United States Patent

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[45] **Sept. 19, 1972**

[54] **COMPRESSING APPARATUS**

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[73] Assignee: **Rotopak Systems Inc.,** Seattle, Wash.

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[21] Appl. No.: **121,700**

[52] **U.S. Cl.**.....**100/89,** 100/DIG. 7, 56/1

[51] **Int. Cl.**.....**B30b 3/04**

[58] **Field of Search**.....100/86, 89, DIG. 7; 56/1

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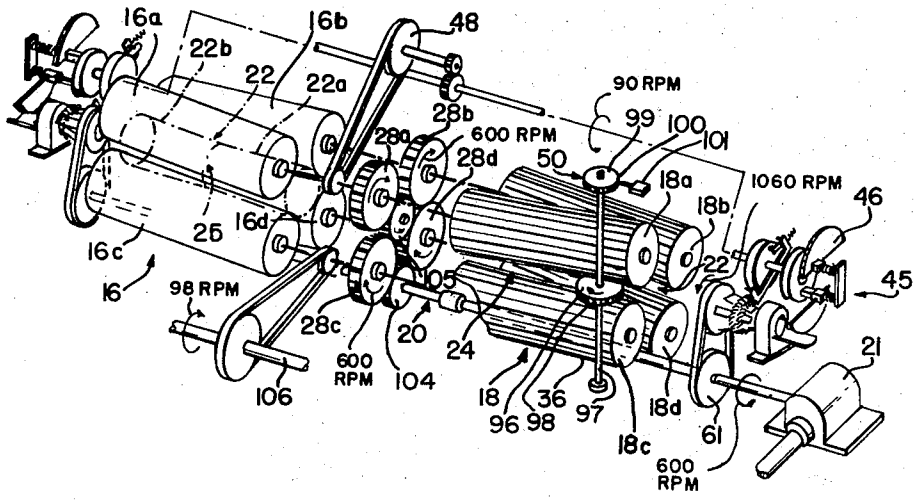
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Attorney—Seed, Berry & Dowrey

[57] **ABSTRACT**

A roller-forming compressing machine in which compressed cores of fibrous material are discharged axially in opposite directions from a pair of channels formed by two sets of circumferentially spaced skewed rollers driven from a center transmission. In each set a density controlling valve controls the discharge of the core and provides a torque to supplement the rolling torque. The rollers are provided with circumferentially spaced elongated rigid cleats. Cutting blades are mounted for axial movement with the core and intermittent rotation into the core for slicing it into cylindrical wafers. The wafers are cut to lengths determined by a metering device which actuates the cutting blades. Each of the rollers is mounted at one end by a ball type suspension for transferring torque regardless of the skewed or radial position of the roller and two of the rollers in each set provide the feed opening and are spring-mounted at their discharge end to vary the capacity of the feed opening.

