# United States Patent [19]

**Wright**

[11] **3,762,310**

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


[54] **METHOD OF BALING**


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[22] Filed: **Jan. 20, 1971**

[21] Appl. No.: **107,905**

**Related U.S. Application Data**

[60] Division of Ser. No. 876,214, Dec. 1, 1969, which is a continuation of Ser. No. 661,070, Aug. 16, 1967, abandoned.

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

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

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



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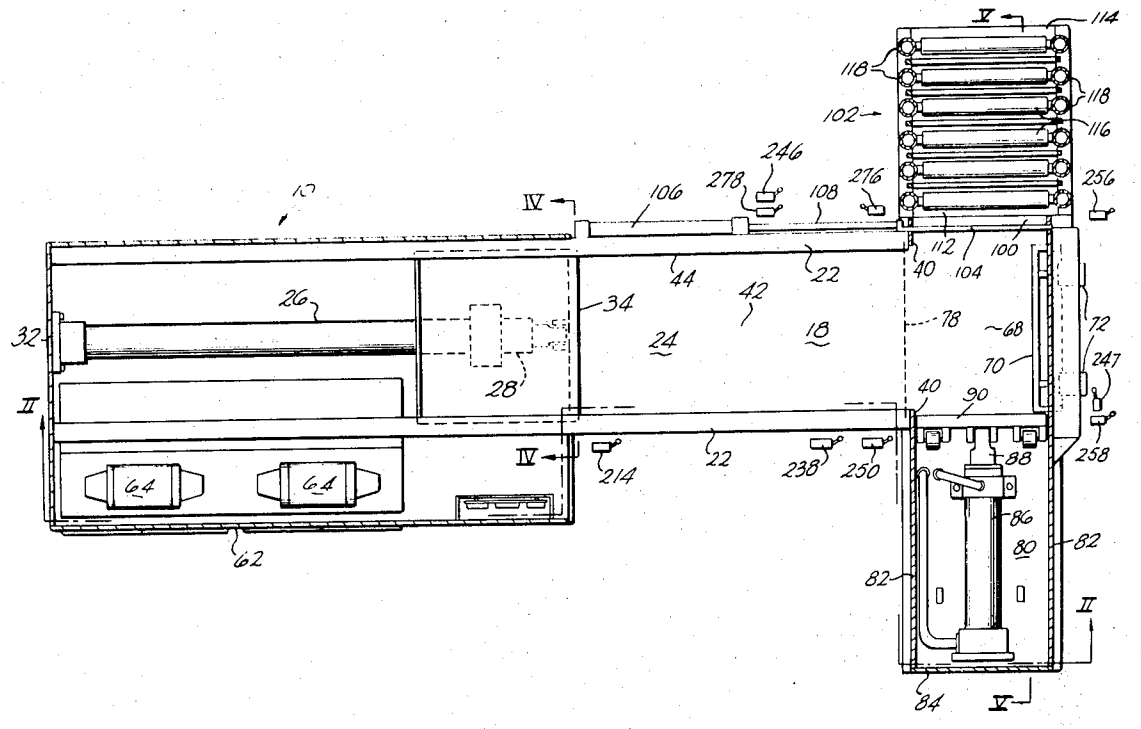
*Primary Examiner*—Billy J. Wilhite
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[57] **ABSTRACT**

A large-capacity baling apparatus having a horizontally disposed compression chamber directly loadable at its upper portion and including transversely moveable means for shifting the compressed medium from the compression chamber into a strapping chamber wherein compression and strapping occur in non-aligned, separate chambers.


**2 Claims, 10 Drawing Figures**



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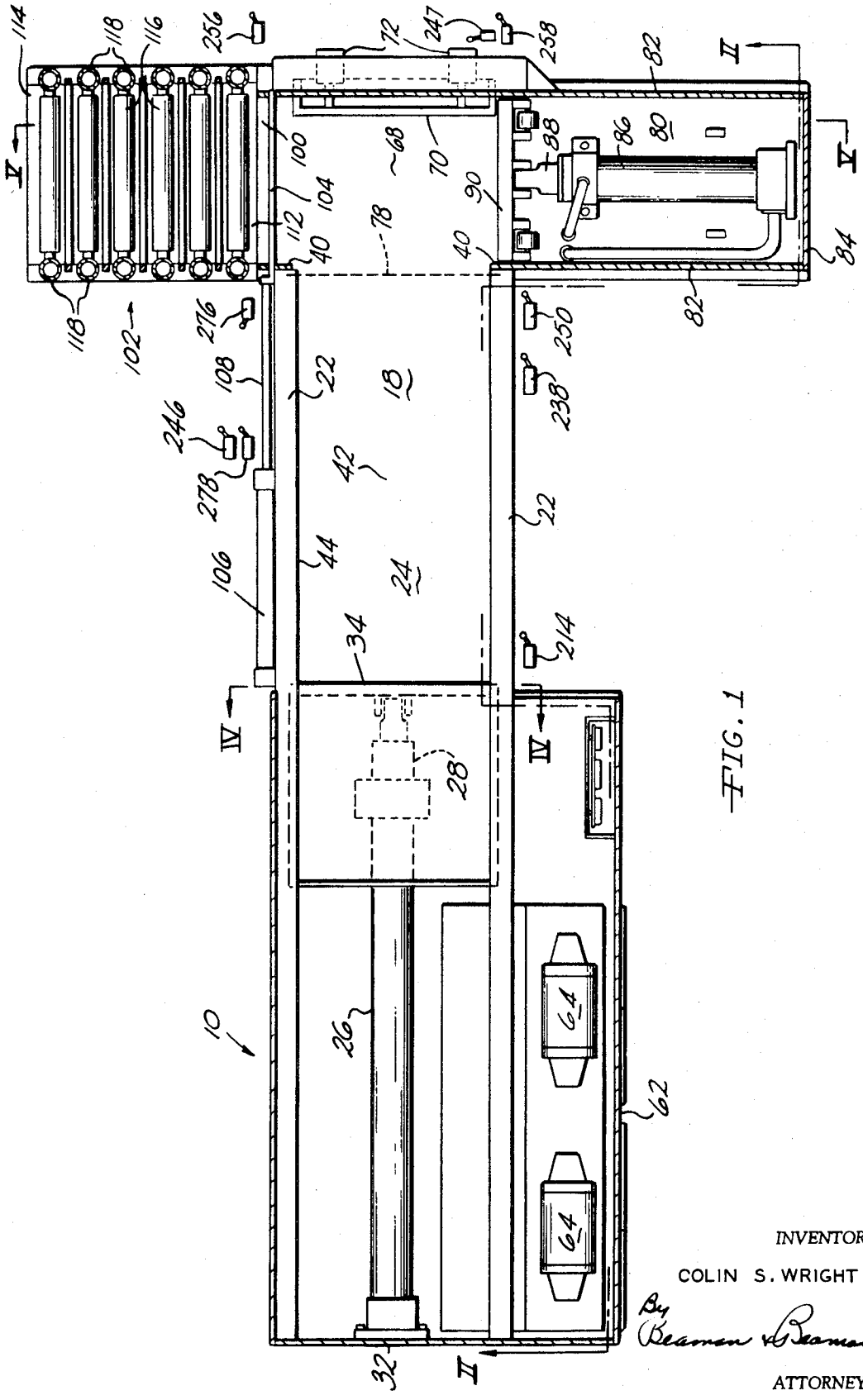



