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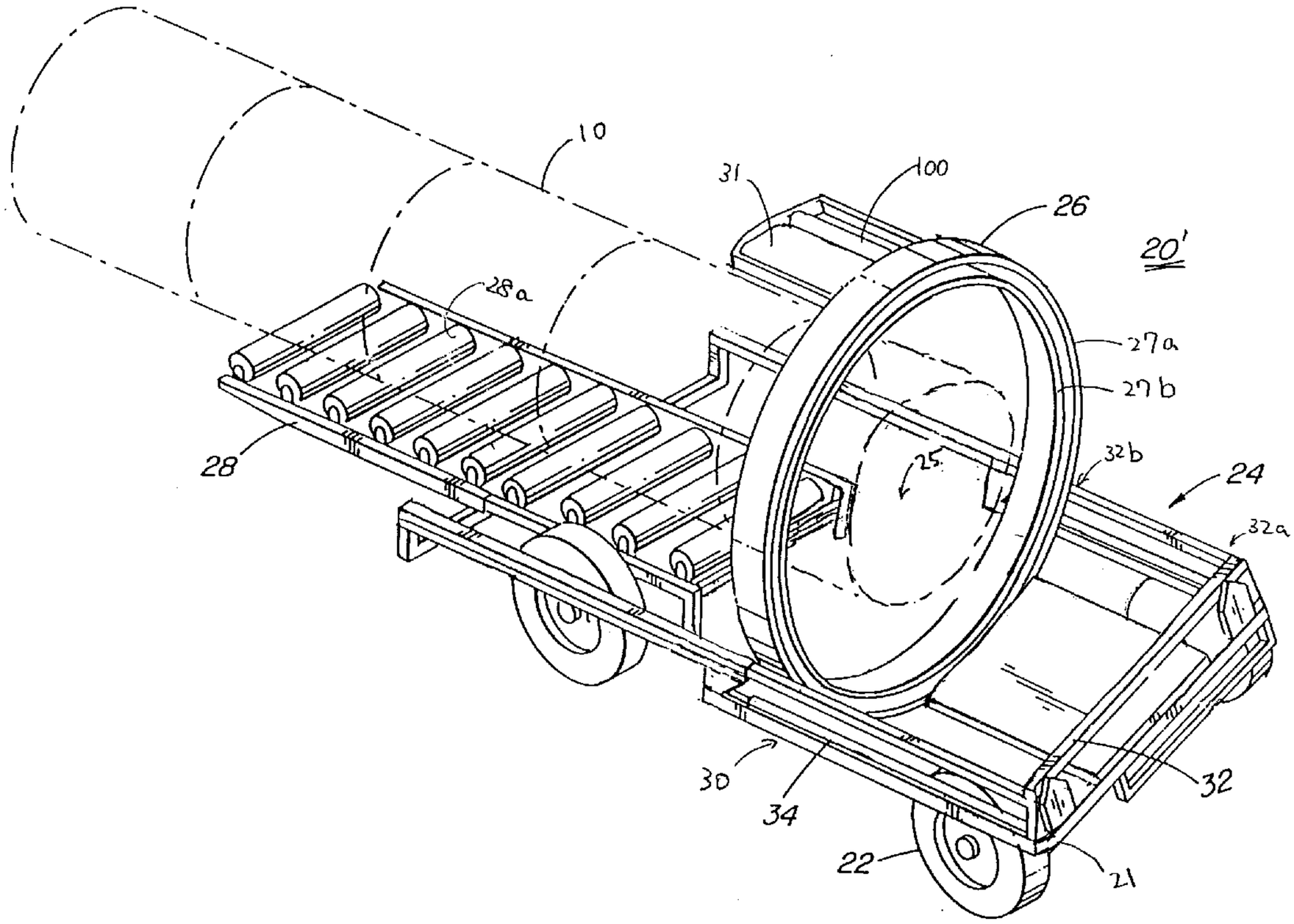
(54) **METHODE ET APPAREIL D'ENRUBANNAGE DE BOTTES DE BOUT EN BOUT**

(54) **METHOD AND APPARATUS FOR WRAPPING BALES END TO END**




(57) A plastic strip stretching device is provided to stretch multiple plastic strips together in a lengthwise direction of the multiple plastic strips. During the operation of wrapping bales, the stretching device and the multiple plastic strips are carried around a bale by a bale wrapping device of a bale wrapping machine for wrapping bales end to end in a row.