20 Claims, 15 Drawing Figures



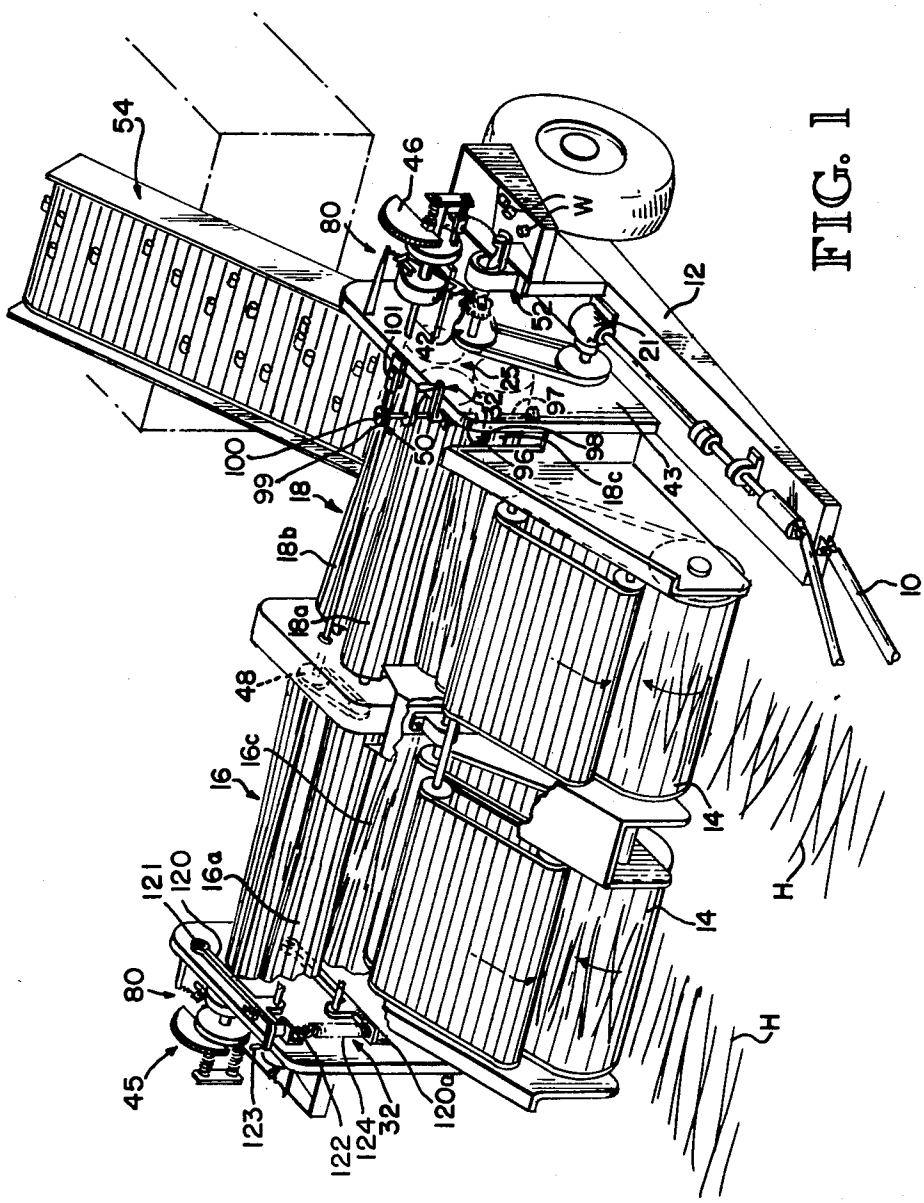


FIG. 1

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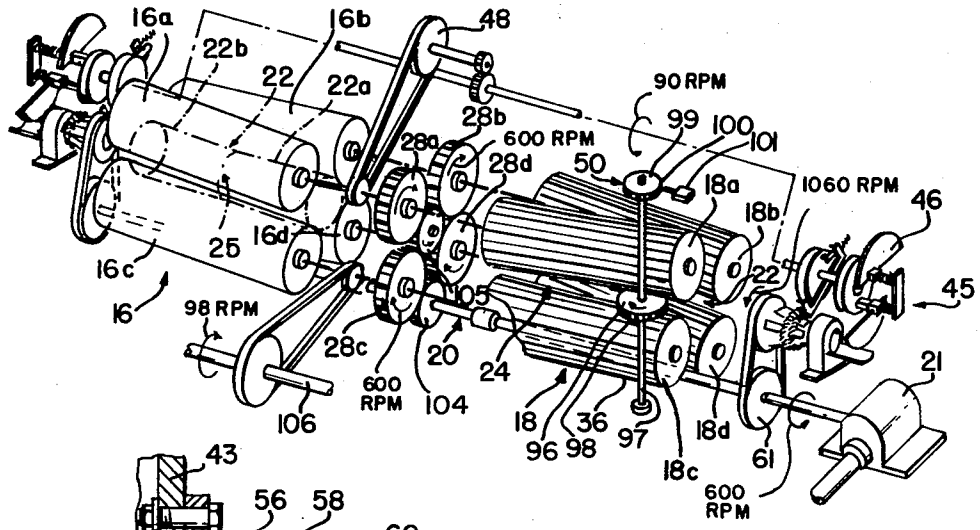


FIG. 2

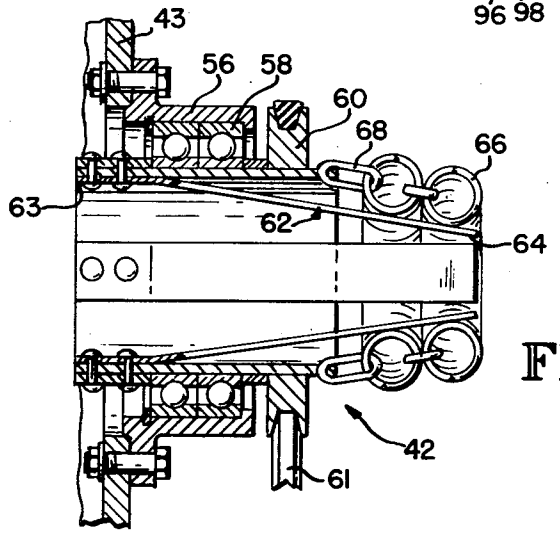


FIG. 3

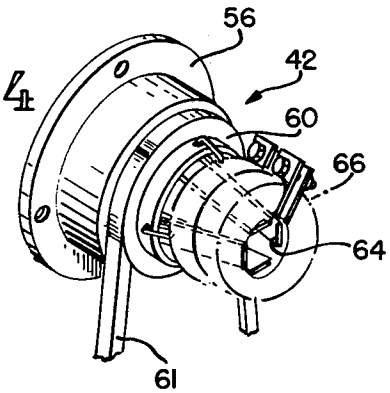


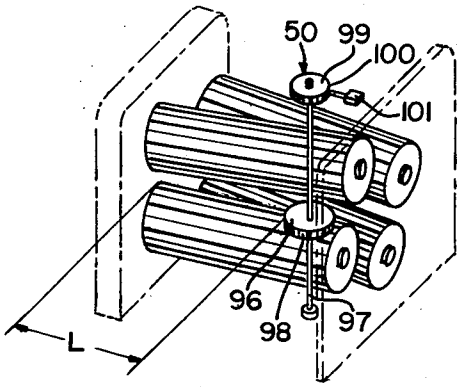
FIG. 4

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FIG. 5



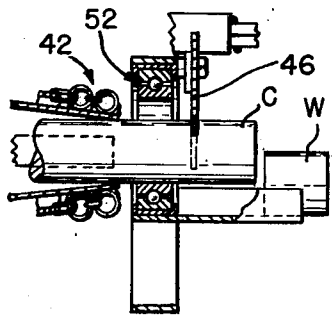
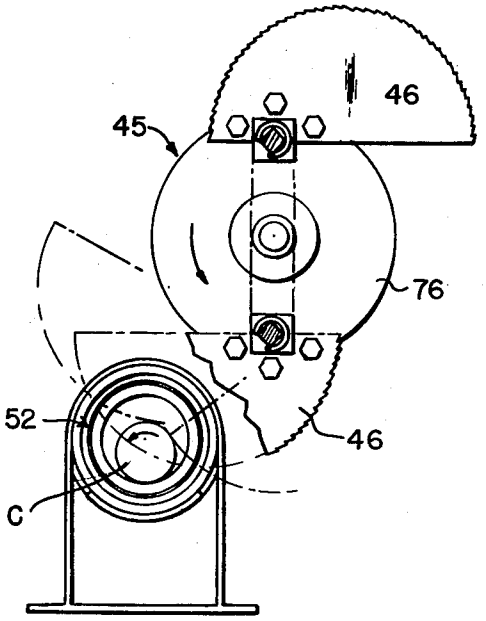


