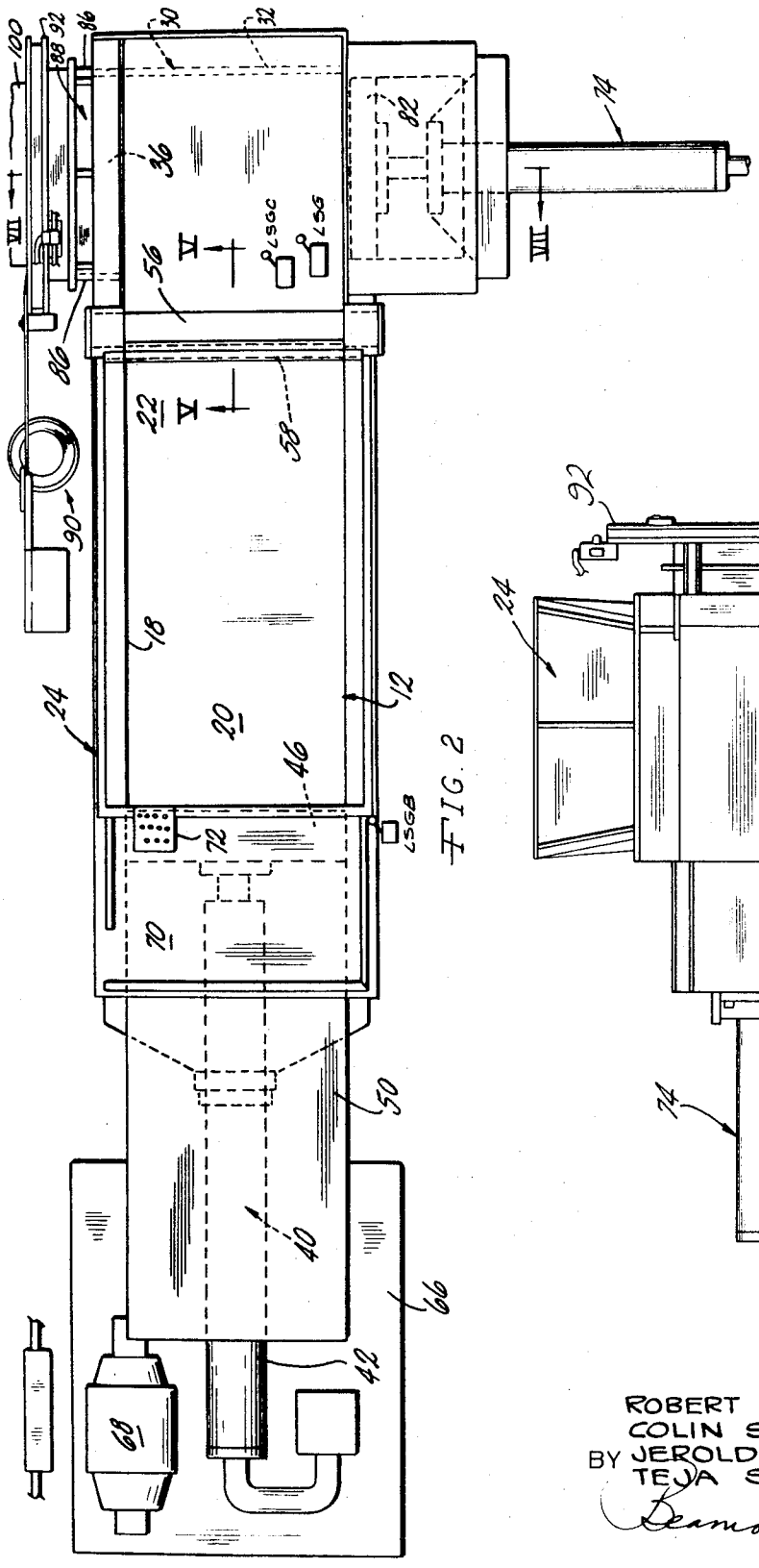


FIG. 2

FIG. 3

INVENTORS
ROBERT E. FOGELSONG
COLIN S. WRIGHT
BY JEROLD W. JOHNSON
TEJA S. JOUHAL
Beaman & Beaman
ATTORNEYS

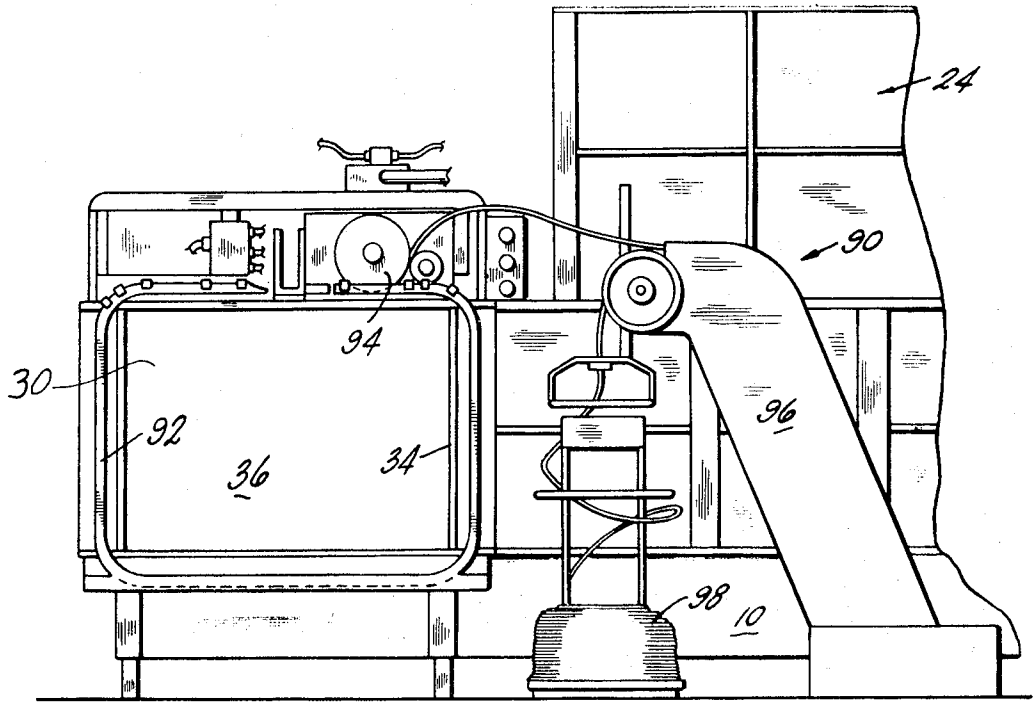


FIG. 6

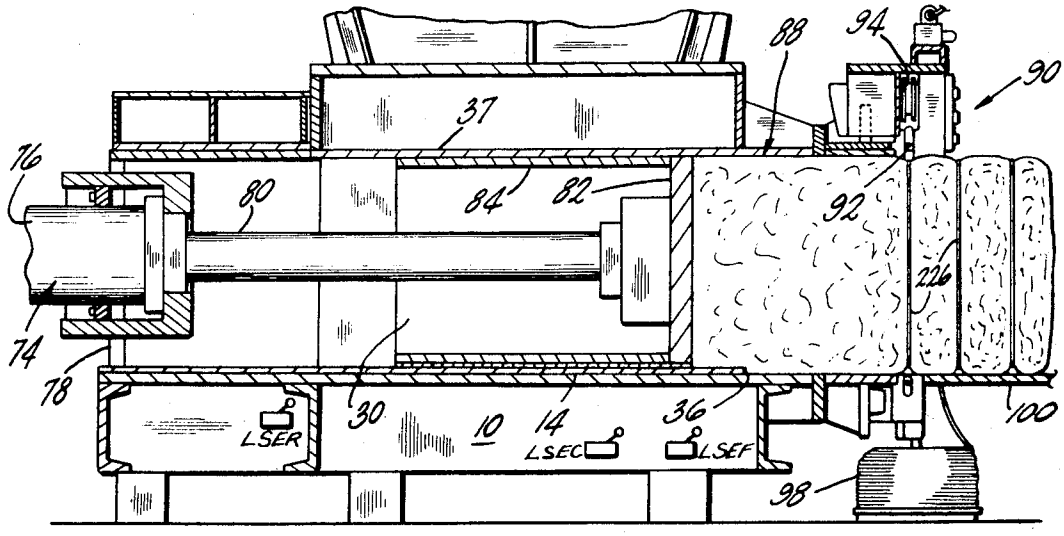


FIG. 7

INVENTORS
COLIN S. WRIGHT
ROBERT E. FOGELSONG
BY JEROLD W. JOHNSON
TEJA S. JOUHAL
Beaman & Beaman
ATTORNEYS

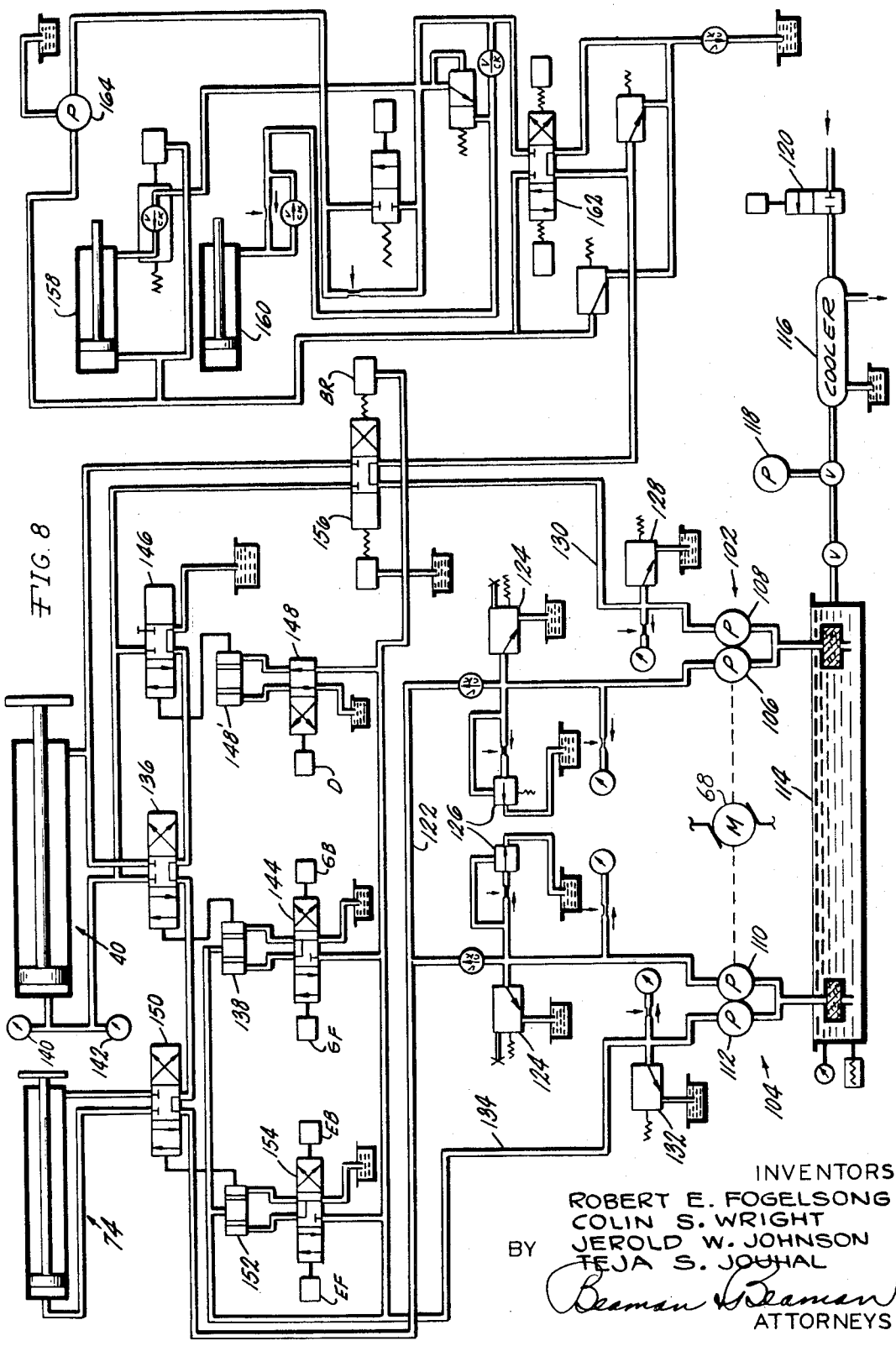


FIG. 8

INVENTORS
ROBERT E. FOGELSONG
COLIN S. WRIGHT
JEROLD W. JOHNSON
TEJA S. JOUHAL
BY Beaman & Beaman
ATTORNEYS

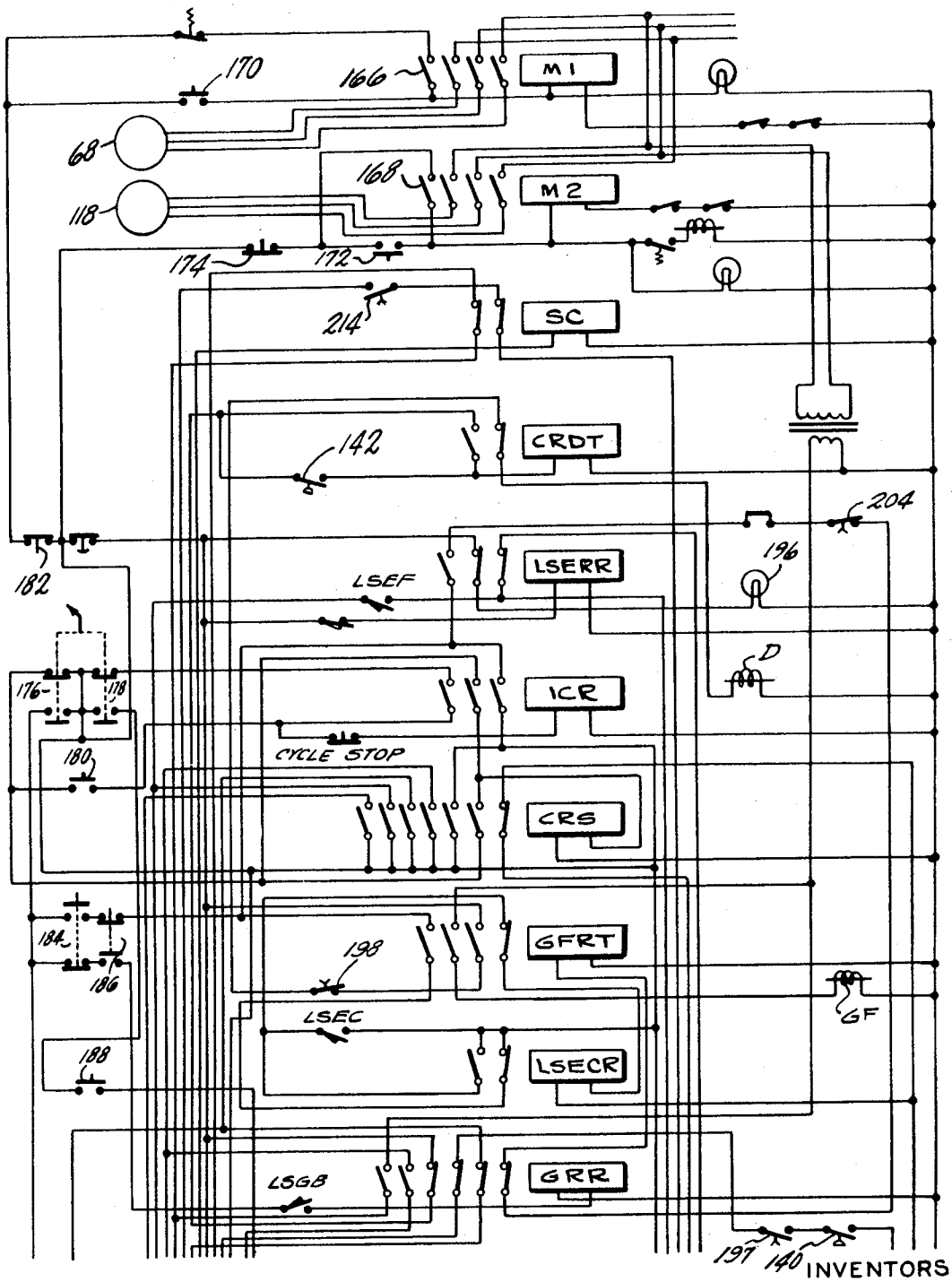


FIG. 9A

INVENTORS