# ABSTRACT

A plastic strip stretching device is provided to stretch multiple plastic strips together in a lengthwise direction of the multiple plastic strips. During the operation of wrapping bales, the stretching device and the multiple plastic strips are carried around a bale by a bale wrapping device of a bale wrapping machine for wrapping bales end to end in a row.

# METHOD AND APPARATUS FOR WRAPPING BALES END TO END

This invention relates to a method and apparatus for wrapping bales end to end in a row.

## BACKGROUND OF THE INVENTION

To produce silage from grass, cut grass is often gathered to form bales and wrapped by plastic strip to ferment the grass.

United States Patent No. 4,793,124 issued on December 27, 1988 to Anderson discloses a bale wrapping machine which wraps bales end to end in a row while allowing the machine to move along a ground surface. Bales are received by a bale receiving support, and moved into a bale wrapping device by a ram cross bar driven by two hydraulic rams moving along the sides of the bale receiving support. The wrapped bales are moved down to a ground surface along an inclined support as they are pushed by the following bales. Such a bale wrapping machine is also called an "in-line wrapping machine" in contrast to a "single wrapping machine" which is dedicated to wrap a single bale.

In the bale wrapping field, relatively thin plastic strip is commonly used. Such thin plastic strip is economical and easy to handle. However, it tends to be easily damages by animals, cut edges of grass sticking out of bales, or other objects. So as to avoid exposing wrapped bales to air, the plastic strip is often wrapped around bales such that the plastic strip is overlapped to form two or more layers of strip on the bales. However, this solution slows down the wrapping operation.

It is known to stretch plastic strip in order to tightly wrap bales. If conventional thin plastic strip is stretched too much, it may tear in the hot sun.

In order to prevent damage from poking or tearing, a thicker plastic strip could be used. However, such a thicker plastic strip would be more costly. It would also require a more complicated mechanism to produce a force large enough to stretch the thicker plastic.

It is known in a single bale wrapping machine to stretch two plastic strips and laminate them together before wrapping a single bale, using hydraulic powered stretchers. It is difficult to move such hydraulic powered stretchers around a bale. Thus, the machine rotates the bale relative to the powered stretcher which is supported by stationary arms. In order to tightly wrap the bale in two planes, the machine also changes the direction of rotation of the bale.

Therefore, it is desirable to provide an in-line bale wrapping machine which allows for the use of conventional plastic strip in such a way that the plastic is not easily poked or torn.

## SUMMARY OF THE INVENTION

The present invention uses a plastic strip stretching device which stretches multiple plastic strips together in a lengthwise direction of the multiple plastic strips for carrying around a bale by an in-line bale wrapping device during the bale wrapping operation.

In accordance with an aspect of the present invention, there is provided a bale wrapping machine for wrapping bales end to end in a row. The bale wrapping machine comprises a machine mover for enabling the machine to move along a ground surface during the wrapping of bales; a bale receiving support for receiving bales; a bale wrapping device adjacent the bale receiving support for carrying a stretching device and multiple plastic strips around a bale, the stretching device stretching the multiple plastic strips together in a lengthwise direction of the multiple plastic strips during the operation of the bale wrapping device; an inclined support adjacent the bale wrapping device for

transporting wrapped bales to a ground surface; and a bale mover for moving bales from the bale receiving support towards the bale wrapping device.

In accordance with another aspect of the present invention, there is provided a bale wrapping machine for wrapping bales end to end in a row, the bale wrapping machine comprising: a machine mover for enabling the machine to move along a ground surface during the wrapping of bales; a bale receiving support for receiving bales; a stretching device having a set of free rotating rollers which receives multiple plastic strips; a bale wrapping device adjacent the bale receiving support, the bale wrapping device having a rotating hoop for carrying the stretching device and the multiple plastic strips around a bale and for stretching multiple plastic strips in a lengthwise direction of the multiple plastic strips together by the stretching device during the operation of the bale wrapping device; an inclined support adjacent the bale wrapping device for transporting wrapped bales to a ground surface; and a bale mover for moving bales from the bale receiving support towards the bale wrapping device.