FIG. 7

FIG. 6



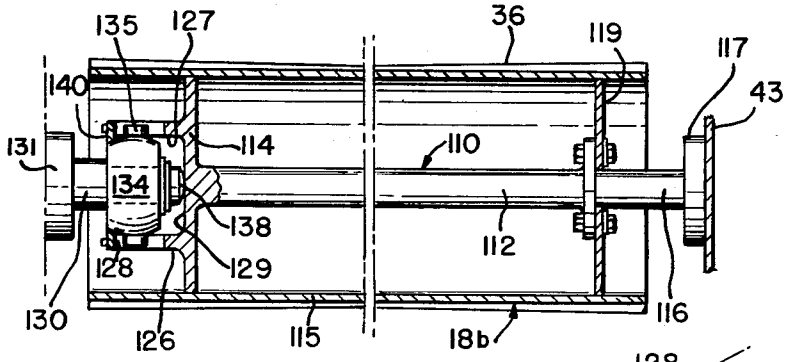


FIG. 8

FIG. 9

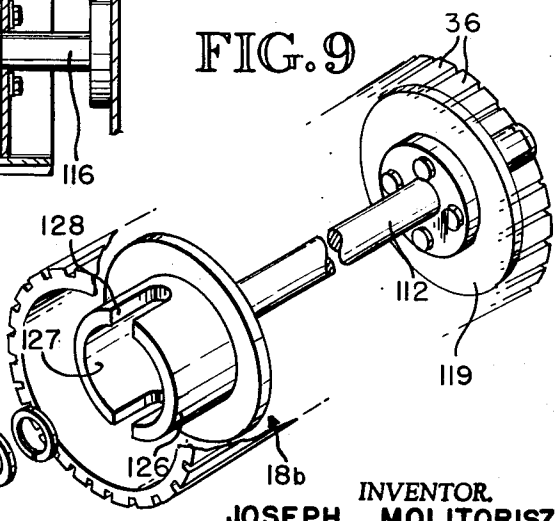
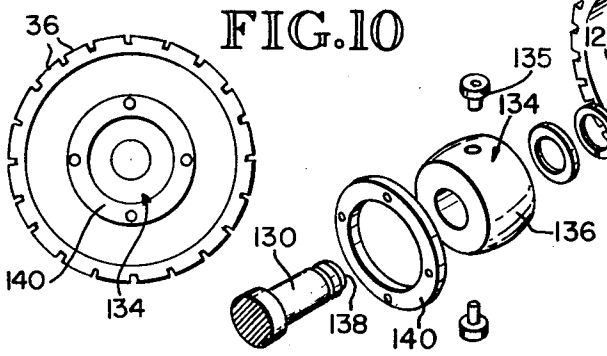


FIG. 10



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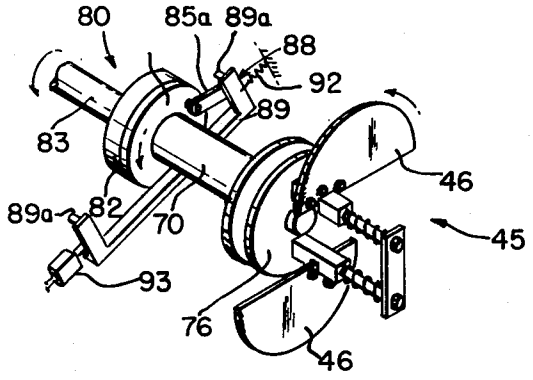


FIG. 11

FIG. 12

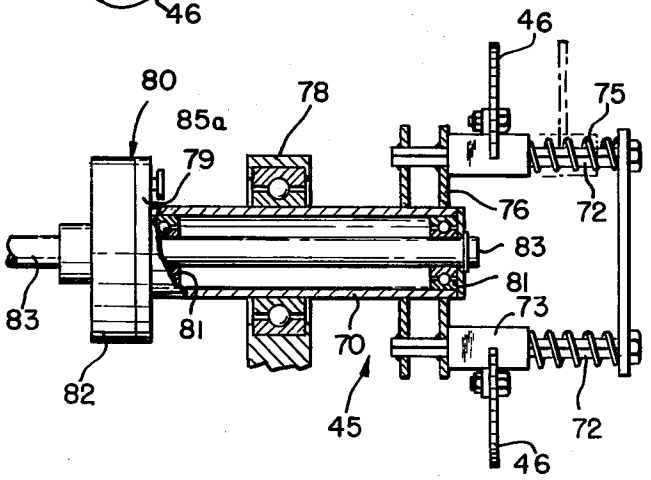


FIG. 13

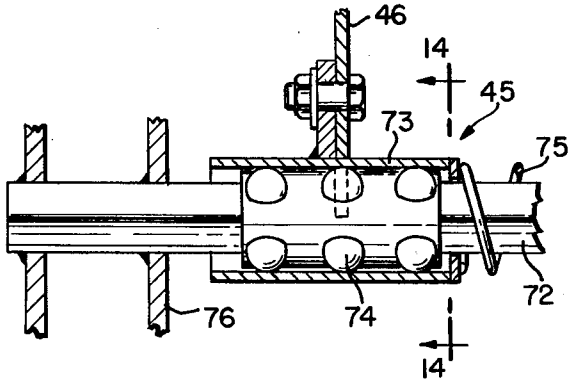
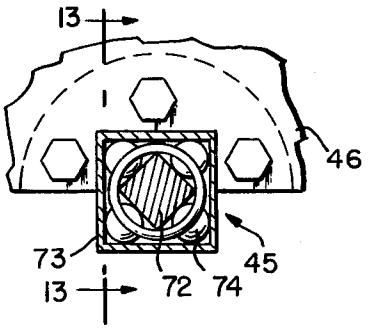


FIG. 14



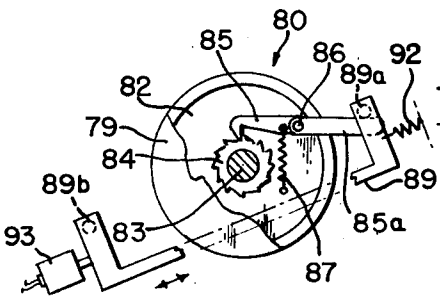


FIG. 15

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COMPRESSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to apparatus for compressing fibrous materials. The invention has particular application to agricultural uses such as the compaction of hay or the like into self-contained wafers, but also industrial utility for the compaction of other materials. The compaction technique is of the type in which sheets of fibrous material are continuously rolled into a compact core by the imposition of radial, axial and tangential forces in a core forming channel defined by circumferentially spaced rollers. This technique is known in the art as "rolling-compressing".

2. Description of the Prior Art

The rolling-compressing technique of forming loose fibrous material into a dense cylindrical core and particularly a core suitable for cutting into wafers had its origin in the late 1950's. Extensive experimental and development work on practical apparatus for employing the technique has continued since. Early machines are disclosed in U.S. Pats. to McColly et al., No. 3,316,694 and to Bushmeyer et al., No. 3,244,088 for example.

More specifically, rolling-compressing apparatus of cylindrical, conical or hyperboloid channel configurations have been experimented with using skewed rollers, channels with large conical angles or mechanical means in the channel to provide axial displacement of the compressed core. Means have also been provided to produce an axial resistance force in order to achieve a desired core density. However, such apparatus and the rolled wafers produced by such prior art techniques have not satisfied the basic requirements for commercial utilization.