ROBERT E. FOGELSONG
COLIN S. WRIGHT
BY JEROLD W. JOHNSON
TEJA S. JOUHAL
Beaman & Beaman
ATTORNEYS

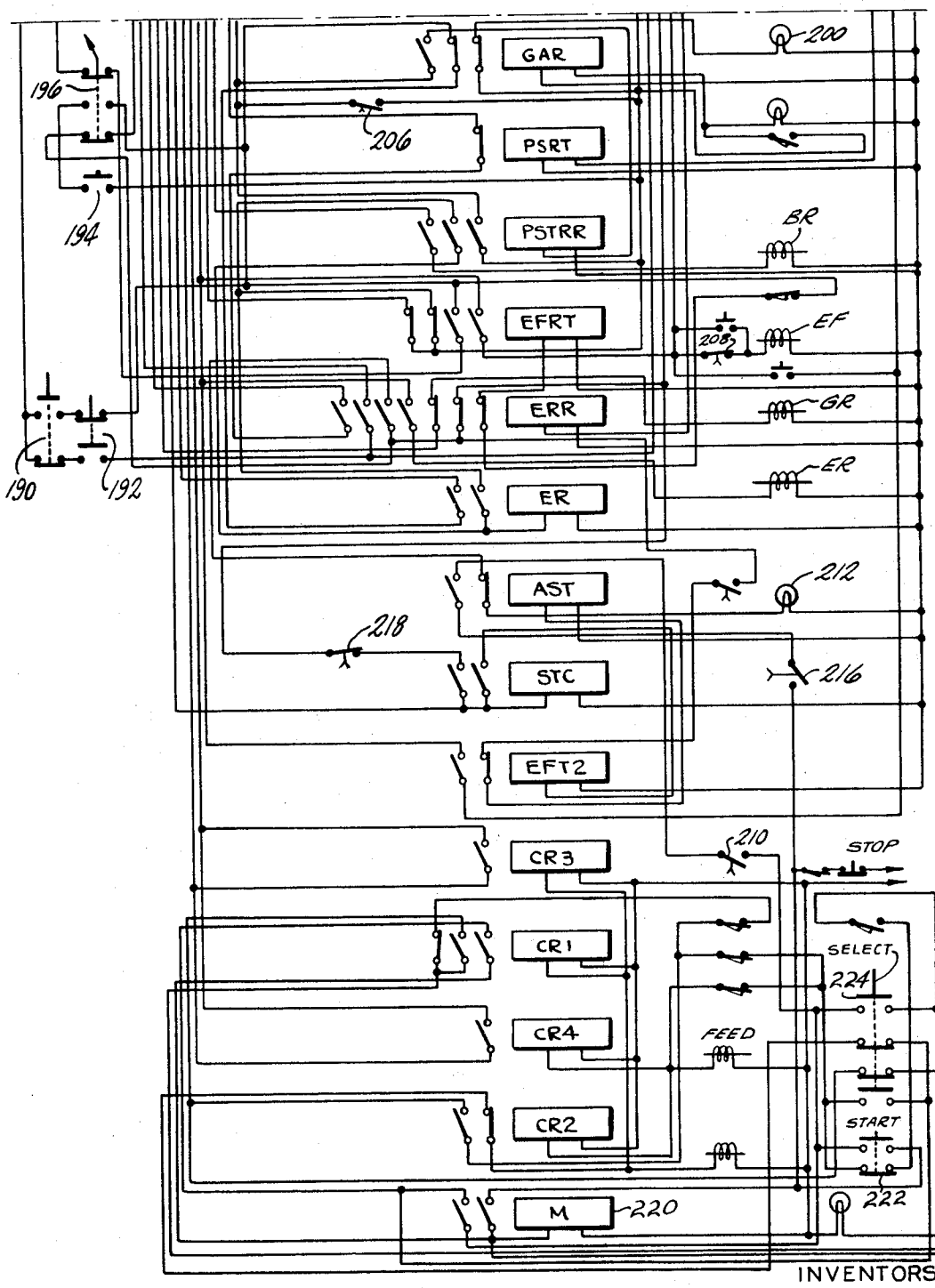


FIG. 9B

INVENTORS
ROBERT E. FOGELSONG
COLIN S. WRIGHT
BY JEROLD W. JOHNSON
TEJA S. JOUHAL
Seaman & Seaman
ATTORNEYS

METHOD OF COMPRESSING PAPER PRODUCTS

CROSS REFERENCE TO RELATED APPLICATIONS

The instant invention is directed to a method of compressing paper products which constitutes an improvement on the assignee's horizontal baler apparatus disclosed in United States Patent application Ser. No. 661,070, filed Aug. 6, 1967, now abandoned, and continuation application Ser. No. 876,214, filed Dec. 1, 1970, now U.S. Pat. No. 3,576,161. The instant application constitutes a division of Ser. No. 30,837, filed Apr. 22, 1970 on Method and Apparatus for Horizontal Baling, now U.S. Pat. No. 3,613,556.

BACKGROUND OF THE INVENTION

The field of the invention relates to the baling of paper products, such as paper, paper board, cardboard, and the like, wherein the product is compressed into a parcel in a series of layers, and is subsequently confined by baling straps disposed in a direction transverse to the general plane of the parcel layers.