In accordance with another aspect of the present invention, there is provided a method for wrapping bales end to end in a row using a bale wrapping machine. The method comprises the steps of receiving bales by a bale receiving support of the bale wrapping machine; moving the bales into a bale wrapping device of the bale wrapping machine; carrying multiple plastic strips around each bale by the bale wrapping device; stretching the multiple plastic strips together in a lengthwise direction of the multiple plastic strips during the operation of the bale wrapping device; moving wrapped bales from the bale wrapping device to an inclined support of the bale wrapping machine; transporting the wrapped bales to a ground surface along the inclined support; and allowing the bale wrapping machine to move along a ground surface during the wrapping of the bales.

Other advantages, objects and features of the present invention will be readily apparent to those skilled in the art from a review of the following detailed description of preferred embodiments in conjunction with the accompanying drawings and claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further understood from the following description with reference to the drawings in which:

Figure 1 is a side view of a bale wrapping machine having a stretching device in accordance with an embodiment of the present invention;

Figure 2 is a perspective view of a bale wrapping machine having a stretching device in accordance with another embodiment of the present invention;

Figure 3 is a perspective view of a plastic strip carrier having a stretching device in accordance with an embodiment of the present invention;

Figure 4 is a side view of the plastic strip carrier shown in Figure 3;

Figure 5 is a partial perspective view of the plastic strip carrier shown in Figure 3 as installed on a rotating hoop; and

Figure 6 is a side view of a wrapping device using two plastic strip carriers.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1, an embodiment of a bale wrapping machine 20 having a plastic strip stretching device 100 in accordance with the present invention is described.

The bale wrapping machine 20 is capable of wrapping bales 10 end to end in a row. The machine 20 has a frame 21, and a machine mover 22 which enables the machine 20 to move along a ground surface during the wrapping operation of bales. The bale wrapping machine 20 also has a bale receiving support 24, a bale wrapping device 26, an inclined support 28 and a bale mover 30. Bales 10 are received by the bale

receiving support 24 and translated into the bale wrapping device 26 along the bale receiving support 24 by the bale mover 30. The bale wrapping device 26 carries multiple plastic strips (one strip 31 is shown in Figure 1) and the stretching device 100 around the bale 10. Bales 10 wrapped by the bale wrapping device 26 are pushed down the inclined support 28 to a ground surface by the following bales. Thus, bales 10 are wrapped end to end in a row, resulting in a row of wrapped bales lying on the ground along the track of the machine 20 due to the movement of the machine 20 enabled by the machine mover 22.

The bale wrapping machine 20 shown in Figure 1 has, as the machine mover 22, three wheels in each side. The machine mover 22 may be also skis, sleds or any one or more mechanisms which allow movement of the machine 20 along the ground surface during the bale wrapping operation.

The bale receiving support 24 may have a roller bed 24a comprising multiple rollers arranged to facilitate the movement of bales 10 along the receiving support 24.

The inclined support 28 may also have a roller bed 28a comprising multiple rollers arranged to facilitate the movement of bales 10 along the inclined support 28. The tail end 29 of the inclined support 28 may be folded up or folded over the rest of the inclined support 28 when the machine 20 is not in use or carried to other locations.

Figure 2 shows another embodiment of a bale wrapping machine 20'. Similar elements to those in Figure 1 are shown with the same reference numerals.

The bale wrapping device 26 shown in Figure 2 comprises a rotating hoop 27a for carrying plastic strips 31 and the stretching device 100 around a bale 10. The rotating hoop 27a is rotatably supported by a fixed hoop 27b provided on the frame 21 of the machine 20. The rotating hoop 27a and the fixed hoop 27b may have different shapes, and may be located in different arrangements. For example, instead of the fixed hoop

27b, the rotating hoop 27a may be supported by one or more fixed supports of a different shape provided on the frame 21.

During the wrapping process, bales 10 are moved from the bale receiving support 24 into the rotating hoop 27a of the bale wrapping device 26 by the bale mover 30. The bale wrapping device 26 is located at a gap 25 between the bale receiving support 24 and the inclined support 28. Bales may be supported over the gap 25 by the pressure between the preceding bales and the bale mover 30. There may be one or more additional supports provided in the gap 25 between the bale receiving support 24 and the inclined support 28.