FIG. 1

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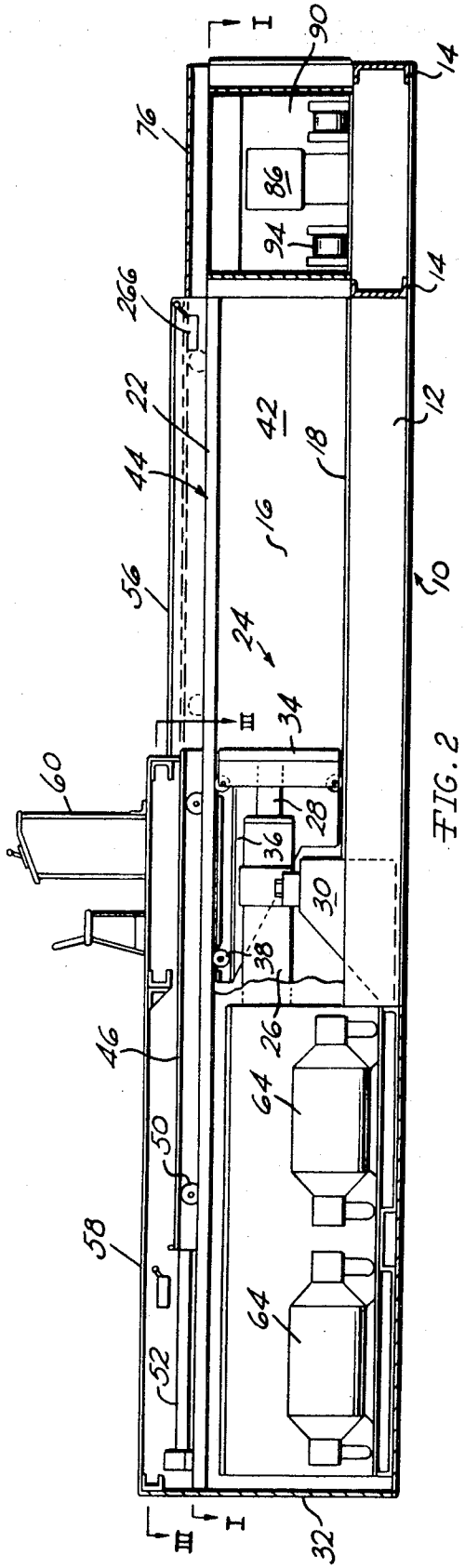



FIG. 2

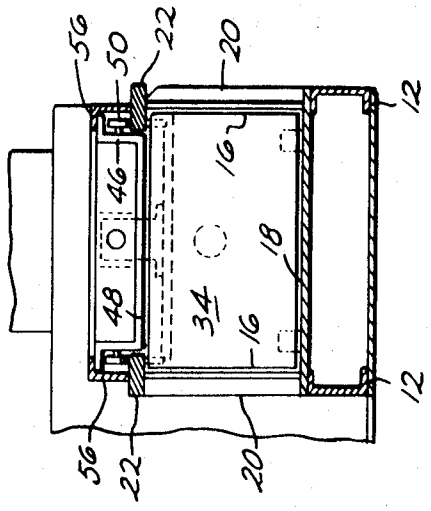



FIG. 4

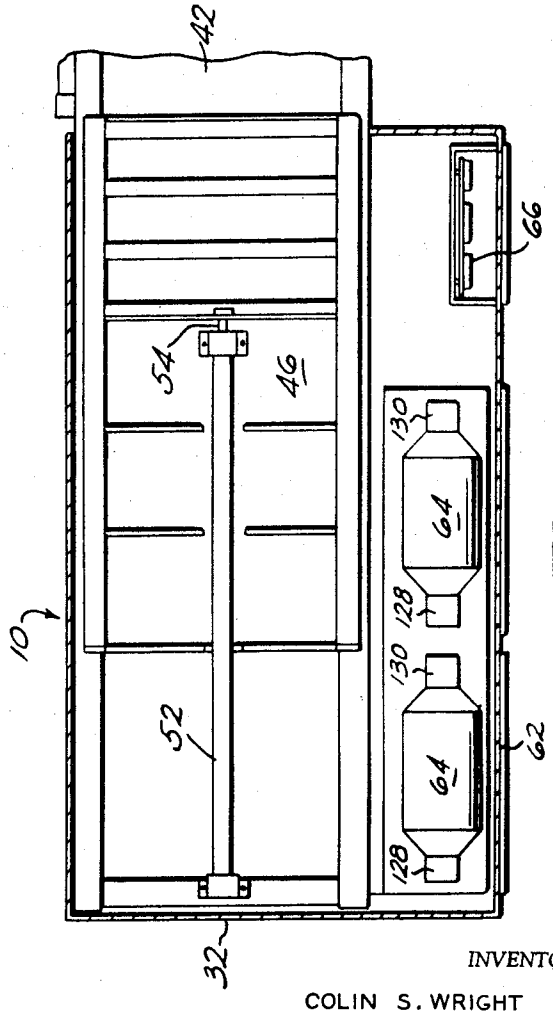



FIG. 3

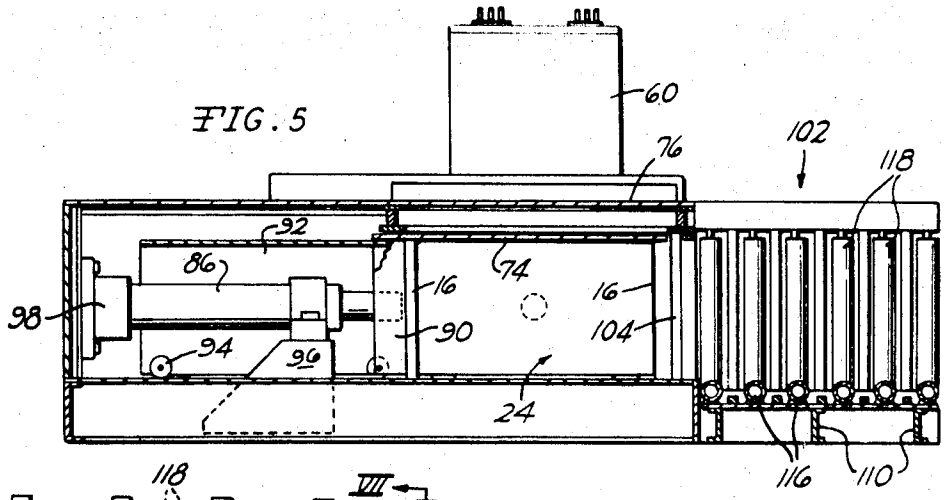
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FIG. 5