In the handling of scrap material it has long been common to compress and bale the same to produce a high density bale, and thereby reduce transportation costs and simplifiy handling. Scrap metal is commonly baled, and in the baling of scrap metal the nature of the material does not usually require strapping in that deforming of the metal past its yield point will permit the bale to be self-defining and shaped. In the baling of resilient, loose, nonmetallic products, such as paper, it is common practice to compress the material into a parcel, an then maintain the configuration of the parcel to form a bale by the use of baling straps or wire. The invention is particularly directed to apparatus for balihg paper products wherein strapping of the compressed parcel is required.

Large capacity paper baling apparatus capable of producing relatively large, high density bales, are usually either of two types, vertical or horizontal. Vertical baling equipment employs a compression chamber through which a vertically moving ram or compression head is translated. Horizontal balers employ a horizontally moving compression ram, and the invention is directed to this latter type in view of the advantages possible with respect to automatic loading, automatic strapping, and the ability to bale large quantities of paper with a minimum of manpower.

Conventional horizontal balers, such as illustrated in U.S. Pat. No. 3,212,434, include an elongated, open end, horizontal chamber into which the material to be compressed is introduced. Compression means in the form of a ram reciprocates with the receiving chamber to force the paper products being compressed into and through the compression chamber. The compression chamber is shaped such that the resistance of movement of the paper through the chamber produces a sufficient compression and density. When the medium has reached the desired density due to compression, a predetermined portion of the compressed material is strapped as it periodically moves through the final stage of the compression chamber. In order to permit strapping, dividers are periodically inserted into the paper being compressed wherein the bale straps or wire may be inserted through the compressed material via the dividers. A disadvantage of this type apparatus lies in the necessity for inserting the dividers, and handling the same, and, additionally, automatic strapping apparatus cannot be readily employed with this type of baler in that the compressed parcel is intermittently moving as it is being strapped.

Although large capacity baling apparatus has been previously manufactured, this type of apparatus has not heretofore successfully adapted itself to automatic strapping equipment, and horizontal baling apparatus such as previously described, does not lend itself to available strapping devices.

Also, conventional baling apparatus of both the vertical and horizontal type usually requires that the paper products introduced therein be previously shredded or comminuted in order to effectively handle the product and produce the desired density. This preliminary operation prior to baling is expensive and troublesome, and a baler capable of being directly supplied without preprocessing the paper has long been desired.

Previous baling devices of both the vertical and horizontal type require several operators in order to achieve the maximum capacity of the baler. These balers were, at the best, only partially automatic in operation and the cycle of operation of known balers does not lend itself to automatic operation. In particular, loading of the baler, and the tying of the bale, are operations which, in the past, required individual attention by the operators.

SUMMARY OF THE INVENTION

The invention pertains the method. of baling large quantities of paper in a relatively short time with a minimum of labor, supervision and maintenance. Additionally, the invention is directed to the method of baling paper products wherein the paper is compressed in a first direction by a series of cycles of a ram wherein a compressed parcel is formed having a plurality of substantially parallel layers perpendicularly disposed to the direction of compression. Thereupon, the method of the invention transfers the compressed particle in a direction substantially parallel to the plane of the parcel layers, and includes the step of strapping or tying the compressed parcel as it is transferred in the direction parallel to the plane of the parceled layers.

In the practice of the invention the baler includes a gatherer chamber directly communicating with a hopper into which the paper product to be baled is continuously introduced. The gatherer and compressor ram which moves the gatherer chamber includes a cover plate upon which the paper product introduced into the hopper is supported as the ram extends, and as the ram retracts, the paper resting thereupon is wiped into the gatherer chamber.

A unique feature of the invention lies in the utilization of shearing means located on the gatherer and compression ram head, and adjacent one end of the gatherer chamber at the entrance to the compression chamber, such that paper products partially disposed within the gatherer chamber and the hopper are sheared prior to the paper being introduced into the compression chamber, and due to the presence of the shearing means the continual feeding of the bulk and unshredded paper into the hopper does not impede the gatherer ram movement.

After the gatherer and compression ram has cycled several times, sufficient paper will have been transferred thereby into the compression chamber to define a compressed parcel of the desired density, and the

compression chamber includes an ejector or transfer ram which transfers the compressed parcel, while under compression, from the compression chamber into automatic strapping means for strapping the compressed parcel to form a bale. The movement of the transfer ram is intermittent, and strapping occurs while the movement of the compressed parcel by the transfer ram is interrupted. The intermittent transferring of the compressed parcel is automatically controlled, and during the transfer and strapping operation, the gatherer ram remains in a modified extended condition such that paper being introduced into the hopper will rest upon the gatherer ram cover plate and be wiped into the gatherer chamber during the initial retraction cycle of the gatherer ram after strapping.

The compression chamber includes a discharge opening in opposed relation to the transfer ram, and this opening will be "closed" by the previously transferred, and at least partially strapped bale. The presence of the previously transferred bale sufficiently closes the compression chamber discharge opening to permit an efficient compression and shaping in the compression chamber during the next parcel compression.

As the compressed parcel moves through the discharge opening under the influence of the transfer ram, parcel retaining means maintains the configuration and compression of the parcel, and strapping of the parcel occurs immediately upon the compressed paper leaving the parcel retainer.

Another of the unique features of the invention lies in the fact that during the final stage of compression of the parcel, the parcel is compressed to a greater extent than is desired in the strapped bale. After final compression of the parcel in the compression chamber, the gatherer ram is slightly retracted to reduce the compression on the parcel prior to its being transferred to the strapper. In this manner the power requirement for transferring the parcel is reduced, and an improved bale is produced in that the likelihood of strap breakage is minimized.

The horizontal disposition of the gatherer and compression chamber permits a very large opening into the gatherer chamber, and a corresponding large entrance into the hopper, and thus the apparatus is able to receive unshredded paper, cardboard, and the like, without clogging. This feature, in conjunction with the shear means located on the gatherer and compression ram head, eliminates many of the leading problems present in conventional paper baling apparatus, and the increased size of the apparatus with respect to known devices also permits the formation of a large bale which is more economically handled than the more common smaller bales.

Balers constructed in accord with the inventive concepts are capable of producing higher baling capacities as compared with balers presently available, while significantly reducing the manpower requirements. The automatic operation of the baler permits the baler to be operated from a central control center, and the construction and layout of the apparatus facilitates servicing and maintenance. The orientation oF the hopper with respect to the apparatus permits the introduction of paper products into the hopper to be accomplished by a conveyor belt, bulldozing, or other low cost material handling techniques.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned advantages of the method of the invention will be appreciated from the following description of an embodiment illustrated in the accompanying drawings wherein:

FIG. **1** is a side elevational view of baler apparatus constructed in accord with the invention, a portion thereof being broken away for purpose of illustration,

FIG. **2** is a top plan view of the baler apparatus, the gatherer and transfer rams being shown in dotted lines in the retracted position,

FIG. **3** is an elevational end view as taken from the right of FIG. **2**,

FIG. **4** is an elevational, sectional view taken through the gatherer chamber along Section IV—IV of FIG. **1**,

FIG. **5** is a detail elevational sectional view as taken along Section V—V of FIG. **2** illustrating the shear structure located on the frame and gatherer and compression ram head, and illustrating the head as it approaches the entrance to the compression chamber,

FIG. **6** is an elevational, detail view of the compression chamber end of the baler apparatus as taken from the opposite side shown in FIG. **1** illustrating the bale strapping or tying equipment.