The rotating hoop 27a of the bale wrapping device 26 is rotated about its axis by a rotating driver (not shown).

It is preferable to synchronize the rotation of the rotating hoop 27a and the movement of the bale mover 30 in such a way that the rotating hoop 27a is rotated as a bale 10 is moved through the rotating hoop 27a. Rotation of the hoop 27a is stopped when the bale is completely or partially wrapped. The rotational speed of the hoop 27a may be varied to adjust the amount of overlap of plastic strips 31 on wrapped bales.

The bale mover 30 may use any moving mechanism and power source as long as it can move bales along the receiving support 24 to the bale wrapping device 26. A hydraulic ram mechanism may be conveniently used. In the embodiments shown in Figures 1 and 2, the bale mover 30 comprises a ram cross member 32 and a pair of hydraulic rams or ram cylinders 34 extending along the sides of the bale receiving support 24. The ram cross member 32 is supported across the pair of rams 34 adjacent the bale wrapping device 26, and moved by the rams 34 between a bale receiving position 32a for receiving a bale and a bale pushing position 32b for pushing the bale towards the bale wrapping device 26. In the embodiment shown in Figure 1, the rams 34 are provided in such a way that the ram cross member 32 is positioned at the bale receiving position 32a when the rams 34 are extended, and the ram cross member 32 is positioned

at the bale pushing position 32b when the rams 34 are retracted. The rams 34 may be provided in the reverse direction as shown in Figure 2.

In accordance with the present invention, the bale wrapping machine 20 uses multiple plastic strips 31 which pass through the plastic strip stretching device 100. The bale wrapping device 26 carries the plastic strip stretching device 100 and multiple plastic strips 31 around a bale 10. During the operation of the bale wrapping device 26, the stretching device 100 stretches the multiple plastic strips 31 together in their lengthwise direction in cooperation with the bale being wrapped.

Stretching multiple plastic strips together is advantageous because the resultant multi-layered strip becomes stronger than a single strip. The in-line bale wrapping machines are often used to wrap large round bales end to end in a continuous manner. When the wrapped bales are moved along the inclined support, localized forces may be generated in the plastic strip wrapping between bales. By using stronger plastic strips, the bales are moved without tearing the plastic strips between the bales.

The present invention allows use of relatively thin plastic strips conventionally used for wrapping bales. The plastic strip does not have to be overlapped as much on the bales.

As a thicker plastic strip is not required to provide sufficient strength in the wrapping, the present invention does not require a powered stretcher which would be required to stretch a thicker plastic strip.

Also, by stretching together, plastic strips tend to stretch more without brakeage, compared to stretching each plastic strip separately. Since multi-layered strip can be stretched more than single layer strip, more bales can be wrapped before the reels must be replaced.

It is preferable to use one or more plastic strips having a tacky surface or surfaces. By using tacky plastic strips, multiple plastic strips are laminated when they are stretched together and stay laminated on bales. Thus, the resultant multi-layered strip becomes even stronger.

Use of multiple plastic strips also allows flexibility in selecting materials of plastic strips.

It is preferable to prevent the light from entering into bales, and to prevent the plastic from becoming too hot. Conventionally, either a black plastic strip or a white plastic strip is used to wrap bales. White plastic strip is advantageous because it reflects light and thus stays cooler. However, black plastic strip has the advantage of letting less light through to the baler.

Use of multiple plastic strips allows a combination of different plastic strips. For example, a combination of a white and black plastic strip may be used to form an outer layer on bales with the white plastic strip, and an inner layer on bales with the black plastic strip.

Any form of plastic strips may be used as long as they are suitable for wrapping bales. Reels of plastic strips may be conveniently used.

The stretching device 100 may be supported by a plastic strip carrier frame 102 together with reels of plastic strips 31. The carrier frame 102 is in turn supported by the bale wrapping device 26 and carried around a bale 10.

Figures 3 to 6 show a preferred embodiment of the stretching device 100 together with a plastic strip carrier 200 for carrying two reels of plastic strips 31a, 31b. The stretching device 100 and the plastic strips 31a, 31b are supported by a carrier frame 102.