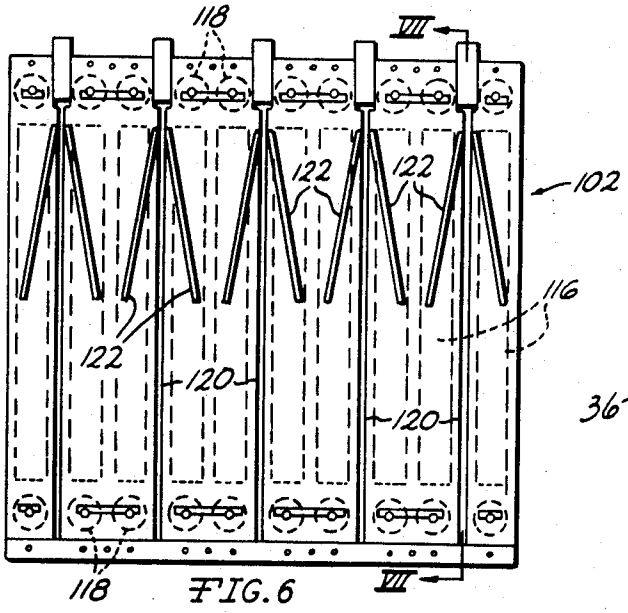




FIG. 6

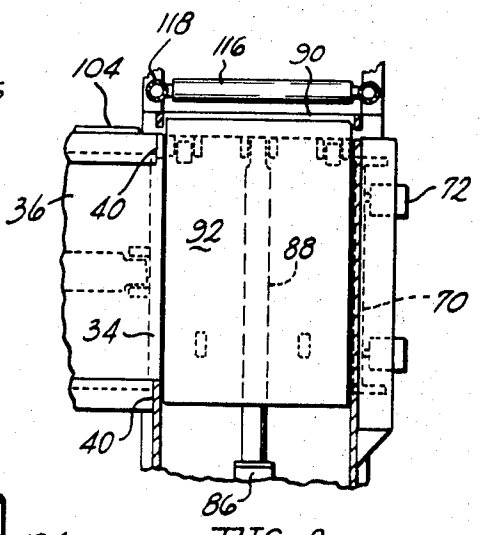



FIG. 8

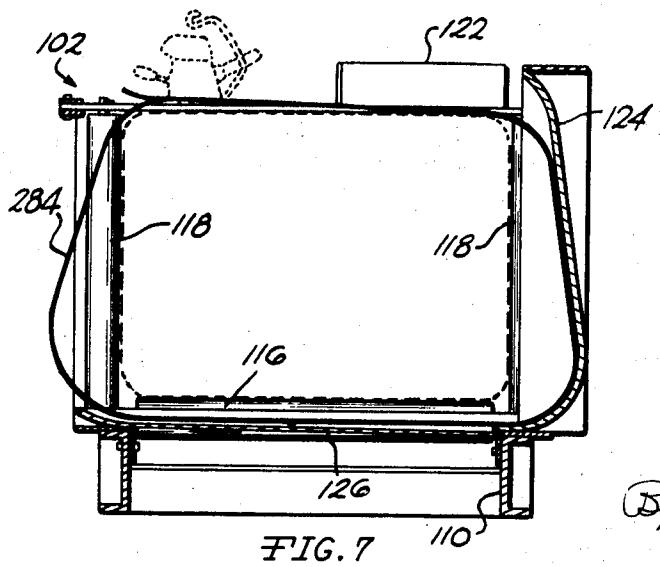



FIG. 7

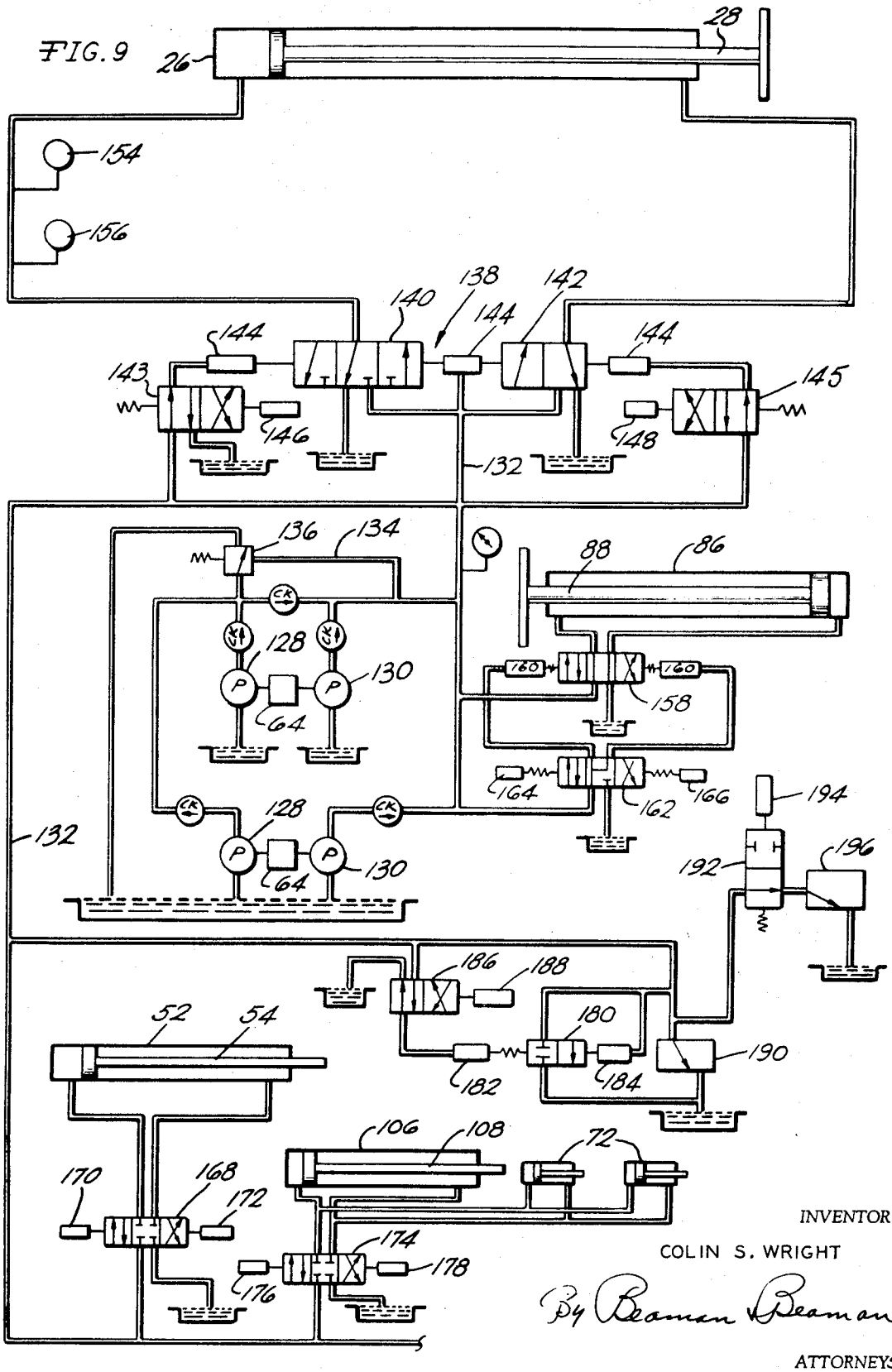
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FIG. 9