FIG. **7** is an enlarged, detail, elevational, sectional view taken through the compression chamber and strapping apparatus along Section VII—VII of FIG. **2** illustrating the transfer ram in an extended condition,

FIG. **8** is a circuit diagram of the hydraulic control system employed with the baler of the invention, and

FIGS. **9***a* and **9***b* are electrical circuit diagrams of the electric circuit employed in the described embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The baler apparatus in accord with the invention includes a frame generally indicated at **10** which consists of channel and I beams supported in a substantially horizontal manner. Located upon the frame **10** is a gatherer chamber **12** defined by a bottom plate **14**, FIG. **4**, and side walls **16**, and is defined at its upper portion by an opening **18** which is of a width substantially corresponding to the horizontal width of the chamber as defined by the side walls **16**, and of a length defined by the end regions **20** and **22**, FIG. **2** of the gatherer chamber.

A hopper **24** is located upon the gatherer chamber **12**, and is defined by obliquely disposed walls **26**, and end walls **28**. It will be apparent from the drawings that the plan configuration of the hopper substantially corresponds to that of the gatherer chamber opening **18** wherein paper products introduced into the hopper will be dispersed throughout the length of the gatherer chamber, when the gatherer and compression ram is in the retracted position. In the commercial embodiment of the invention the opening **18** of the gatherer chamber is 10 feet long and 5 feet wide, and the resultant bale formed is 4 × 3 × 5 feet long, the length of the bale being defined by the width of the compression chamber, as will be later described.

A compression chamber generally indicated at **30** is defined on the frame **10** in alignment with the gatherer chamber **12**. The compression chamber may be considered as an extension of the gatherer chamber in that it is in direct alignment with the gatherer chamber, and

the entrance to the compression chamber is defined at the gatherer chamber end region **22.** The compression chamber **30** is defined at its lower region by an extension of the bottom plate **14,** and the compression chamber includes an end wall **32.** The left side wall **16** of the gatherer chamber, FIG. **4,** extends into the compression chamber to the edge **34,** FIG. **5,** of the opening **36,** defined in the compression chamber which forms the discharge opening therefor. Likewise, the right side wall **16** extends into the compression chamber to the head of the transfer ram as will be described. The upper dimension of the compression chamber is defined by the top plate **37,** FIGS. **5** and **7.**

An end plate **38** is defined upon the frame **10,** and the gatherer and compression ram **40** is mounted thereon. In the specification and claims the ram **40** is often designated as the "gatherer ram," and this ram serves to both gather the paper products within the gatherer chamber, as well as produce the compression of the parcel of paper products formed in the compression chamber, thus the ram **40** performs the dual function of gathering and compressing in the described embodiment. The ram **40** includes a cylinder **42** in which the piston **44** reciprocates. The cylinder **42,** in the commercial embodiment, has a 12 inches internal diameter, and is capable of exerting a pressure of **135** tons upon the piston. The piston includes a head **46** of a rectangular configuration corresponding to the cross sectional configuraion of the gatherer chamber **12,** and the head rides upon wear rails **48** mounted on the bottom plate **14,** FIG. **4.**

The head **46** includes an upper cover plate **50** affixed to the upper regions thereof which extends the width of the gatherer opening **18,** and the cover plate **50** extends rearwardly from the head back over the cylinder and piston a sufficient distance wherein upon full extension of the piston **44** the cover plate will completely close the opening **18** such that paper products being introduced into the hopper **24** when the piston is completely extended are received and supported upon the cover plate **50** and will not fall "behind" the head **46.**

At the upper edge of the head **46** a shear blade or knife **52** is mounted in a support beam **54.** The knife **52** extends across the width of the head **46,** and moves with the head.

The shear beam knife which cooperates with the ram mounted knife **52** is mounted upon the frame **10** adjacent top plate **37** upon a shear beam **56** disposed across the gatherer chamber and axially located at the entrance to the compression chamber **30,** FIG. **5.** The shear beam **56** is of a substantial strength in order to prevent bending, and includes a knife **58** at its lower region capable of forming a shear relationship with the head mounted knife **52** as the head mounted knife passes thereunder as the ram head **46** enters chamber **30.** The shear beam and knife extend across the width of the gatherer and compression chambers, and an adjustment screw **60,** and shims are employed with the shear beam and beam knife in order to very accurately locate the beam knife on the frame to produce the desired shearing clearance with the head knife.

The purpose of the knives **52** and **58** is to shear off paper products that are being transferred by the head **46** into the compression chamber **30,** but are out of alignment with the compression chamber, i.e., partially extending above the head into the hopper **24.** The beam knife **58** has a 2° rake angle defined thereon, FIG. **2,** and a rubber closure apron **62** extends in front of the shear beam **56** to provide protection. As the head **46** passes under the shear beam **56,** the material within the hopper that is sheared by the knives **52** and **58** merely falls back on the ram cover plate **50,** and this material is wiped into the gatherer chamber by the hopper wiping wall **64,** FIG. **1,** as the gatherer ram and cover plate is retracted and passes under the wiping wall.

A support **66** is mounted below the cylinder **42** and the electric motor **68** and hydraulic pumps, as well as the control apparatus, gauges, etc., are mounted upon the support **66** which constitutes the reservoir for the required hydraulic fluid. Also, a control platform **70** is defined upon the frame **10** adjacent the gatherer chamber ram end region **20** which includes the control panel **72** such that the operator at the control panel may have direct visibility into the hopper and the gatherer chamber, and thereby supervise the baler operation from this central location.

An ejector or transfer ram **74** is mounted on the frame **10** adjacent the compression chamber **30** and includes a cylinder **76** which is mounted in the wall **78** formed on the frame **10.** The cylinder **76** receives a piston **80** terminating in the transfer head **82.** The transfer head **82** is of a rectangular configuration substantially corresponding to the dimensions of the compression chamber, and the head face, when retracted, is in substantial alignment with the right gatherer chamber side wall **16,** FIG. **4,** as to constitute an extension thereof when the paper is being compressed in the compression chamber. At this time, the transfer ram piston is fully retracted.

The transfer head **82** is of slightly less dimension that the compression chamber discharge opening **36,** and is of similar configuration whereby when the transfer ram is fully extended, the head **82** may pass through the discharge opening. A skirt **84** is mounted upon the transfer ram to prevent paper from accumulating behind the head. Suitable conduits connect the double-acting cylinder of the transfer ram with the hydraulic pump and control apparatus.

At the compression chamber discharge opening **36,** the top plate **37,** and the bottom plate **14** may be extended to the right as shown in FIG. **7,** and side walls **86** are defined on the frame which extends away from the head **82** in alignment with the discharge opening such that a "nozzle" or bale retainer passage **88** is defined adjacent the compression chamber discharge opening **36** to maintain the compressed state of the parcel prior to strapping.