The stretching device 100 comprises a set of rollers having three free rotating rollers 104a, 104b and 104c.

The present invention allows use of free rotating rollers because there is no need to actively control tension applied to the plastic strips. When wrapping bales end to end, there is no need to wrap ends of bales which are covered by neighbouring bales. Hence, the surfaces of bales to be wrapped are generally located at the same position within the wrapping device. Accordingly, the wrapping device can wrap each bale substantially in the same condition. Therefore, there is no need to use powered stretchers to provide a constant tension applied to the plastic strips. By contrast, a single wrapping apparatus needs a powered stretcher because it is required to wrap different surfaces having different shapes of bales.

The first roller 104a receives the plastic strips 31a and 31b together. The plastic strips 31a and 31b are passed through between the first and second rollers 104a and 104b, and between the second and third rollers 104b and 104c. During the wrapping operation of the bale wrapping device, the plastic strips 31a and 31b are stretched together by friction of the rollers 104a, 104b, 104c in cooperation with the bale wrapping device, i.e. a tension caused in the plastic strips by the bale which is being wrapped.

The first roller 104a is preferably positioned at a position close to the second roller 104b. Thus, the plastic strips 31a, 31b can be applied with stronger friction and stretched more. Also, when the plastic strips 31a and 31b pass between these two rollers 104a, 104b, they are brought into contact with each other. When at least one of the contacting surfaces of the plastic strips 31a, 31b is tacky, the strips 31a and 31b are laminated together.

It is preferable that the first roller 104a is movable away from the second roller 104b. When the strips 31a, 31b are installed, by moving the first roller 104a away from the second roller 104b, free ends of the strips 31a, 31b are easily passed through between

the first and second rollers 104a, 104b. In order to move the first roller 104a, a pivotable lever 106 is provided in the stretching device 100.

The carrier frame 102 is provided with recesses 108a, 108b for receiving the reels of plastic strips 31a, 31b.

In order to prevent intrusion of broken grass or dirt between contacting surfaces of the plastic strips 31a, 31b, it is preferable to provide a shield 110 to cover at least exposed parts of the contacting surfaces of the plastic strips 31a, 31b.

In use, one end 102a of the carrier frame 102 is attached to the rotating hoop 27a, as shown in Figure 5.

In this embodiment, the rotating hoop 27a rotates in the direction shown by an arrow 112. Using three rollers 104a, 104b, 104c, the plastic strip 31a becomes an outer layer on the bale. It is preferable to use a white strip as the plastic strip 31a, and a black strip as the plastic strip 31b.

As shown in Figure 6, it is preferable to provide two sets of the stretching device 100 and the plastic strip carrier 200 at the opposite sides of the rotating hoop 27a. More than two sets of the stretching device and the plastic strip carrier may be also used. By using multiple sets, the wrapping may be carried out efficiently.

While particular embodiments of the present invention have been shown and described, changes and modifications may be made to such embodiments without departing from the true scope of the invention. For example, the rams may be provided in the other direction, or a single ram or more than two rams may be used for the bale receiving support. The number of hoops used, the design, the rotating direction of the bale wrapping device may be also modified. In the stretching device, the number of rollers and arrangement of the rollers may be changed. The number of plastic strips used and arrangement of them may be also changed.

**What is claimed is:**

1. A bale wrapping machine for wrapping bales end to end in a row, the bale wrapping machine comprising:

a machine mover for enabling the machine to move along a ground surface during the wrapping of bales;

a bale receiving support for receiving bales;

a bale wrapping device adjacent the bale receiving support for carrying a stretching device and multiple plastic strips around a bale, the stretching device stretching the multiple plastic strips together in a lengthwise direction of the multiple plastic strips during the operation of the bale wrapping device;

an inclined support adjacent the bale wrapping device for transporting wrapped bales to a ground surface; and

a bale mover for moving bales from the bale receiving support towards the bale wrapping device.

2. A bale wrapping machine as claimed in claim 1, wherein the stretching device comprises a set of rollers which receives the multiple plastic strips and provides lengthwise tension to the multiple plastic strips during the operation of the bale wrapping device.