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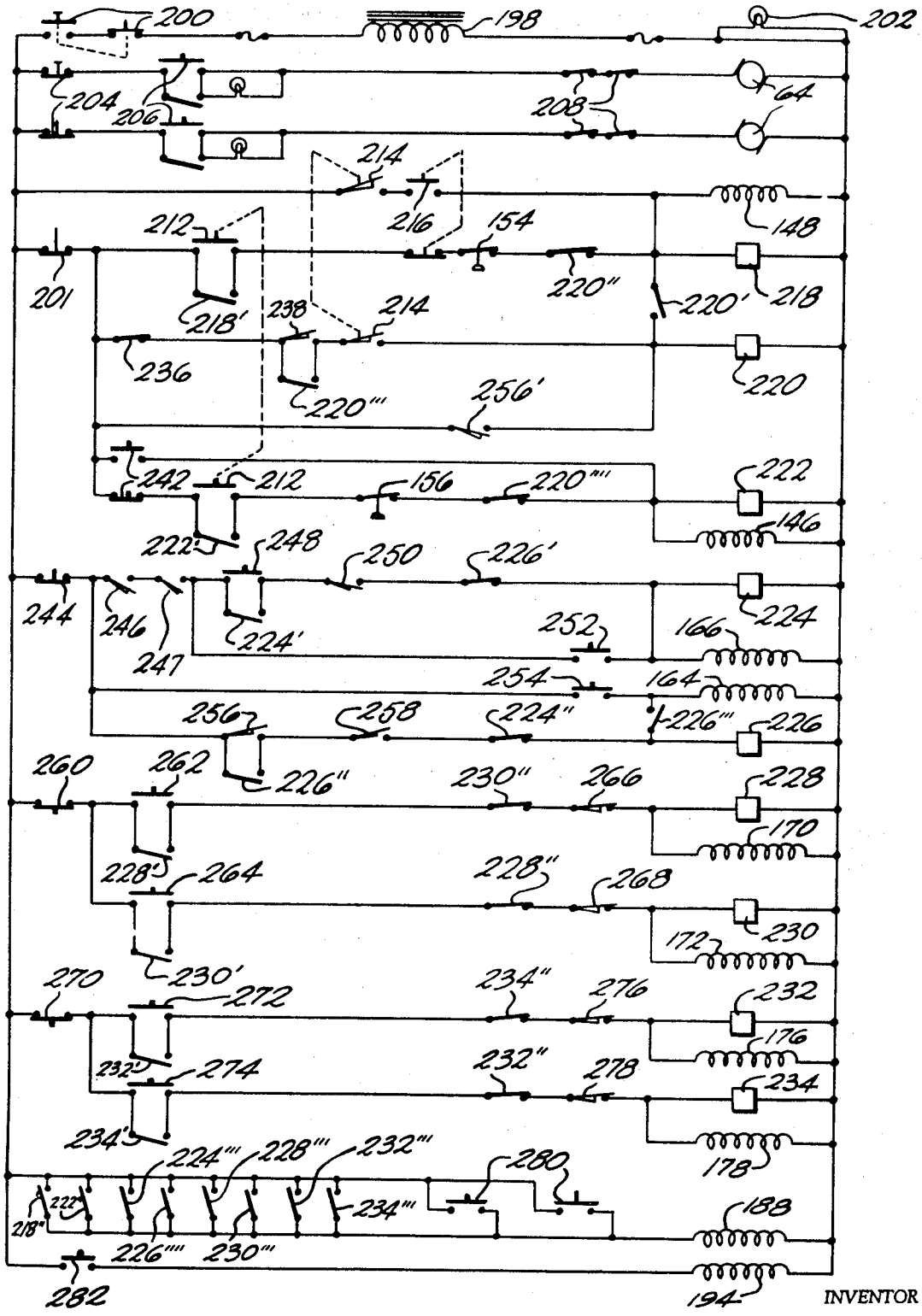



FIG. 10

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# METHOD OF BALING

## CROSS REFERENCE TO RELATED APPLICATIONS

This application is a division of Ser. No. 876,214 filed Dec. 1, 1969, now U.S. Pat. No. 3,576,161 which application is a continuation of application Ser. No. 661,070 filed Aug. 16, 1967, now abandoned.

## BACKGROUND OF THE INVENTION

The invention relates to the field of baling loose, compressible medium such as paper, cardboard and the like wherein compression is produced in a horizontally disposed compression chamber by means of a hydraulic ram, and the compressed medium is transferred from the compression ram for strapping purposes.

Baling apparatus for scrap materials, such as paper, cardboard and the like which is of the so-called "high capacity" type capable of producing relatively large, high-density bales, and baling a large tonnage in a given time period are usually of two types, vertical or horizontal. Vertical baling equipment employes a compression chamber which is vertically disposed, and the horizontal type balers use a compression chamber horizontally disposed.

Large vertical chamber balers receive the material to be baled within the compression chamber and a ram, either hydraulic or mechanical, is moved vertically, usually upperwardly, to compress the material at an end region of the chamber. After several compression strokes, with additional material being introduced into the chamber between strokes, a bale is formed in the end portion of the chamber and strapping of the bale occurs while it is located within the compression chamber. This arrangement has the disadvantage of rendering the baler inactive while strapping of the bale occurs. Additionally, vertical chamber baling devices have relatively small compression chamber loading openings due to the constructional limitations of this type of baler.

Horizontally disposed balers, such as represented in U.S. Pat. No. 3,212,434, consist of an elongated, open end, horizontal chamber into which the material to be compressed is introduced. Ram or compression means periodically reciprocate within the chamber to force the medium being compressed into and through the compression chamber. The compression chamber is so shaped that the resistance of movement of the medium through the chamber produces a sufficient compression and density. When the medium has achieved the desired density, a predetermined portion of the compressed material is strapped as it periodically moves through a final stage of the compression chamber. In order to facilitate strapping, dividers are periodically inserted into the medium being compressed wherein the bale straps may be inserted through the compressed material and produce the strapping of the bale. In a horizontal baler of conventional construction the density of the material being compressed fluctuates with the movement of the ram or plunger and control of the density, and size of the bale is difficult to regulate.

Conventional baling apparatus of the vertical and horizontal type usually requires that paper and cardboard be shredded or hogged prior to being introduced into the compression chamber. Such shredding is primarily necessitated by the inability of the loading openings of conventional baling apparatus to accommodate large boxes and paper sheets, and it is usually necessary to employ shredding means with the balers in order to permit the most efficient and effective use of the balers.



Conventional vertical and horizontal compression chamber balers do not lend themselves to automatic strapping mechanisms, as such automatic devices can only be used with great difficulty in the limited clearance and space available with a vertical baling apparatus, and automatic strapping devices are very difficult to use with horizontal balers in that the portion of the compressed medium which constitutes a bale is moving through the compression chamber while it is being strapped.

Large capacity baling apparatus of conventional arrangement and structure requires at least three or four men in order to obtain maximum output of the baler, and the nature of the equipment is such as to require considerable manual operation and supervision.

## SUMMARY OF THE INVENTION

The invention pertains to a method of baling of unique design which is capable of baling large tonnage in a relatively short time interval with a minimum of labor and supervision.

After the desired material has been compressed to a high density, the degree of compression is reduced and a traverse ram or plunger is actuated which moves at right angles to the compression ram and transfers the compressed material from the compression chamber directly into a strapping chamber.