Rolling-compressing systems with receiving channels defined by skewed hyperbolic rollers were attempted. Such systems were complicated and did not provide adequate and flexible means to control core density nor the necessary flexibility to accept unavoidable intake fluctuations. Rolling-compressing systems consisting of separate receiving and finishing channels have inherent difficulties in passing the compressed core from the receiving to the finishing channel. One such difficulty is the accumulation of fibers at the interspace between the two roller systems.

Rollers used in known rolling-compressing apparatus have been provided with elastic coatings and/or other surface coatings to improve torque transfer, adjust the relative velocities between the roller and core, and to prevent the adherence of particles to the rollers surfaces. These techniques were inadequate because the coatings flexed rather than the fibrous material and the surfaces were exposed to severe wear by the abrasive nature of the material of the core.

Slicing and metering of prior art machines was generally unsuccessful because of the physical size of the cutting mechanism and the slow cutting rate which placed limitations on the capacity of the machine. Furthermore, cutting often unduly damaged the outer surface of the core.

The capacities of mobile rolling-compressing machines were often increased by undesirably increasing roller rotation speed. Prior machines have also been extremely large, complicated, and expensive due to the number of channels, the roller suspension techniques, and the common practice of driving the rollings of the channels from independent sources. In particular, prior suspension techniques for skewed roller configurations have been unsatisfactory for commercial acceptance.

SUMMARY OF THE INVENTION

This application is directed toward various unique features employed to produce a practical, commercially feasible mobile agricultural compacting machine which uses the rolling-compressing technique. The features, as will be apparent are equally applicable to either stationary or mobile compressing machines. While the various features uniquely work in combination to provide an overall optimum machine they are also useful individually in various of the prior art machines and provide unique advantages over similar features of those machines.

A first of the unique features is a density control valve having radially movable core-engaging means biased inwardly for providing an axial resistance force in the discharged core in a manner which does not damage the external surface of the core. The bias of the core-engaging means is adjustable to vary the density. In addition, the valve means also provides a radial component of force on the core and is rotated at the same velocity and direction as the core. The valve advantageously supports the core after it leaves the discharge of the channel and prevents the core from unwrapping under centrifugal force due to the rapid rotation of the core. The unique rotational support of the core by the valve means also acts in combination with the cutting blades by providing a supplementary rotational torque to the core to counteract the opposite torque produced as a cutting blade slices through the core. The entrance to the valve is of a diameter larger than the largest core that can be discharged from the channel even under overfeeding and thus can accommodate any size core. The exit of the valve means is smaller than the diameter of the smallest core to be discharged from the channel and thus the valve will always be contacted by the core.

The valve serves to hold the core within the channel by producing an axial resistant force of a predetermined magnitude. When sufficient material has entered the channel and is wrapped on the core to produce the desired axial force component to overcome the valve induced axial resistance force, axial discharge occurs. Since the resistance force is an externally imposed force, it remains independent of the feeding of the channel so that the feeding rate may vary without seriously affecting the core density.

A second feature is the provision of a roller surface modification to increase torque transfer, correct the profile of the roller in a skewed roller channel, bend and crush the fibers to reduce their elasticity, and in high moisture content materials remove the liquid from the torque transmitting portion of the roller and the channel. The modification occurs through a plurality of circumferentially spaced longitudinal cleats or ribs on the periphery of the rollers. These cleats increase the frictional engagement between the surface of the core and the roller and, in effect, cause the roller to engage the core like a gear. In the case of a channel formed by rollers at a small skew angle the desired profile cor-

rection will produce a surface generated by the rotating roller of two frusto-conical sections joined at their smaller ends. To obtain this shape the radial dimension of the cleat is made greater at the ends of the roller than at the midsection. The cleats are spaced and rigid to provide a sharp bending and crushing action on the fibrous material of the core to stress it almost to the yield point so as to produce the elasticity of the fibers. This advantageously provides a core not tending to unwrap and thus able to hold its shape over long periods. The passages between the cleats provide a discharge means for the liquid squeezed from the material and are extended throughout the length of the channel to provide passages out of the channel for the liquid.

Another feature is the provision of a metering device and a cutting blade to reduce damage on the core surface and maintain a high cutting capacity. In the preferred form two cutter blades 180° apart are employed with each being mounted for rotational and independent axial movement. While one of the cutting blades is slicing the core the other is repositioned to engage the next length of core to be sliced, thus doubling the cutting capacity. The radial force imposed on the core by the cutting blade is counteracted by a freely rotatable ring which supports the core as it is being cut. The annular ring advantageously provides the radial counteracting force without providing a counter torque on the core that would damage the exterior layer of the core. The metering device measures the length of core desired to be cut and actuates the cutter when the desired length is obtained. The metering acts on the core within the channel prior to the core receiving its last revolutions in contact with the rollers so that any deformation done to the surface of the core by the metering device is corrected by further rolling.

One of the most important features to provide a commercially feasible mobile agricultural machine is the provision of two sets of circumferentially spaced rollers defining two transversely spaced rolling-compression chambers with a center drive common to both sets of rollers. The center drive reduces the lateral dimensions of the overall machine and greatly simplifies the expense and maintenance of the machine. The use of two sets of rollers effectively increases the capacity of the machine. The center drive also advantageously distributes equal power to the various rollers.

Another feature is the means for suspending the roller in a manner which provides rotational coupling between the power source and the roller regardless of the skewing or radial movement of the roller and which also can carry to the frame the radial and axial forces on the roller. The roller suspension is also housed and sealed within the confines of the roller body to prevent ingress of debris or wrapping of the material around the coupling mechanisms. It is also safe since no shafts are exposed externally of the roller.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an overall perspective of a compressing machine embodying the principles of the invention.

FIG. **2** is a schematic isometric illustrating the drive train for the machine shown in FIG. **1**.

FIG. **3** is a section of the density control valve employed in the machine of FIG. **1**.

FIG. **4** is an isometric of the valve shown in FIG. **3**.

FIG. **5** is an isometric illustrating the metering means of the invention.

FIG. **6** is an end elevation of the cutting means.

FIG. **7** is a vertical section of the cutting and valve means of the invention.

FIG **8** is a longitudinal section of one of the rollers showing the suspension for the rollers.

FIG. **9** is an exploded isometric of the rollers and suspension shown in FIG. **8**.

FIG. **10** is an end elevation of the roller in FIG. **8** showing the placement of the cleats.

FIG. **11** is another isometric illustration of the cutting means of the invention.