3. A bale wrapping machine as claimed in claim 2, wherein the set of rollers includes a first roller and a second roller, the first roller being positioned close to the second roller and bringing the multiple plastic strips into contact with each other when the multiple plastic strips pass through between the first and second rollers during the operation of the bale wrapping device.

4. A bale wrapping machine as claimed in claim 3, wherein the first roller is movable away from the second roller to facilitate receipt of ends of the multiple plastic strips between the first roller and the second roller.

5. A bale wrapping machine as claimed in claim 2, wherein the set of rollers comprises free rotating rollers.

6. A bale wrapping machine as claimed in claim 1, wherein the multiple plastic strips include first and second plastic strips, the first plastic strip for forming an outer layer on the bale and the second plastic strip for forming an inner layer on the bale, the first plastic strip having a higher light reflecting capability than the second plastic strip.

7. A bale wrapping machine as claimed in claim 1, wherein the multiple plastic strips include first and second plastic strips, the first plastic strip for forming an outer layer on the bale and the second plastic strip for forming an inner layer on the bale, the second plastic strip having a higher light absorbing capability than the first plastic strip.

8. A bale wrapping machine as claimed in claim 1, wherein at least one of the multiple plastic strips has a surface adapted to adhere to a neighbouring plastic strip.

9. A bale wrapping machine as claimed in claim 1, wherein the bale wrapping device has a rotating hoop, and the stretching device and multiple plastic strips are supported by the rotating hoop and carried around a bale when the rotating hoop is rotated.

10. A bale wrapping machine for wrapping bales end to end in a row, the bale wrapping machine comprising:

a machine mover for enabling the machine to move along a ground surface during the wrapping of bales;

a bale receiving support for receiving bales;

a stretching device having a set of free rotating rollers which receives multiple plastic strips;

a bale wrapping device adjacent the bale receiving support, the bale wrapping device having a rotating hoop for carrying the stretching device and the multiple plastic strips around a bale and for stretching multiple plastic strips together in a lengthwise

direction of the multiple plastic strips with the stretching device during the operation of the bale wrapping device;

an inclined support adjacent the bale wrapping device for transporting wrapped bales to a ground surface; and

a bale mover for moving bales from the bale receiving support towards the bale wrapping device.

11. A bale wrapping machine as claimed in claim 10, wherein the set of rollers of the stretching device includes a first roller and a second roller, the first roller being positioned close to the second roller and bringing the multiple plastic strips into contact with each other when the multiple plastic strips pass through between the first and second rollers during the operation of the bale wrapping device.

12. A bale wrapping machine as claimed in claim 12, wherein the first roller is movable away from the second roller to facilitate receipt of ends of the multiple plastic strips between the first roller and the second roller.

13. A bale wrapping machine as claimed in claim 10, wherein the multiple plastic strips include a first and second plastic strips, the first plastic strip for forming an outer layer on the bale and the second plastic strip for forming an inner layer on the bale, the first plastic strip having a higher light reflecting capability than the second plastic strip.

14. A bale wrapping machine as claimed in claim 10, wherein the multiple plastic strips include first and second plastic strips, the first plastic strip for forming an outer layer on the bale and the second plastic strip for forming an inner layer on the bale, the second plastic strip having a higher light absorbing capability than the first plastic strip.

15. A bale wrapping machine as claimed in claim 10, wherein at least one of the multiple plastic strips has a surface adapted to adhere to a neighboring plastic strip.

16. A method for wrapping bales end to end in a row using a bale wrapping machine, the method comprising the steps of:

receiving bales by a bale receiving support of the bale wrapping machine;

moving the bales into a bale wrapping device of the bale wrapping machine;

carrying multiple plastic strips around each bale by the bale wrapping device;

stretching the multiple plastic strips together in a lengthwise direction of the multiple plastic strips during the operation of the bale wrapping device;

moving wrapped bales from the bale wrapping device to an inclined support of the bale wrapping machine;

transporting the wrapped bales to a ground surface along the inclined support; and

allowing the bale wrapping machine to move along a ground surface during the wrapping of the bales.

17. A method for wrapping bales as claimed in claim 16, wherein the stretching step laminates the multiple plastic strips.

18. A method for wrapping bales as claimed in claim 16, wherein the carrying step comprises the steps of:

carrying the multiple plastic strips including first and second plastic strips, the first plastic strip having a higher light reflecting capability than the second plastic strip; and

forming on the bales an outer layer with the first plastic strip, and an inner layer with the second plastic strip.