Bale strapping occurs at the exit of the parcel retainer passage, and the apparatus for strapping the bale may be of the type manufactured by United States Steel Model 203 which employs round strap of **12** through **15** gauge. The particular features of the strapping apparatus **90** do not form a part of the present invention and will only basically be described. The apparatus **90** includes a rectangular shaped track **92** through which the strap passes during tying and drive wheels **94** for driving the strap are mounted upon the apparatus adjacent the exit of the parcel retaining passage. The strapping apparatus also includes feeding apparatus **96,** and strap supply means upon which a coil **98** of tying strap is supported for feeding into the tying mechanism. The strapping apparatus illustrated is fully automatic, and as will be described, includes control means which are interconnected with the other controls of the baler.

A bale supporting platform **100** is disposed adjacent the frame **10** having a supporting surface in substantial alignment with the bottom plate **14** such that the strapped bale may be received thereon as it is indexed by the transfer ram. Of course, the bale receiving platform may comprise a loading dock or other material handling surface, such as a conveyor.

The fluid current employed with the disclosed baler is illustrated in FIG. **8**, and this current includes a large electric motor **68**, such as of 100 H.P., which is connected to a pair of dual, high/low capacity high pressure pumps **102** and **104**. The stages **106** and **108** of pump **102** are capable of pumping **70** and **12** gallons per minute, respectively, at pressures up to 2200 pounds per square inch. The stages **110** and **112** of the pump **104** are capable of pumping **60** and 7.5 gallons per minute, respectively, at 2200 pounds per square inch.

The fluid reservoir **114** is located in support **66** and has associated therewith a heat exchanger **116** for lowering the temperature of the hydraulic fluid, and a circulating pump **118** provides circulation between the reservoir and the cooler **116**. Cooling water fed into the heat exchanger **116** is controlled by a solonoid operated valve **120**, and appropriate thermometers and thermostats are associated with the reservoir to maintain the desired temperature of the fluid.

The high capacity pump stages **106** and **110** communicate with a common conduit **122**, and relief check valves **124** communicate with these stages, as do the vent valves **126**. The relief check valves **124** maintain the desired pressure of 2200 pounds per square inch. A maximum pressure valve **128** communicates with the output of the pump stage **108** for maintaining 1300 pounds per square inch in the conduit **130**, and the pressure valve **132** communicating with the output of the pump stage **112** maintains 500 pounds per square inch in the output conduit **134**.

The gatherer ram **40** is of the double acting type and is controlled by the control valve **136** which is positioned by the control cylinder **138**. A pair of pressure switches **140** and **142** communicate with the pressure end of the ram **40** as illustrated. The switch **140** operates between 700 and 1200 pounds per square inch, while switch **142** is set to operate at 1000 psi. The control valve **136** is supplied with high pressure fluid from the conduit **122**, and the position of this valve, as determined by the control cylinder **138**, is regulated by the low pressure control valve **144** communicating with conduit **134**. The valve **144** is solonoid operated and is operatively connected to electric solonoids GF and GB.

A second control valve for the compression side of the gatherer ram **40** is located at **146**, and this valve is positioned by the small control cylinder **148**', which is in turn operated by the solonoid operated valve **148** which communicates with the low pressure conduit **134**, and whose position is determined by the solonoid D. The valve **146** also selectively communicates with the high pressure conduit **122**.

Control of the ejector or transfer ram **74** is accomplished through the high pressure valve **150** which is supplied from the conduit **122**. Positioning of this valve is under the control of the cylinder **152**, which is positioned by the low pressure valve **154**. The position of the valve **154** is controlled by solonoids EF and EB.

Valve **156** controls the hydraulic supply to the hydraulic components of the strapper shown at the right of FIG. **8**. The valve **156** communicates with the pump stage **108**, as well as with both sides of the gatherer ram piston **44**, and the position of the valve **156** is determined by solonoid pilot BR. The strapper circuit includes a gripper ram **158** for holding the strap during securing, and a knotter ram **160** is also included in the circuit. These rams are controlled through a valve **162** operated by solonoids which position the valve in one of its three operative conditions. The circuit also includes a pump **164** communicating with the reservoir **114** and the gripper and knotter rams.

Pressure switch **142**, as will be later described, is used to sense the pressure during compression, and pressure switch **140** is employed to sense the occurrence of the desired compression pressure.

The electric circuitry used with the apparatus is shown in FIGS. **9***a* and **9***b*, FIG. **9***b* being a continuation of the circuit shown in FIG. **9***a*.

Starting of the primary pump motor **68** is achieved through relay **166**, while starting of the hydraulic fluid cooling pump **118** is controlled by relay **168**. Switch **170** activates the primary pump motor, while start switch **172** and stop switch **174** is connected to the circulating motor. Whether the baler is to be operated under automatic or semiautomatic control is determined by the switches **176** and **178**, switch **176** constituting the automatic control, while switch **178** places the system under semiautomatic operation. The start cycle is controlled by switch **180**, while stopping of the cycle is controlled by switch **182**.

Forward motion of the gatherer ram under manual control is achieved by the switch **184**, while retraction of the gatherer ram is operated by switch **186**. The gatherer position control occurs at switch **188**.

Operation of the ejector or transfer ram on a manual basis is accomplished by switches **190** and **192** which produce the forward and return motions of the transfer ram, respectively. The ejector forward jog ram switch appears at **194**, and the ejector index and manual control switch is shown at **196**.

The solonoids for the control valves and the relays indicated on the drawings are as follows: Relay SC is the automatic strapper in cycle relay and includes normally closed contacts controlling the transfer ram forward solonoid EF and the "strap cycle complete" relay STC. The transfer ram forward contact is open during strapping. Relay CRDT includes a normally closed contact supplying differential valve **148** control solonoid D, and also includes a normally open circuit which bypasses the pressure switch **142**. Additionally, relay CRDT controls timed closing switch **197** and is in series with pressure switch **142**.

The return control relay for the transfer ram LSERR includes a normally closed contact operating the indicating light **196** for indicating when the transfer ram is not retracted. Additionally, this relay control includes a normally open contact in the forward gatherer ram circuit as indicated by relay GERT, and a normally closed contact in the circuit to the transfer ram return control relay ERR.

The automatic control relay ICR includes the normally open contact in the selector switch circuit **176–178** determining automatic or manual operation, and also includes a normally open contact in the cycle start circuit CRS as well as a normally open contact in the gatherer ram forward circuit relay GFRT.

The cycle start relay CRS includes a normally open switch in its own circuit, and a normally open switch in the gatherer ram forward circuit GFRT, a normally open switch in the gatherer ram return circuit GRR, a normally open circuit in the transfer ram forward circuit EFRT, as well as the transfer return circuit ERR, a normally closed circuit in the bypass circuit to solonoid EF, and a normally open circuit in the strapper start circuit AST.

The gatherer ram forward relay GFRT includes a normally open circuit controlling the gatherer ram forward solonoid GF and a time controlled switch **198,** normally closed, in the circuit to solonoid D. Additionally, this relay includes a normally open circuit in its own supply and a normally open circuit to the solonoid D.

The transfer ram return cycle complete relay LSECR includes a normally closed contact in the gatherer forward circuit and a normally open contact in its own circuit bypassing limit switch LSEC. The gatherer ram return relay GRR includes a normally open circuit to solonoid GR, a normally closed contact in the gatherer ram forward circuit GFRT, a normally open contact in its own circuit, a normally closed contact in the range force circuit PSRT, a normally closed contact in the CRDT circuit, and a normally open contact in the transfer ram forward circuit EFRT.