FIG. **12** is a fragmentary side elevation of the cutting means.

FIG. **13** is a fragmentary section of a portion of the cutting means shown in FIG. **11** taken along the line **13—13** of FIG. **14**.

FIG. **14** is a fragmentary vertical section of the cutting means taken along line **14—14** of FIG. **13**.

FIG. **15** is a schematic illustrating a clutching mechanism for actuating the cutting means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles of the present invention are illustrated for purposes of description as embodied in an agricultural machine suitable for movement through a field of fibrous material such as hay. A particular rolling-compressing technique with which these features are usable but not limited to is described in my copending patent application entitled "Method and Apparatus for Compacting Fibrous Materials", Ser. No. 121,704 filed concurrently herewith.

The mobile compacting machine illustrated includes a draw bar **10** secured to a trailer frame **12**. Suitable powered feed conveyors **14** deliver the fibrous material such as hay H rearwardly to the compressing portion of the machine. In the embodiment illustrated, the means for compressing the fibrous material into a cylindrical core C includes two sets of rollers **16** and **18**. The rollers are powered by a suitable drive train **20** which is connected through a gear box **21** to the conventional power take-off of a tractor. Each of the sets of rollers is identical and the rollers in each set are circumferentially spaced to define a respective single channel for forming the sheets of fibrous material into a compacted cylindrical core. The double sets of rollers uniquely provide for simultaneous compression of two cores; however, for the purpose of this description only one set of rollers and its operation will be described.

Roller set **18** includes four rollers, **18***a*, **18***b*, **18***c* and **18***d*. These rollers are circumferentially spaced and define in general a core forming channel **22**, the shape of which is approximated for the purposes of this description as two frusto-conical sections **22***a* and **22***b* joined at their smaller diameter. The channel is shown in phantom lines in roller set **16** for purposes of clarity but is facing opposite the direction from the channel **22** in roller set **18**. The shape of the channel is caused by skewing the discharge ends of the rollers approximately 3° relative to the channel axis. A space is provided between the forward rollers **18***a* and **18***c* to provide a transverse inlet **24** into the channel. As will be described in more detail, the skewing of the rollers pro-

vides the core formed within the channel with an axial velocity component to move the core to the axial channel discharge **25**. The discharge is at the right in roller set **18** and to the left in roller set **16** as viewed in FIG. **1**. Both sets of rollers **16** and **18** are powered by the drive train **20** through a plurality of gears **28***a*, **28***b*, **28***c* and **28***d* to rotate the rollers in common directions indicated by the arrows. The discharge ends of the forward rollers **18***a* and **18***c* adjacent the discharge **25** are mounted for radial movement relative to the channel and are spring biased inwardly by a biasing mechanism **32** (FIG. **1**).

As thus far described, the channel defined by the skewed rollers **18** is a complex shape having a varying diameter caused by a correction to the roller profile. The shape is approximated by two frusto-conical sections. The form of the peripheral surfaces of the rollers is modified to achieve the optimum wafer structure and to absorb the minimum amount of energy during the rolling process. This modification is in the form of longitudinal cleats having their largest radial thicknesses at the ends of the rollers and tapering down to a small radial thickness at the midsection of the channel. Through the use of these cleats the diametrical ratio and thus the peripheral velocities ratios between the rollers and cores remain nearly constant during the entire length of the channel. It should be understood that the correction to the channel is introduced on the cleats only with the remaining surface of the rollers being cylindrical.

The skewing of the rollers gives the fibrous material an axial velocity in the channel. For the purposes of this invention it should be understood that the action of the rollers causes the loose fibrous material to wind itself into a core becoming more tightly compacted toward the discharge end of the channel, finally emerging as a self-binding core having a density of about 30 pounds per cubic foot.

VALVE MEANS

Another important factor is to produce a core of the desired density, for example 30 – 50 lbs per cu. ft. for hay. This requires that the core not be discharged from the channel prior to reaching this density. As illustrated in FIG. **1** a density control valve **42** is positioned on a side-plate **43** of the vehicle frame adjacent the discharge **25** of the channel **22**. One of the purposes of the valve is to provide an axial force resisting the axial force imposed by the rollers in the channel thus preventing the discharge of the core until the roller imposed axial forces exceed the axial resistance force. As will be seen the axial resistance is applied in such a manner that no relative rotational movement occurs between the valve and the core thus preventing damage to the outer layer of the core.

Another purpose of the valve is to provide a torque supplementing the torque produced by the rollers to offset the countertorque applied during cutting of the core into cylindrical wafers W by the cutting blades **46** of the cutter **45** which is powered by a drive **48**. The valve **42** includes an annular ring **56** which is secured to the side frame **43**. The annular ring mounts a pair of bearings **58** the inside races of which are secured to a rotatable ring **60**. A belt drive **61** powers the rotatable ring at the same angular velocity as that of the core. A plurality of circumferentially spaced leaf springs **62** are secured to the rotating ring **60** and are permanently bent to have a wide entrance **63** of a diameter larger than the discharge of the channel so that expansion of the channel by the radial movement of the rollers **18***a* and **18***c* will allow the larger diameter core to still fit within the entrance of the valve. The leaf springs form an exit **64** of a diameter smaller than the normal diameter of the core so that the core will always engage the leaf springs somewhere along their length. Supplementary coil springs **66** are secured around the leaf springs adjacent the exit **64**. The coil springs are adjustable in tension to adjust the magnitude of the resistance force. In the preferred form the springs are secured to the rotating ring **60** by clips **68**. When cutting is provided, a metering means **50** is employed to measure the length of the wafers and a rotatable ring **52** supports the core during cutting. The wafers are removed by an elevator **54**. The driven valve also increases the surface where the torque is transferred to the core, thus protecting the structure of the core and assisting the rollers.

CLEAT

The exact shape of the cleats **36** which are fixed to the roller body is best shown in FIGS. **8** to **10**. As can be seen in FIG. **8**, the thinnest radial dimension through the cleats exists at the midsection of the channel **22**. The cleats increase the frictional coefficient between the roller surface and the fibrous material and the change in radial thickness provides a correction for maintaining a constant peripheral velocity ratio between the roller and core throughout the channel. The cleat is preferably made of a rigid material and is generally rectangular in cross-section. The rigid material and shape of the cleat cause the fibrous material to be crushed and sharply bent by the abrupt edges of the cleats at the space between adjacent cleats during the rolling of the core. This intermittent and frequent contact between the cleat and the fibrous material works the fibers such as to reduce their elasticity well below the level which would significantly tend to open the core. The gear effect of the cleats also prevents the fibers from building up on the roller surface by causing limited slipping to make the roller self-cleaning.