In carrying out the method of the invention in the formation of a bale of compressed paper, cardboard or the like, the bale is formed in a plurality of strokes, resulting in a layered or laminated bale construction. In conventional horizontal baling devices of the type described above such layers or laminations results in the compressed matter expanding and contracting during strapping due to the pulsation of the compression ram. In the baler disclosed herein the compressed bale is transferred from the compression chamber in a direction parallel to the bale layers and confined in the strapping chamber in a static condition. Thus, the method of operation of the baler in accordance with the invention is capable of producing high density bales and substantially maintaining the density during strapping. By overcompression of the bale in the baling chamber and then reducing the compression a predetermined amount prior to strapping each bale is of a substantially uniform size and configuration which materially simplifies bale handling and storage.

## BRIEF DESCRIPTION OF THE DRAWINGS

The advantages arising from the functional relationships of the components of an embodiment of the baler illustrating the method of the invention will be apparent from the following description and accompanying drawings wherein:

FIG. 1 is a plan, sectional view of baler apparatus in accord with the invention taken along section I—I of FIG. 2,

FIG. 2 is an elevational, sectional view of the baler apparatus of FIG. 1, taken along Section II—II thereof,

FIG. 3 is an enlarged, detail, sectional plan view of the left half of the baler apparatus, illustrating the cover ram and related components as taken along section III—III of FIG. 2,

FIG. 4 is an elevational, detail, sectional view taken through the compression chamber along section IV—IV of FIG. 1,

FIG. 5 is an elevational, sectional view illustrating the traverse ram, compression chamber and strapping chamber relationship taken along section V—V of FIG. 1,

FIG. 6 is an enlarged, detailed, plan view of the strapping chamber,

FIG. 7 is an elevational, sectional view of the strapping chamber taken along section VII—VII of FIG. 6,

FIG. 8 is a detail, plan, sectional view of the compression chamber and traverse ram taken along a section line similar to that of FIG. 1, illustrating the traverse ram in the extended relationship for transferring a bale into the strapping chamber,

FIG. 9 is a circuit diagram of the hydraulic control system used with the baler of the invention, and

FIG. 10 is an electrical circuit diagram of the electric circuit used with the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE BALER ILLUSTRATING THE METHOD OF THE INVENTION

The baler apparatus in accord with the invention consists of a frame **10** which is of a generally L-shape, as will be appreciated from FIG. **1**. The base of the frame **10**, in the disclosed embodiment, is formed of large channel members, as will be apparent from FIGS. **2** and **4**. Parallel channel members **12** form supporting structure for the compression chamber, and parallel channel members **14** disposed at right angles to the members **12** form the base for the traverse ram compartment. The compression chamber is defined by parallel side walls **16**, consisting of relatively heavy sheet steel, mounted in a vertical relationship upon the bottom plate **18** which is interposed between and upon the channel members **12**. The side walls **16** may extend the length of the U-shaped members **12**. Suitable reinforcing members are associated with the side walls **16** to maintain the side walls in the proper relationship, and in the compression region the side walls are reinforced by vertically disposed bracing elements **20**, FIG. **4**. An elongated cover track and reinforcing member **22** is affixed to the upper edge of each of the side walls **16**, FIG. **4**, and extends a slight distance inwardly with respect to the side walls.

With reference to FIG. **1**, the portion of the side walls **16** to the right of section IV—IV partially form the compression chamber **24**, and the portion of the side walls to the left of section IV—IV constitute an enclosure for the compression ram or plunger **26** of the baler. Preferably, the compression ram **26** takes the form of a large hydraulic cylinder having a piston **28** reciprocal therein. The ram **26** is mounted at one end upon support structure **30** affixed to the members **12**, FIG. **2**, and is attached at its rear end to the end wall **32** of the frame. The ram **26** is centrally disposed between the side walls **16** and parallel thereto. The piston **28** is provided with a plunger head or wall element **34** of an elevational rectangular configuration, FIG. **4**, mounted upon a carriage **36** having antifriction rollers or wheels **38** mounted thereon. The upper rollers **38** engage the underside of the elongated members **22**, while the lower rollers engage the bottom plate **18**, and thereby support the piston mounted wall **34**.

The side walls **16** terminate at ends **40**, FIG. **1**, and the compression chamber portion **42** substantially extending from the side wall ends to the ram wall or head **34** is open at its upper portion defining an elongated loading opening **44** of the width substantially equal to the width of the compression chamber, and of a length substantialy equal to the length of movement of the piston and head during compression of the medium to be baled.

The compression chamber loading opening **44** is closed during compression by an elongated cover **46** adapted to be selectively disposed within the loading opening. The cover **46** is of a length slightly greater than the length of the opening, and includes a downwardly extending portion **48**, FIG. **4**, which substantially aligns with the underside of the member **22**. Wheels or rollers **50** are rotatably mounted upon the cover and engage the upper surface of the members **22** and movement of the cover to open and close the loading opening **44** is accomplished by actuation of the cover ram **52** which consists of a hydraulic motor having a piston **54** affixed to the cover. The cover ram **52** is attached to the frame and extension of the piston will shift the cover from the retracted position shown in full lines in FIG. **2**, to the dotted lines position of FIG. **2**, which closes the loading opening **44**. Parallel angle members **56** affixed to the elongated members **22** include a horizontally disposed portion which overrides the longitudinal edges of the cover, and prevents the cover from lifting from the members **22**.

The cover **46** and ram **52** are positioned below an upper plate **58** mounted upon the frame **10**, and the control console **60** is mounted upon the plate **58**. As is apparent in FIGS. **1** through **3**, a housing **62** for the motors **64** and associated pumps is attached to the frame offset with respect to the channel members **12**. Control components **66** are also mounted within the housing.

The portion **68** of the compression chamber remote from the compression ram is defined by a movable end wall **70** which may be moved toward the head **34** in its normal position during compression and moved to the right, FIG. **1**, by rams **72**, during bale transfer. The compression chamber portion **68** is covered by a top wall **74** which is of high-strength characteristics and reinforced by reinforcing members **76**. The top wall **74** extends toward the compression chamber portion **42** only slightly beyond the side wall ends **40** and, of course, it will be appreciated that the length of the access loading opening **44** of the compression chamber will be axially defined by the edge of the top wall **74** positioned at dotted line **78**, FIG. **1**, and the position of the cover **46** when in the retracted position, as in FIG. **2**.