The gatherer ram position circuit GAR includes a normally closed contact in series with the pilot light **200** to indicate when the gatherer ram is in the proper position for operation of the transfer ram, and includes a normally open contact in the PSTRR circuit and a normally closed contact in the transfer ram forward circuit EFRT.

The range force circuit PSRT includes a normally closed circuit in the gatherer ram return circuit GRR, a time controlled normally closed switch **204** in the gatherer ram forward circuit GFRT, and a time controlled normally open switch **206** in the PSTRR circuit.

The PSTRR circuit includes the normally open contact in series with solonoid BR with respect to the gatherer ram position, and includes a normally open circuit bypassing time controlled switch **206** supplying the relay, and normally open contacts of this relay are included in the transfer ram signal relay circuit er.

The transfer ram forward circuit EFRT, which is for the first strap on index or forward to limit switch LSEF on ejection of the bale, includes normally open contacts in the ejector forward circuit to solonoid EF, as well as the normally closed timed opening switch **208** in the same circuit. Additionally, this relay includes a normally closed contact in the range force circuit PSRT, a normally open contact in its own circuit from the transfer ram switch **190–192,** a normally closed circuit in the transfer ram signal circuit ER, and a timed closing normally open switch **210** in the circuit to the automatic start control relay AST for the strapper.

The transfer ram return circuit relay ERR includes a normally open circuit supplying solonoid ER, a normally closed circuit to the ejector forward relay EFRT, a normally open circuit bypassing limit switch LSEF, a normally closed circuit to the gatherer ram return solonoid GR, a normally open circuit in the gatherer ram return circuit GRR, a normally open contact in the circuit to the indicator light **212** to indicate when the strapping operation has been completed, and a normally closed contact in the circuit to strap cycle complete relay STC.

The transfer ram signal relay ER includes a pair of normally open contact switches which are in the circuit to the transfer ram forward relay EFRT and a normally open circuit bypassing the normally open circuit PSTRR supplying relay ER.

Relay AST includes a time controlled closing switch **214** normally open in the circuit to strapper cycle complete relay STC. Additionally, this relay controls a normally closed timed opening switch **216** to the supply for the automatic strapper, a normally open contact in the same circuit, and a normally closed contact in the indicator light **212** to indicate completion of the strapping cycle.

The strapper cycle complete relay STC includes a pair of normally open circuits in series with each other and the transfer ram forward relay EFT**2.** The EFT2 relay includes a normally open circuit in the transfer ram solonoid EF, a normally closed circuit in the strapper circuit AST, and a timed opening, normally closed, switch **218** in its own circuit.

Relays CR**1,** CR**2,** CR3 and CR4 control the automatic operation of the strapper apparatus, and the operation of these relays, and their associated equipment automatically occur to perform the desired sequential operation of the strapper. The strapper motor starting relay is indicated at **220,** the strapper start switch is at **222** and the select switch is at **224.** The strapper circuit includes a plurality of limit switches to produce the desired operation and the operation of the strapper circuits do not form a part of the instant invention other than the correlation of the operation of the strapper to the operator of the gatherer and transfer rams.

Several limit switches are mounted upon the baler apparatus to sense the position of the gatherer ram and the transfer ram. These limit switches are schematically represented in FIGS. **2** and **7** and are operated by suitable actuating means mounted on the associated piston or head, not shown. Limit switch LSGB indicates the full retraction of the gatherer ram, while switch LSGC indicates the mormal movement of the gatherer ram while cycling to transfer paper products from the gatherer chamber **12** into the compression chamber **30.** Limit switch LSG indicates the position of the gatherer ram when the transfer ram is energized to transfer the compressed parcel from the compression chamber into the discharge opening, and through the strapper.

Limit switch LSER is employed with the transfer ram to indicate complete retraction thereof. Switch LSEC indicates the position of the traverse ram when the strapping cycle begins, and limit switch LSEF indicates the full extension of the traverse ram.

Operation of baler apparatus in accord with the previously described embodiment is as follows:

Initially, the gatherer ram piston **44** will be fully retracted, as will the transfer ram piston **80,** and the strapping apparatus will be in a deenergized state. After the operator has started the pump motor **68** and the other motors previously described, such as the recirculating and strapper motors, paper products are then introduced into the hopper **24** from a location above the hopper. An endless conveyor may be used for this purpose, or if the baler apparatus is mounted in a pit, or at a location below a floor surface, the paper products may be bulldozed or otherwise transferred into the hopper. It is one of the advantages of the invention that

paper products may be continually introduced into the hopper, and upon the paper products being supplied to the apparatus the automatic run switch **176** may be energized to begin the reciprocation of the gatherer ram **40.** If desired, the operator may defer initiation of the gatherer ram movement until the gatherer chamber **12** has been substantially filled. Upon the operator initiating the cycling of the gatherer ram, the solonoids GF and D will be energized which produces an actuation in the valves **144** and **148,** respectively, to permit pressurized fluid to be introduced into the left, or pressurized side of the gatherer ram piston, FIG. **8,** which causes the gatherer ram and head to move towards the compression chamber **30.** During the initial stage of compression the valves **136** and **146** are positioned such that fluid being exhausted from the piston rod side of the gatherer ram is introduced into the pressurized side of the piston. This utilization of the hydraulic fluid exhausted from the piston rod side of the gatherer ram constitutes a regeneration cycle which permits a maximum amount of pressurized fluid to be introduced into the pressurized side of the gatherer ram such than an initial rapid movement of the ram is possible.

During the initial movements of the gatherer ram, the conduit **122** will be supplied from both pump stages **106** and **110.** When the resistance to movement becomes great enough to cause a fluid pressure within the supply conduit to approximately reach 1000 pounds psi, such a condition is sensed by the pressure switch **142** which then opens and deenergizes solonoid D which causes the valve **146** to shift and terminate the regeneration cycle by exhausting the fluid on the piston rod side of the gatherer ram to the reservoir. The gatherer ram piston then continues to compress the material within the compression chamber **30.**

Completion of the first stroke of the gatherer ram is sensed by the limit switch LSGC located adjacent the entrance to compression chamber **30.** Closing of the limit switch LSGC will energize relay GRR and deenergize relay GFRT thereby energizing solonoid GB and deenergizing solonoid GF. This sequence permits pressurized fluid to be introduced into the piston rod end of the gatherer ram and retract the ram. The compressed paper material will remain within the compression chamber **30** when the gatherer ram is retracted.

Retraction of the gatherer ram **40** is sensed by the limit switch LSGB. When the apparatus is set for automatic operation the actuation of the limit switch LSGB will cause an actuation of the relay GFRT which will reenergize the solonoids GF and D and condition the circuit to again move the gatherer ram toward the compression chamber. In this manner the gatherer ram is cycled between its extended and retracted positions, and during this cycling the paper products to be compressed continue to be introduced into the hopper. Depending upon the position of the gatherer ram, paper introduced into the hopper will either fall directly into the gatherer chamber **12,** or rest upon the ram cover plate **50.** The paper resting upon the cover plate is wiped from the cover plate by wall **64** as the ram retracts, and falls into the gatherer chamber.

As the gatherer ram cycles, any paper products that may not have completely fallen in the gatherer chamber, and may be extending above head **46** as to be partially located in the gatherer chamber and the hopper, are sheared by the knife blades **52** and **58** as the gatherer ram head **46** enters the compression chamber. As previously described, this shearing prevents the apparatus from clogging, and insures the desired automatic operation. The shearing produces a "self-cleaning" action which significantly reduces the attention required.