During the rolling process liquids are squeezed from fibrous materials having a high moisture content. The passages between the cleats remove the liquid from the working surface of the cleat and by extending the cleats along the entire length of the roller the passages provide an exit for the flow of this liquid out of the channel.

CUTTING MEANS

The cutting means **45** includes a pair of slicing blades **46** mounted on a common tubular shaft **70** for rotation into the core C. Each blade is mounted to also provide for axial movement relative to the channel on a rod **72**. For this purpose each blade is secured to a sleeve **73** slidably journaled on the rod **72** by bearings **74**. The sleeves are biased toward the channel **22** by springs **75**. As is readily apparent, when the blade engages the core it is free to slide along the rod **72** against the pressure of the spring **75**. As the blade leaves the core after slicing the wafer it then is forced back toward the discharge end of the channel to be in position for the next cut.

By using two blades **46**, one blade can be cutting while the other is being repositioned for initiation of the next cut. Thus the frequency of the cuts can be increased to at least three cuts per second to keep up with a high capacity machine. The rods **72** are secured to a bracket **76** which is in turn secured to the common shaft **70**. The latter rides in a bearing **78** secured to the frame **12** of the machine and is secured at its free end to one rotatable plate **79** of a clutch mechanism **80**. The other plate **82** of the clutch mechanism is secured to a continuously rotated shaft **83** connected at one end to the drive train **48** and extending by its other end through the plate **79** into the shaft **70** wherein it is journal mounted by a pair of axially spaced bearings **81**—**81** as shown in FIG. **12**.

As best shown in FIG. **15** the clutch **80** selectively connects the shaft **83** and the plate **79** by a pawl and ratchet mechanism. The shaft **83** is provided with a ratchet **84** having its teeth engaged by a pawl **85**. The pawl is pivoted on the inner end of a pin **86** which freely passes through the clutch plate **79** and connects to a pawl extension **85***a*. A spring **87** biases the pawl into engagement with the ratchet teeth. As is readily apparent, unless influenced by an external force, the shaft **83** will remain coupled to the pawl **85**.

The pawl **85** is disengaged from the ratchet **84** by operation of movable stop means **88** comprised of a generally C-shaped slide bar **89** having commonly extending upper and lower arms **89***a* and **89***b*. The lower arm **89***b* is connected to a solenoid **93** which receives a signal from the metering means **50** in a manner to be described. The slide bar **89** is biased toward the solenoid **93** by a spring **92** into an active position wherein the upper arm **89***a* obstructs the rotation movement of the pawl extension **85***a* and thus the pawl **85** away from the ratchet **84** to disengage the clutch **80**. Energization of the solenoid **93** will then push the slide bar upwardly in opposition to the spring **92** and move the upper arm **89a** out of the path of the pawl extension **85***a* allowing the pawl to engage the ratchet thereby coupling the shafts **70** and **83** together to cause 180° rotation of the cutter **45**. When the shaft **70** reaches 180° of rotation the pawl extension engages the underside of the lower arm **89***b* and again disengages the clutch until the solenoid is again energized to lift the arm **89***b* out of the path of the pawl extension. Thus it is readily seen that the metering means actuates the clutter for intermittent 180° rotation.

METERING

Referring to FIG. **5**, the metering means **50** includes a wheel **96** keyed to a shaft **97**. The wheel is axially aligned at 90° to the core axis of rotation and extends into the channel **22** through the space between rollers **18***a* and **18***c* downstream from the feed zone L. The wheel is provided with circumferentially spaced ribs **98** which frictionally engage the core. As is readily apparent, the axial movement of the core C will thus rotate the wheel shaft **97**. Since the core will receive additional rolling downstream of the wheel, any damage to the surface of the core by the ribs **98** will be rolled out prior to discharge of the core.

Secured to one end of the shaft **97** is a sensing means in the form of a circular plate **99** having peripheral spaced cams or switch actuators **100**. A microswitch **101** is disposed adjacent the plate with its switch actuating arm extending into the path of the switch actuators to open or close the switch each time the arm is engaged or disengaged by a switch actuator. The switch sends a signal to the solenoid **93** to energize the cutter as was previously described. By changing the number of cams the wafer length can be varied.

DOUBLE ROLLER SETS AND CENTER DRIVE

In order to have a commercially acceptable agricultural rolling-compressing machine suitable for propulsion through a field of fibrous crop as well as an efficient stationary machine, the size of the machine must be minimized without reducing its output capacity. It is a unique feature of this invention to provide such a machine by placing two sets of rollers axially aligned transversely of the machine. The double output thus accommodates the requirements for high output capacity. The compactness is advantageously obtained by a center drive means which is utilized by both sets of rollers and a unique roller suspension.

The double sets of rollers **16** and **18** with their drive means are best shown in FIG. **2** wherein it is seen that the input drive train **20** powers a bottom pinion gear **104** which distributes the power equally to the gears **28***c* and **28***d*. The latter in turn drive a center pinion **105** which equally powers the gears **28***a* and **28***b*. The four gears **28***a* through **28***d* are connected in common, respectively to the rollers of like letter suffix in the roller sets **16** and **18**.

It is estimated that the power requirement using this equal distribution system is about 60 horsepower, well within the range obtainable from the power takeoff of a farm tractor. The low power requirements of the rollers also allow the input drive train **20** to be used for powering the pick-up elevator shaft **106**, the cutter drive **48** and the valve drive **61**. A further advantageous feature of the common center drive is that the discharge ends of the rollers may be skewed or permitted to move radially while still maintaining driving engagement with the other ends of the rollers.

ROLLER SUSPENSION

The rollers have to be supported for rotation while providing the necessary torsional displacement for skewing as well as some limited radial displacement at the discharge end of the channel. As best shown in FIGS. **8** and **9**, each of the rollers, for example roller **18***b*, includes a roller shaft assembly **110** having an inner elongated roller shaft **112** and an outer cylindrical roller body **115**. The roller shaft has a coupling wall **114** at one end and a projecting portion **116** at the other end which is mounted in a bearing **117** on the end plate **43** that is positioned to skew the respective roller. The wall **114** and a complementing wall assembly **119** interconnect the shaft **112** and the roller body **115**.