A traverse ram chamber **80** is defined upon the frame **10** by side walls **82**, and an end wall **84** mounted upon the channel members **14**, FIG. **4**. The chamber **80** contains the traverse ram **86** which consists of a hydraulic motor having a piston **88**. A wall or plunger **90** is mounted upon the outer end of the piston **88** and is of a rectangular configuration to enclose that portion of the compression chamber **68** intermediate the adjacent side wall end **40** and the end wall **70**, and the bottom plate **18** and the top wall **74**, when the traverse ram is in the retracted position shown in FIG. **1**. The wall or plunger **90** is provided with a box-like rectangular shroud **92**, FIGS. **5** and **8**, which is of a length slightly greater than the width of the compression chamber **24**

and is supported upon rollers **94** engaging the bottom plate **18.** The ram **86** is affixed to the frame at **96** and **98,** and is of sufficient length to move the wall **90** from the retracted position shown in FIGS. **1** and **5,** to the extended position illustrated in FIG. **8.**

The compression chamber is provided with a discharge opening **100** defined by the end **40** of the side wall disposed adjacent the strapping chamber **102,** the bottom plate **18,** the end wall **70** and the top wall **74.** The discharge opening **100** is in directly opposed relationship to the moveable wall or plunger **90** and the compressed medium is transferred through the discharge opening into the strapping chamber by the traverse ram **86.**

The discharge opening **100** is selectively opened and closed by a gate **104** slidably mounted on the frame in the longitudinal direction of the compression chamber. The gate **104** is operated by a hydraulic ram **106** having a piston **108,** and suitable guides and supports are associated with the gate to adequately support the gate at all times. In FIG. **1** the gate is illustrated in the operative or compressing position to close the discharge opening. Retraction of the ram piston **108** withdraws the gate completely from opening **100** to provide full access through the opening, as shown in FIG. **8.**

The strapping chamber **102** is mounted upon support elements **110** and is of a generally rectangular configuration having an open inlet end **112** and an open outlet end **114.** The disclosed strapping chamber includes a plurality of rollers which are closely disposed to each other for permitting the compressed material to be translated into the strapping chamber with a minimum of friction. The strapping chamber includes a plurality of lower rollers **116** disposed in a horizontal relationship wherein the uppermost portion of the rollers is in substantial horizontal alignment with the compression chamber bottom plate **18.** The sides of the compression chamber are defined by a plurality of parallel rollers **118,** the innermost portion of the side rollers at the right of FIG. **7** being in substantial alignment with the end wall **70,** and the innermost portion of the side rollers at the left of FIG. **7** being in substantial alignment with the end **40** of the adjacent compression chamber side wall. The strapping chamber **102** includes suitable frame work and support components for the rollers, and the support components are so related as to define a plurality of slots **120,** FIG. **6,** intermediate predetermined side and bottom rollers. Strap guides **122** are associated with the slots defined in the upper portion of the strapping chamber, and a strap guide **124** is associated with the rear of the strapping chamber. Likewise, the strapping chamber is provided with lower strap guides **126** disposed between the bottom rollers **116.**

The outlet **114** of the strapping chamber extends away from the baler apparatus, and a bale receiving dock, platform or conveyer will be disposed adjacent the strapping chamber outlet to receive the strapped bale upon the bale being ejected from the strapping chamber.

Operation of the baler in accord with the invention is semiautomatic and the control means are illustrated in FIGS. **9** and **10.**

In the disclosed embodiment two electric motors **64** are employed which are preferably each of 75 H.P., and each are operatively connected with a hydraulic pump **128** and a hydraulic pump **130.** The pumps **128** are of a high capacity, low pressure type capable of pumping 75 gallons per minute at pressures approaching 1,500 pounds per square inch. The pumps **130** are of low capacity, high pressure capable of pumping 50 gallons per minute at pressures exceeding 2,500 pounds per square inch. The output of the pumps **128** and **130** is normally supplied to the primary pressurized conduit **132.** However, when the pressure within the conduit **132** exceeds 1,500 pounds per square inch the control conduit **134** actuates bypass valve **136** to bypass the output of the low pressure pumps **128** into the hydraulic fluid reservoir.

Control of the compression ram **26** is accomplished by a hydraulically operated valve **138** of the Olmstead type. The portion **140** of the control valve **138** is associated with the end of the ram producing piston extension, and the valve portion **142** is associated with the piston rod end of the ram. Small hydraulic cylinders **144** control the operation of the valve **138,** and the control cylinders **144** are operated by the primary pressure on valves **143** and **145** controlled by the solenoids **146** and **148,** respectively.

Pressure switches **154** and **156** communicate with the extension end of the ram **26** to sense the pressure within the ram during compression of the medium being baled. Switch **154,** as will be later described, is used to sense the pressure during compression and regulate the regeneration operation. Pressure switch **156** is employed to sense the occurrence of the desired compression pressure.

Operation of the traverse ram **86** is controlled by the hydraulically actuated valve **158,** which is shifted between its various positions by control cylinders **160.** Control cylinders **160** are operated by the valve **162** controlled by solenoids **164** and **166.**

As the cover ram **52** does not require the volume and pressures of the compression and traverse rams, control of the cover ram is directly accomplished through valve **168** which is shifted between its operative positions by solenoids **170** and **172.** Likewise, the gate ram **106** may be directly controlled by valve **174** and solenoids **176** and **178,** and the wall rams **72** are connected in parallel with ram **106.**

The pressure within the hydraulic circuit is regulated by pressure control apparatus including the hydraulically operated valve **180** controlled by control cylinders **182** and **184.** The cylinder **182** is energized through the valve **186** actuated by solenoid **188,** and the control cylinder **184** is operated by the primary pressure source of the system. A pressure relief valve **190** which opens at 2,500 pounds per square inch communicates with the pressure conduit **132** and the primary pressure also communicates with a valve **192** operated by solenoid **194.** The valve **192** communicates with a pressure relief valve **196** which opens at 2,000 pounds per square inch to return the fluid to the reservoir. The flow of fluid through the pressure relief valve **196** occurs as long as the valve **192** is in the open position illustrated, and the position illustrated is the normal operating position of the system. Solenoid **188** must be energized at all times when pressure is required in the system, otherwise, the valve **186** will shift to a position causing the valve **180** to exhaust directly to the reservoir. Energizing of the solenoid **188** causes the fluid to flow through the valve **192** and the pressure relief valve **196** to maintain 2,000 pounds per square inch pressure in the system. Should pressures higher than 2,000 pounds per square inch be momentarily desired

to properly orient the rams, for instance, if the operator permited more material to be placed in the compression chamber **24** than intended, higher pressure is produced by energizing solenoid **194** to prevent flow through valve **192** and render pressure relief valve **190** operative to control the pressurized system.

The electrical circuit used in the control of the baler apparatus is illustrated in FIG. **10** and switches operated by a common relay are designated by primes.

Power for the circuit is provided through a transformer **198** and switch **200** represents a manual standby switch while lamp **202** indicates energization of the power. The pump motors **64** are controlled by stop switches **204**, and start switches **206**, and include the usual overload switches **208** and pilot lights to indicate energization of the pump motors. The control of solenoid **148** includes a stopswitch **210**, a double contact cycle switch **212**, a double control limit switch **214**, jog switch **216** and pressure switch **154**. Normally open relay switch **220'** is controlled by time delay relay **220**, as is normally closed relay switch **220''**. The circuit also includes an isolating switch **236** and the limit switch **238** is connected in series with a second portion of limit switch **214**. Normally open relay switch **220'''** bridges limit switch **238** and the circuit includes the normally open relay contact switch **218'**.

The compression ram control circuit further includes limit switch contacts **256'** and a jog forward switch **242**. The second contacts of switch **212** are in series with pressure switch **156** and relay **222** includes normally open contacts **222'**, while normally closed contact **220''''** of relay **220** are included in series with the pressure switch **156**. The solenoid **146** is operated by the circuitry described immediately above.