The final stroke of the gatherer ram is determined by pressure switch **140** which indicates the presence of sufficient paper material within the compression chamber to produce a bale of the density and dimension desired. Upon operation of pressure switch **140,** the gatherer ram continues forward until timed relay PSRT times out. At this time, solonoid BR is energized and the gatherer ram head **46** retracts to limit switch LSG located adjacent the entrance to the compression chamber. This retraction of the gatherer ram amounts to approximately 3 ½ inches from the maximum extension of the head **46,** and by retracting the gatherer ram this extent, the compression pressures on the paper parcel within the compression chamber are reduced permitting the transfer ram to be of a smaller size than would otherwise be required, and produces a more desirable transfer motion. Additionally, the release of the "overcompression" of the compressed parcel within the compression chamber minimizes the likelihood of damage to the bale straps during handling of the bales.

Limit switch LSG senses the appropriate time for operation of the transfer ram **74.** Limit switch LSG is maintained actuated during the duration of the overtravel by the gatherer ram. Upon the release of limit switch LSG, timed relay EFRT is energized, solonoid EF is energized and the transfer ram **74** receives pressurized fluid to extend the piston **80** and translate the head **82** across the compression chamber in a direction perpendicular to the direction of movement of the gatherer ram. As the transfer ram piston extends, the head **82** begins pushing the compressed paper parcel within the compression chamber through the discharge opening **36** in an intermittent manner into the parcel retaining passage **88.** The parcel is automatically strapped by the strapper **90** as the intermittent movement of the transfer ram moves the compressed parcel through the strapping aPparatus.

Upon the release of limit switch LSG relay EFRT is energized which begins the movement of the forward motion of the transfer ram. Relay AST, which signals the automatic strapping cycle, is energized and the transfer ram moves forward for a predetermined time under the influence of the timed contact of relay EFT2. After the predetermined timed movement of the transfer ram, the ram movement ceases and the strapper cycle places a strap around the bale in alignment with track **92.** This intermittent movement of the transfer ram takes place until limit LSEF is engaged before EFT2 times out and each time the transfer ram movement ceases the strapper cycle is energized to place a strap around the bale. The length of movement of the transfer ram head **82** during each indexing movement will usually be approximately 12 inches, in that this spacing between baling straps **226,** FIG. **7,** is adequate for most paper products. The track **92** lies in a plane that is substantially perpendicular to the plane of the layers defined in the compressed parcel and, thus, the straps **226** will most effectively retain the compression of the material forming the bale. As the strapped bales are pushed on to the platform **100** they are removed as strapping for each bale is completed. In the described machine, a bale will be completely strapped when the

transfer head pushing on the following bale is substantially half way across the compression chamber **30.**

Limit switch LSEF will sense the full extension of the transfer ram **74,** and the limit switch LSEF will automatically return the transfer ram to its fully retracted position. Limit switch LSER will sense the retracted condition of the transfer ram and signal the gatherer ram **40** to retract, and limit switch LSGB will sense the retracted condition of the compression ram and begin a new cycle of operation.

During the time that the gatherer ram **74** has been extended, and while strapping has occurred, the paper material being introduced into the hopper has been accumulating the gatherer ram cover plate **50.** Thus, upon the initial retraction of the gatherer ram after a strapping cycle, a considerable amount of paper material will be wiped off into the gatherer chamber. The accumulation of a rather large quantity of paper products on the cover plate causes no problems with respect to the gatherer ram movement in that the shear knives **52** and **58** insure a "clean" injection of compressed material into the compression chamber.

As the material is being transferred from the gatherer chamber to the compression chamber, and compressed therein, the material tends to form in layers perpendicularly related to the direction of movement of the gatherer ram piston **44.** In that several cycles of the gatherer occur in the formation of the compressed parcel, which is later formed into a strapped bale, it will be appreciated that the compressed parcel of paper products within the compression chamber **30** consist of a plurality opening layers. These layers are disposed substantially parallel to the direction of movement of the transfer ram as it moves across the compression chamber and pushes and compressed parcel into the strapping apparatus **90.** Thus, it will be appreciated that the compressed parcel described. formed by compressing in one direction, and transferred by a force perpendicularly disposed to the compression force. This perpendicular application of force to the compressed parcel is considered unique to paper baling, and is considered to have the advantage permitting the compressed parcel to be readily confined within the passage **88** for strapping purposes. Additionally, the movement of the gatherer and transfer rams at right angles to each other substantially reduces the time required for baling and tying a bale as compared with available equipment. In the commercial embodiment of the invention a complete baling cycle is approximately 180 seconds.

In that the discharge opening **36** defined in the compression chamber utilizes no gate or other closure during the formation of the first bale, the paper products compressed into the compression chamber will tend to partially extend from the dischare oplening as the compressed parcel is formed. As the paper continues to be compressed into the compression chamber, the parcel will form in the described manner, nd upon indexing the transfer ram **74** across the compression chamber, strapping of the bale occurs as desired. The end of the first parcel initially received within the strapping apparatus will be rather indefinitely defined due to the lack of confinement of the compressed material adjacent the discharge opening. However, in the formation of subsequent bales, the "end" of the previously formed partially strapped parcel is located in the compression chamber discharge opening, and seals the same during formation of the next compressed parcel, and then the "end" of the previously formed parcel will form the "wall" of the compression chamber at the discharge opening thereof.

It will be appreciated that the aforedescribed embodiment of the invention produces a paper baler capable of automatic operation at every stage of the formation of the bale. Compression, transferring of the compressed parcel, and strapping are automatically interrelated, and it is intended that modifications to the inventive concept which would be apparent to those skilled in the art be considered as included in the scope of the invention.

We claim:

1. The method of compressing, forming and strapping a bale of flexible, resilient material, such as paper products, comprising the steps of compressing the material in a compression zone in a first given direction to form a compressed parcel having layers transversely oriented to said first given direction, maintaining said parcel under compression in said zone and intermittently translating the compressed parcel in a second direction substantially parallel to said layers thereof and transverse to said first given direction, the extent of movement of said parcel in said second direction during each cycle of movement being substantially less than the length of the parcel in said second direction, exteriorly strapping the parcel in a direction transverse to the direction of orientation of the parcel layers intermediate cycles of movement of said parcel in said second direction, the compression of the parcel being of a maximum extent prior to translating the parcel in said second direction, and partially releasing the pressure on the parcel while in the compression zone prior to strapping.

2. The method of compressing, forming and strapping a bale of flexible, resilient material, such as paper products, comprising the steps of compressing material in a compression zone in a first given direction to form a compressed parcel having layers transversly oreinted to said first given direction, maintaining said pracel under compression in said zone and intermittently translating the compressed parcel in a second direction substantially parallel to said layers thereof and transverse to said first given direction, the extent of movement of said parcel in said second direction during each cycle of movement being substantially less than the length of the parcel in said second direction, exteriorly strapping the parcel in a direction transverse to the direction of orientation of the parcel layers intermediate cycles of movement of said parcel in said second direction, the parcel being first compressed in the compression zone to a maximum extent prior to translating the parcel in said second direction, and then partially releasing the compression on the parcel in the compression zone prior to strapping by permitting said parcel to expand in a direction counter to said first direction a predetermined amount.

* * * * *