The coupling wall **114** of the roller shaft **112** includes a cylindrical socket **126** having an internal circumferential bearing surface **127** and two diametrically opposed slots **128**. The socket also has a transverse bearing wall **129**. Each of the drive gears **28***a*–**28***d* are keyed to a respective transmission shaft **130** that rides in a bearing **131**. A bearing collar **134** formed of a section of a sphere is secured to the transmission shaft **130** and is provided with two diametrically opposed cam fol-

lowers 135 which ride in the slots 128. The external spherical segment bearing surface 136 of the collar 134 abuts the internal circumferential bearing surface 127 of the socket 126. As is readily apparent the cam followers 135 can apply rotational torque to the respective rollers 18*a–d* regardless of the torsional or radial displacement of the roller whereas the external bearing surface 136 absorbs the radial forces applied on the roller.

The end of the transmission shaft 130 is rounded as at 138 to provide bearing contact with the bearing wall 129 of the socket. The rounded bearing surface 138 thus absorbs axial forces of the roller. The configuration of the axis of the transmission shaft is made such that the surface of the rounded end 138 of the transmission shaft and the circumferential bearing surface of the collar 134 would be on the same spherical surface if continuous. This configuration is essential to maintain a constant relative position between the collar and the socket at any angular position within allowable limits. The collar 134 is held in place within the socket 126 by a conventional retaining ring 140 which allows a limited angular displacement of the socket relative to the collar, prevents axial movement of the roller to the right as viewed in FIG. 8, and seals the socket to allow proper lubrication and keep the system clear of dust. The roller body 115 overhangs the coupling to prevent material fibers from wrapping around the shafts.

The discharge ends of the pairs of rollers 16*a*, 16*c* and 18*a*, 18*c* are mounted for radial movement relative to the respective channel and each such pair is spring-biased inwardly by a respective biasing mechanism 32, shown in FIG. 1. Referring to FIG. 1 and using rollers 18*a*, 18*c* for example, the biasing mechanism includes a pair of spaced arms 120–120*a* pivotally mounted to the frame 43 at 121 and providing journals for the rollers 18*a*, 18*c* forward of the pivots. The forward ends of the arms are biased toward one another by a tension spring 124 which is coupled at its lower end to the lower arm 120*a* and is connected at its upper end to an adjustable hook 122. This hook slidably extends through the upper arm and threadably receives a nut having a handle 123 for adjusting the tension of the spring. A pair of stops 125 on the end plate 43 limit the inward swing of the arms 120–120*a* to thereby define the minimum feed opening between the rollers 18*a*, 18*c*. Since their other ends are driven through ball-type couplings as previously described, it is seen that the rollers 18*a*, 18*c* are free to pivot while driven so that their spring-loaded ends can move in and out to accommodate fluctuations in the quantity of material entering the feed opening.

While preferred forms of the invention have been illustrated and described, it should be understood that changes may be made without departing from the principles thereof. Accordingly, the invention is to be limited only by a literal interpretation of the claims appended hereto.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A fibrous material compacting machine of the type forming a compressed material core and having a plurality of circumferentially spaced cylindrical rollers skewed at one end defining a variable diameter core-forming channel having a transverse material inlet and an axial discharge, the improvement comprising elongated longitudinal protrusions secured to the periphery of each roller and circumferentially spaced therearound, said protrusions extending a substantial length along the roller whereby the torque transfer of the roller to the core is increased, said protrusions being rigid whereby substantial bending of the fibrous material occurs at the edges of adjacent protrusions to reduce the elasticity of the fibrous material and make the rollers self-cleaning, and said protrusions having greater radial thicknesses at their ends than at the mid-section of the roller to maintain a constant angular velocity ratio between the rollers and the core throughout the channel.

2. The machine of claim 1 said spaced protrusions defining longitudinal liquid passages for removing from the channel liquid squeezed from the material by the rigid protrusions.

3. A fibrous material compacting machine of the type having a plurality of circumferentially spaced rollers defining a channel having a transverse inlet and an axial discharge, means for feeding fibrous material into the channel, means for rotating the rollers for wrapping the material into a compressed core, and means for moving the compressed core through said axial discharge, the improvement comprising cutting means for cutting the core into lengths of predetermined size, metering means having a rotary sensing device engageable with the core for actuating the cutting means when said predetermined length is attained, said cutting means including at least two blades movable axially with the axially moving core, means for alternately moving the blades radially from an initial position into the core to sever it to form the cut length, while the other blade can return to its initial position, and means for supporting the core radially as it is being severed.

4. The machine of claim 3 said means for supporting the core including a ring having an interior surface engageable with the core and supported for free rotational movement therewith.

5. The machine of claim 3 including valve means engaging the core adjacent the cutting blade, said valve means including means for imposing a torque on the core at the same direction and angular velocity as the core.

6. The machine of claim 3 said cutting means including spaced parallel bars slidably receiving the blades, means on said bars for urging the cutting blades in a direction opposite to the axial movement of said core, said means for moving the blades radially through the core including a rotatably mounted common shaft fixed to said parallel rods, a clutch secured to said common shaft, said metering means including means for actuating said clutch for intermittent 180° revolutions whereby each cutting blade is rotated into said core and slides axially along said bar with the second blade returned in the opposite axial direction by the urging means.

7. The machine of claim 3 said rotary sensing device including a wheel having circumferentially spaced peripheral ribs engageable with the core within said channel for rotating the wheel prior to the core receiving its final rolling, a shaft secured to the wheel,

signalling means for intermittently signalling when a predetermined length of core has been discharged including a disc secured to said shaft and having switch actuators evenly spaced circumferentially therearound, switch means engageable with said switch actuators for causing said signal, and means responsive to said signal for actuating the cutting means.

8. The machine of claim 7 said cutting means including two cutting blades spaced 180° apart and selectively rotatably powered to slice the core, said cutting means including a power source, a clutch between the power source and the cutting blades, and said means for actuating the cutting means including two position stop means for engaging the clutch and then disengaging the clutch after 180° of rotation of the clutch to selectively move one of the cutting blades through the core.