The traverse ram control circuit includes the stop switch **244**. Limit switches **246** and **247** are connected in series with the cycle switch **248** and the limit switch **250**. Cycle switch **248** is bridged by normally open contacts **224'** of relay **224** and limit switch **250** is in series with the normally closed contacts **226'** of time delay relay **226**. Relay **224** is connected in parallel with solenoid **166** and a jog forward switch **252** is included in this circuit. A jog retract switch **254** is connected in series with the solenoid **164** and the circuit to relay **226** includes limit switch **256**, limit switch **258** and normally open relay switch **226''**, and normally closed relay switch **224''**. The solenoid **164** and relay **226** are bridged by the normally open relay switch **226'''**.

Control of the cover ram **52** is accomplished through a circuit including stop switch **260** and start switches **262** and **264**. Switch **262** is bridged by normally open relay contacts **228'** and switch **264** is bridged by normally open relay contacts **230'**. Solenoid **170**, and relay **228** are connected in series with limit switch **266** and the normally closed relay contacts **230''**. Solenoid **172** and relay **230** are in series with the limit switch **268** and the normally closed relay contacts **228''**.

The gate ram **106** includes in its circuit the stop switch **270** and start switches **272** and **274**, bridged by normally open relay contacts **232'** and **234'**, respectively. Solenoid **176** and relay **232** are in series with limit switch **276**, and normally closed relay contacts **234''**. Solenoid **178**, and relay **234** are in series with limit switch **278** and normally closed relay contacts **232''**.

As solenoid **188** is to be energized whenever pressure is required in the system, which is most of the time, the normally open relay contacts **218''**, **222''**, **224'''**, **226''''**, **228'''**, **230'''**, **232'''**, **234'''** are connected in parallel with the circuit to the solenoid **188**, as well as are the jog switches **280**.

In the event that a 2,500 pounds per square inch fluid pressure is desired, the solenoid **194** is energized by the manually operated switch **282**. The switch **282** is of the type which must be manually depressed as the requirement for the higher pressures resulting from energization of the solenoid **194** will only be momentary.

The limit switches described above are mounted upon the baler structure for actuation by the appropriate pistons, plungers, gates, etc., and the approximate location of the switches is diagrammatically indicated in FIGS. **1** and **2**.

The operation of a baler apparatus in accord with the invention is as follows:

Loading of the baler apparatus occurs when the compression chamber loading opening **44** is fully open and the compression, cover and traverse rams are in the retracted positions shown in FIGS. **1** and **2**. In the preferred embodiment of the invention the distance separating the compression chamber side walls **16** is substantially 60 inches, while the longitudinal length of the compression chamber loading opening **44** is substantially 120 inches. The unusually large size of the access opening permits bulky boxes, cartons and other scrap paper articles to be introduced into the compression chamber without the need for shredding or hogging the scrap articles. The vertical dimension of the compression chamber is substantially 36 inches, and the aforementioned dimensions permit the compression chamber to be quickly loaded by means of a conveyer or other mechanical material handling apparatus. As the baler is of the horizontal type, it is possible to locate the baler below floor level wherein material to be baled may be directly pushed into the compression chamber by a bulldozer or the like. Of course, the baler apparatus may be mounted upon a ground level supporting surface, rather than being located within a pit, and in such instance a loading platform would probably be located adjacent the compression chamber opening on a horizontal level therewith to aid in introduction of the material into the compression chamber.

When the compression chamber has been filled, the operator located at the console **60** will energize the primary motor switches **206**, if the pump motors **64** have not already been started. The swtich **262** is closed to energize solenoid **170** to shift valve **168** to extend the cover rim and close opening **44**. The operator then closes cycle switch **212** which energizes solenoids **146** and **148** which produces an actuation of the valve **138** permitting pressurized fluid to be introduced into the left, or extension end of the compression ram **26**, FIG. **9**, to begin extending the piston **28** and moving the compression ram wall or plunger **34** toward the end wall **70**. During the initial stage of compression the valve portion **142**, as energized by valve **145**, is positioned such that the fluid being exhausted from the piston rod side of the compression ram is introduced into the pressurized circuit, and the supply conduit **132** and extension side of the ram **26**. This utilization of the hydraulic fluid exhausted from the compression ram constitutes a regeneration cycle permitting a maximum amount of pressurized fluid to be introduced into the compression ram and produce an initial rapid movement of the compression ram.

During the initial movement of the compression ram the pressurized fluid conduit **132** will be receiving fluid from both pumps **128** and both pumps **130**, in that the pressure within the system will be less than 1,500 pounds per square inch. When the resistance to movement of the compression ram becomes great enough to cause the fluid pressure within the supply conduit to reach approximately 800 pounds per square inch, such a condition is sensed by the pressure switch **154**. Pressure switch **154** then opens and deenergizes solenoid **148** which shifts valve portion **142** from the regeneration position, to the exhaust-to-reservoir position shown in FIG. **9**. The compression ram piston will continue to compress the material within the compression chamber, and upon the pressure within the supply conduit **132** reaching 1,500 pounds per square inch, the bypass valve **136** will open to bypass the output of the low pressure-high volume pumps **128** into the fluid reservoir. Continued pressurizing of the compression ram is now accomplished solely by the two low capacity-high pressure pumps **130**. The purpose for removing pumps **128** from the operative system at 1,500 lbs. per/sq. in. is to permit the desired fluid pressures to be developed with electric motors of approximately 75 H.P. each.

Completion of the first stroke of the compression ram is sensed by the limit switch **238** located adjacent the entrance to compression chamber portion **68**. Closing the limit switch **238** will energize relay **220** and thereby energize solenoid **148** and deenergize solenoid **146**. This operation permits pressurized fluid to be introduced into the piston rod end of the compression ram and retract the ram. The compressed material will stay within the compression chamber portion **68** when the compression ram is retracted.

Retraction of the compression ram **26** is sensed by the limit switch **214** which opens to hold the retracted ram on "manual standby" by deenergizing solenoid **148**. After the cover **46** is retracted additional material to be compressed is introduced into the compression chamber through opening **44** and the above cycle is repeated. Several loadings, usually three or four, of the compression chamber will be necessary before the desired density bale has been achieved. Of course, the number of cycles of the compression ram will be determined by the amount of material introduced into the compression chamber with each loading, and the nature of the material being compressed.

On the final compression ram stroke the operator must isolate the retracting limit switch **238**, and thus the isolating switch **236** will be opened. This operation will prevent the automatic return of the compression ram. As the final compression stroke will produce a pressure within the compression ram which has been preset in pressure switch **156**, the desired fluid pressure will actuate pressure switch **156** and deenergize solenoids **146** and **148** to place the valve **138** in a neutral position. The compression ram extends to its limit wherein the moveable compression wall or plunger **34** is substantially aligned with the ends **40** of the side walls **16** as in FIG. **8**. During the final compression stroke, should the operator have misjudged the amount of material within the compression chamber **24**, and find that the usual working pressure of 2,000 lbs./sq. in. is insufficient to position the compression ram in the "traverse" position of FIG. **8**, the operator may momentarily close switch **282** to activate solenoid **194** and valve **192** to raise the working pressure to 2,500 lbs./sq. in. and thus, position the compression ram wall as illustrated in FIG. **8**. If this operation is insufficient to permit extension of ram **26** to its limit, retraction of the rams **72** when the gate cam **106** is retracted will permit wall **70** to move and thereby reduce the compression enough so ram **26** can fully extend.

The limit switch **250** is preferably of the magnetic detector type, and a magnet located upon the compression ram structure energizes the limit switch **250** when the compression ram wall **34** is in the position shown in FIG. **8**. Closing of the limit switch **250** will prepare the traverse ram circuit for energization.