9. A mobile agricultural machine of the type having a plurality of circumferentially spaced rollers defining a core-forming channel with a transverse intake between two adjacent rollers and an axial discharge for forming a fibrous material crop into a cylindrical core the combination comprising first and second generally axially aligned, transverse roller sets each defining a core-forming channel, means for driving said rollers of each set to compress the crop into an axially discharged core, means for cutting the axially discharged core into predetermined lengths, and means for removing the cut lengths from the machine, said roller driving means including central transmission means positioned between said roller-sets, coupling means secured to each of the rollers, said central transmission means being secured in common to generally axially aligned coupling means of the respective sets for reducing the width of the machine and providing ease of assembling, and means connecting said central transmission means to a power source.

10. The machine of claim 9 said roller-sets each including four rollers, said central transmission means including a plurality of driven gears one coupled to each of the generally axially aligned coupling means of said roller-sets, and power distribution means including a first drive gear meshing with two adjacent driven gears, and a second central drive gear meshing with all four driven gears to transmit power from said first two adjacent driven gears to the remaining two.

11. The machine of claim 9 said central transmission means including a plurality of transmission shafts, said rollers including roller supporting means each having a coupling end, said coupling means including a socket secured to said coupling end of said roller shaft and having an internal bearing surface, two diametrically opposed slots in said socket, a bearing collar secured to the end of said transmission shaft, said collar having a circumferential external spherical segment bearing surface positioned to abut said internal bearing surface of said socket, two diametrically opposed cam followers protruding outwardly from said collar and received in said slots whereby regardless of the relative axial alignments of said rollers and said transmission shafts radial forces can be transmitted between said roller and said transmission shaft and said transmission shaft can transmit torque to said roller shaft.

12. The machine of claim 11 said socket also including an internal radial bearing wall and each of said transmission shafts having a rounded end of the same curvature as said external bearing surface forming a continuation of said spherical segment bearing surface abutting said bearing wall whereby axial thrust forces from said rollers will be imposed on said transmission shaft and in part will be balanced by the axially aligned roller of said other set.

13. A fibrous material core-forming machine of the type having a plurality of circumferentially spaced skewed rollers defining a core-forming channel with a transverse intake between two adjacent rollers and an axial discharge the combination comprising first and second generally axially aligned, transverse roller sets each defining a core-forming channel, means for driving said rollers of each set to compress the fibrous material into an axially discharged core, means for cutting the axially discharged core into predetermined lengths, and means for removing the cut lengths from the machine, said roller driving means including central transmission means positioned between said roller-sets, coupling means secured to each of the rollers, said central transmission means being secured in common to generally axially aligned coupling means of the respective sets, said central transmission means including a plurality of transmission shafts, said rollers including supporting means having a coupling end and a free end, said coupling means including a socket secured to said coupling end of said roller supporting means and having an internal bearing surface and two diametrically opposed slots, a bearing collar secured to the end of said transmission shaft, said collar having an external partially spherical bearing surface positioned against said internal bearing surface of said socket, two diametrically opposed cam followers protruding outwardly from said collar and received in said slots whereby, regardless of the relative axial alignments of said roller and said transmission shaft, radial forces can be transmitted between said roller and said transmission shaft and said transmission shaft can transmit torque to said roller.

14. The machine of claim 13 said socket also including an internal radial bearing wall and each of said transmission shafts having a rounded end of an arc equal to said spherical bearing surface and abutting said bearing wall whereby axial thrust forces from end rollers are passed to said transmission shaft.

15. In a fibrous material compacting machine of the type comprising a plurality of circumferentially spaced rollers each having a roller body and roller supporting means, including a coupling end and a free end, and defining a core-forming channel having a transverse material inlet and an axial discharge, roller suspension apparatus for carrying the rollers between frame members of the machine comprising, bearing means mounting said free end of said roller supporting means on a frame member, a transmission shaft, and means coupling said transmission shaft and said coupling end for transmitting torque to the coupling end when said free end is skewed about the circumference of the channel or is moved radially of the channel and for counteracting radial forces between the roller and the transmission shaft, said coupling means including a socket secured to said coupling end and having an internal circumferential bearing surface and two diamet-

rically opposed axial slots, a bearing collar fixed to said transmission shaft and having an external bearing surface in the form of a spherical segment received within said socket with said collar external bearing surface abutting said socket bearing surface whereby radial forces imposed on said roller body by the compressed core in the core-forming channel will be transmitted between the socket and collar bearing surface to said transmission shaft regardless of the relative axial alignments of the transmission shaft and roller, and two diametrically opposed protruding cam followers on said bearing collar received within said slots for transmitting torque between said collar and socket.

16. The machine of claim 15 said coupling means also including axial thrust counteracting means including an internal radial bearing wall on said socket, and a rounded end on said transmission shaft in the spherical plane of the spherical segment bearing surface of said collar and engaging said bearing wall whereby the axial forces imposed on said roller body by the compressed core will be passed from said coupling end through said coupling to said transmission shaft regardless of the relative axial alignment of the transmission and roller.

17. The machine of claim 16 said coupling means including a retaining ring for closing the end of said socket around said collar to prevent axial movement of the roller relative the transmission shaft in a direction toward said roller supporting means free end and to seal the space within said socket against ingress of foreign matter, said roller body extending axially beyond said socket to shield said socket from the fibrous material to prevent wrapping of the fibrous material on said socket.

18. A fibrous material compacting machine of the type having a plurality of circumferentially spaced rollers defining a channel having a transverse inlet and an axial discharge, means for feeding fibrous material into the channel, means for rotating the rollers for wrapping the material into a compressed core, and means for moving the compressed core through said axial discharge, the improvement comprising cutting means for cutting the core into lengths of predetermined size, said cutting means including at least two blades independently movable axially with the axially moving core so that one blade can be cutting and moving with the core while the other is returning to an initial position preparatory to initiating another cut into the core, means for alternately moving the blades radially from said initial position into the core to sever it to form the cut lengths while the other blade is returning to its initial position, and means for supporting the core radially as it is being severed.

19. The machine of claim 18, said means for supporting the core including a ring having an interior surface engageable with the core and supported for free rotational movement therewith.

20. The machine of claim 18, said cutting means including spaced parallel bars slidably receiving the blades, means on said bars for urging the cutting blades in a direction opposite to the axial movement of said core, said means for moving the blades radially through the core including a rotatably mounted common shaft fixed to said parallel rods, a clutch secured to said common shaft, means for actuating said clutch for intermittent 180° revolutions whereby each cutting blade is rotated into said core and slides axially along said bar with the second blade returned in the opposite axial direction by the urging means.

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