It will be appreciated that it is necessary to close the compression chamber loading opening **44** during each compression stroke of the compression ram. Thus, prior to initiating each compression stroke of the compression ram, the operator will close switch **262**, which energizes solenoid **170** and introduces pressurized fluid into the extension portion of the cover ram to roll the cover over the compression chamber loading opening. When the cover is in place, as represented in dotted lines in FIG. **2**, the compression ram cycle may be actuated. Retraction of the cover is produced by closing switch **264** to energize solenoid **172**. Rather than the semiautomatic control of the cover ram as described above, it is within the scope of the invention to interlock the control switches **262** and **264** with the compression ram cycle circuit wherein the cover **46** will automatically slide into a closed position as the compression ram is moved forward and retract from the access opening when the compression cam is retracted. Limit switch **266** senses the closed position of the cover and opens when the cover is fully closing opening **44**, and limit switch **268** senses full retraction of the cover ram and deenergizes the circuit at complete retraction.

When the compression ram is in the position locating the wall **34** adjacent the ends **40** of the side walls, as in FIG. **8.**, the operator closes switch **274** to energize the solenoid **178** and gate ram valve **174** and retract the piston **108** to pull the gate **104** from the compression chamber discharge opening **100**. The opened and closed positions of the gate **104** are sensed by the limit switches **278**, **276**, and **246**. Limit switch **247** closes upon wall **70** and rams **72** fully retracting. Thus, limit switches **246** and **247** deenergize the traverse ram circuit as long as the gate closes the compression chamber discharge opening **100** and the rams **72** are extended.

The operator now closes push-button switch **248** to energize solenoid **166** and relay **224**. This operation actuates valve **162**, which in turn actuates the hydraulically operated valve **158** to permit pressurized fluid to be introduced into the traverse ram **86** to extend the traverse ram piston **88**. As the traverse ram **88** piston extends, the moveable wall **90** is pushed across the compression chamber portion **68** and pushes the compressed material therein through the discharge opening **100** into the strapping chamber **102**. The movement of the traverse ram wall **90** will continue until the moveable wall is positioned as shown in FIG. **8.**, substantially within the strapping chamber inlet end **112**. At this time the compressed material will be fully received within the strapping chamber.

Limit switch **256** is located at the entrance **112** of the strapping chamber and will sense the full extension of the traverse ram **86**. The limit switch **256** will automatically return both the compression ram, through con-

tacts **256'**, and the traverse ram to retracted positions as the limit switch energizes the solenoids **148** and **164** two or three seconds after the traverse ram has penetrated the strapping chamber inlet. Limit switch **258** will sense the retracted position of the traverse ram and hold the traverse ram on "manual standby," and limit switch **214** will sense the retracted condition of the compression ram, and likewise, maintain the compression ram in a "manual standby" condition.

The operator closes switch **272** to actuate solenoid **176** and relay **232** to extend the gate ram **106** and locate the gate within the compression chamber discharge opening **100** and extend rams **72** to move wall **70** toward head **34.** Also, the operator will close switch **264** and energize solenoid **172** to retract the cover ram **52** and provide access to the compression chamber portion **42** for loading with new material to be compressed.

Compression of the material has usually taken place through several cycles of the compression ram. Thus, the material within the compression chamber portion **68,** prior to being transferred to the strapping chamber **102,** will exist in layers perpendicularly disposed to the axis of the compression ram. Upon the compression material being transferred to the strapping chamber, the tendency for the compressed material will be to expand against the side rollers **118.** However, as the side rollers **118** will not permit expansion, the dimensions of the compressed material will be closely maintained.

Strapping of the compressed material within the strapping chamber **102** is quickly accomplished by inserting the baling straps **184** into the slots **120** disposed between the rollers **116** and **118.** The presence of the band strap guides **122, 124,** and **126,** facilitates the placing of the banding straps about the bale, and either an automatic or a manual strapping apparatus may be employed to tension and clamp the straps **284.**

It will be appreciated that the bale is strapped in the direction as to confine the bale against expansion due to the "layering" of the compressed material. Thus, upon the bale being removed from the strapping chamber **102,** no significant expansion of the bale will be permitted by the baling straps.

Strapping of the bales within the strapping chamber takes place simultaneously while the next bale is being compressed within the compression chamber. Thus, the baler in accord with the invention permits simultaneous bale compression and strapping. The bale previously inserted into the strapping chamber will usually be completely strapped by the time that the subsequently compressed material is ready to be transferred into the strapping chamber. Upon the compressed material within chamber portion **68** being of the desired density, the gate **104** is opened and the traverse ram **86** actuated to introduce the compressed material into the strapping chamber. This operation will push the strapped bale from the strapping chamber **102** through the strapping chamber outlet **114** and onto a conveyor or platform. The traverse ram **86** is retracted, the gate **104** is reinserted into the discharge opening **100** and the strapping and compression cycle repeated.

The fluid pressures and the size of the rams used in the invention permit a very high density bale to be formed. In an embodiment of the invention using the dimensions previously stated, and wherein the dimension of the compression chamber portion **68** parallel to the ram **26** is substantially 48 inches, a bale size 60 × 36 × 48 inches is produced which will weigh between 1,500 pounds and 1,700 pounds. Usually, three strokes of the compression ram will be used when baling mixed corrugated boxes, paper, etc., and the designed cycle time for the compression ram is approximately 25 seconds. The cycle time for the traverse ram is approximately 15 seconds, and the total time to form a complete bale is in the neighborhood of 90 seconds under optimum conditions. Baling apparatus of the disclosed type can be operated efficiently with three attendants, one attendant operating the control console, another attendant supervising the loading of the material, and the third attendant supervising or producing the strapping of the bale. By using two motors and double pump systems, the baling apparatus is capable of operating at one-half speed should one of the motors or pumps require maintenance.

The movable wall **70** provides a dual function in the operation of the apparatus. Its basic function is to reduce the power requirement of traverse ram **86** when transferring the bale from the compression chamber to the strapping chamber. By retracting wall **70** prior to extending ram **86** the friction between the bale and wall **70** will be reduced as the bale is transferred. Secondly, as previously mentioned, if the compression ram **26** is unable to fully extend during the last compression stroke the retraction of wall **70** will permit this operation and thereby assure that head **34** is properly oriented to opening **100** during transfer of the bale.

It will be appreciated that modifications to the inventive concept may be apparent to those skilled in the art without departing from the spirit and scope thereof and it is intended that the invention be defined only by the scope of the following claims:

I claim:

**1.** The method of baling paper products wherein the paper products are compressed into a bale to form a plurality of layers comprising the steps of compressing paper products in a first direction to form a parcel of compressed paper products in a compression zone having layers substantially perpendicularly disposed to said first direction with said parcel as initially disposed in said zone being in a state of maximum compression, reducing the compression of said parcel while in said zone a predetermined amount, then transferring said parcel in its state of reduced compression from said zone to a strapping station in a direction substantially parallel to said layers and strapping said parcel into a bale as it is transferred from said zone.

**2.** The method as defined in claim **1** wherein said reduction in compression is accomplished by permitting said parcel to expand in said first direction a predetermined amount.

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