19. A method for wrapping bales as claimed in claim 16, wherein the carrying step comprises the steps of:

carrying the multiple plastic strips including first and second plastic strips, the second plastic strip having a higher heart retaining capability than the first plastic strip; and

forming on the bales an outer layer with the first plastic strip, and an inner layer with the second plastic strip.

20. A method for wrapping bales as claimed in claim 16, wherein the carrying step comprises the steps of:

carrying the multiple plastic strips including a plastic strip having a surface adapted to adhere to a neighbouring plastic strip.

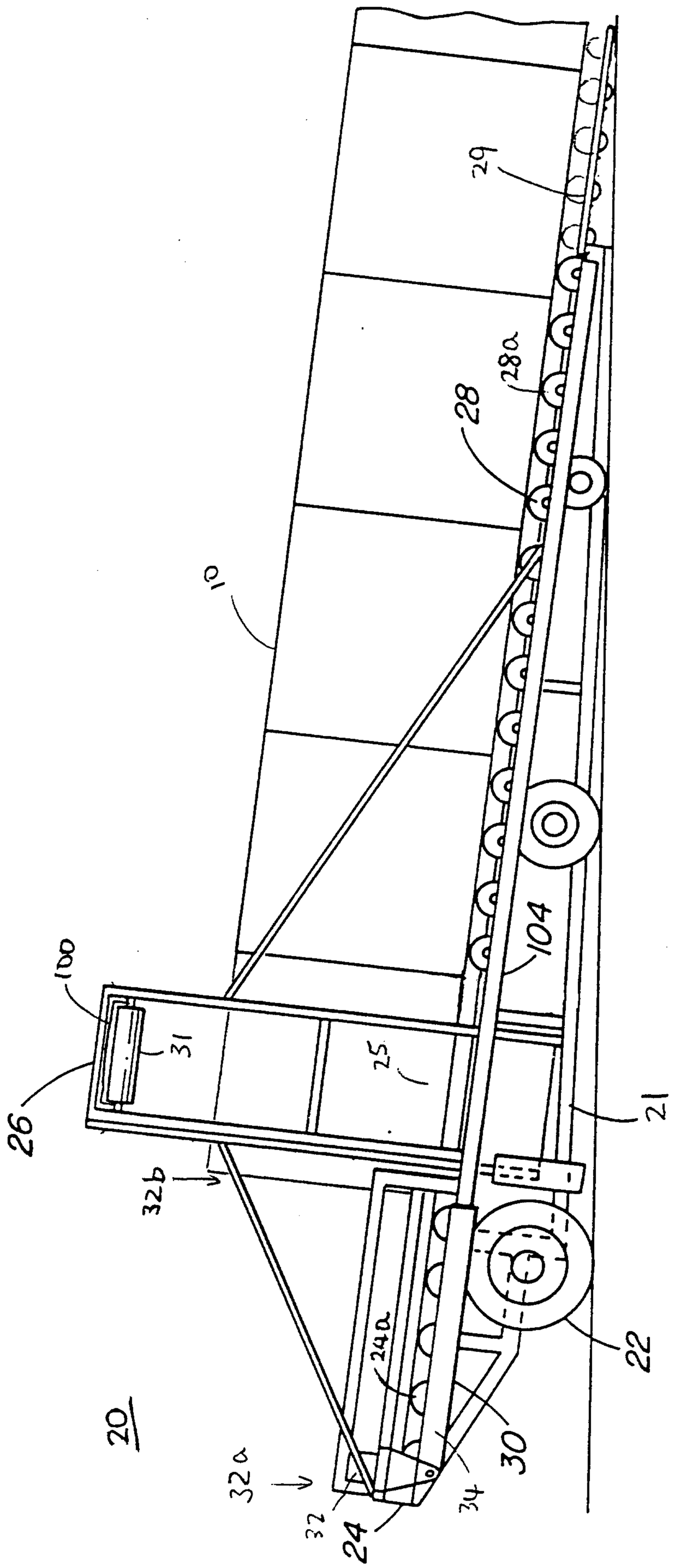



FIG. 1

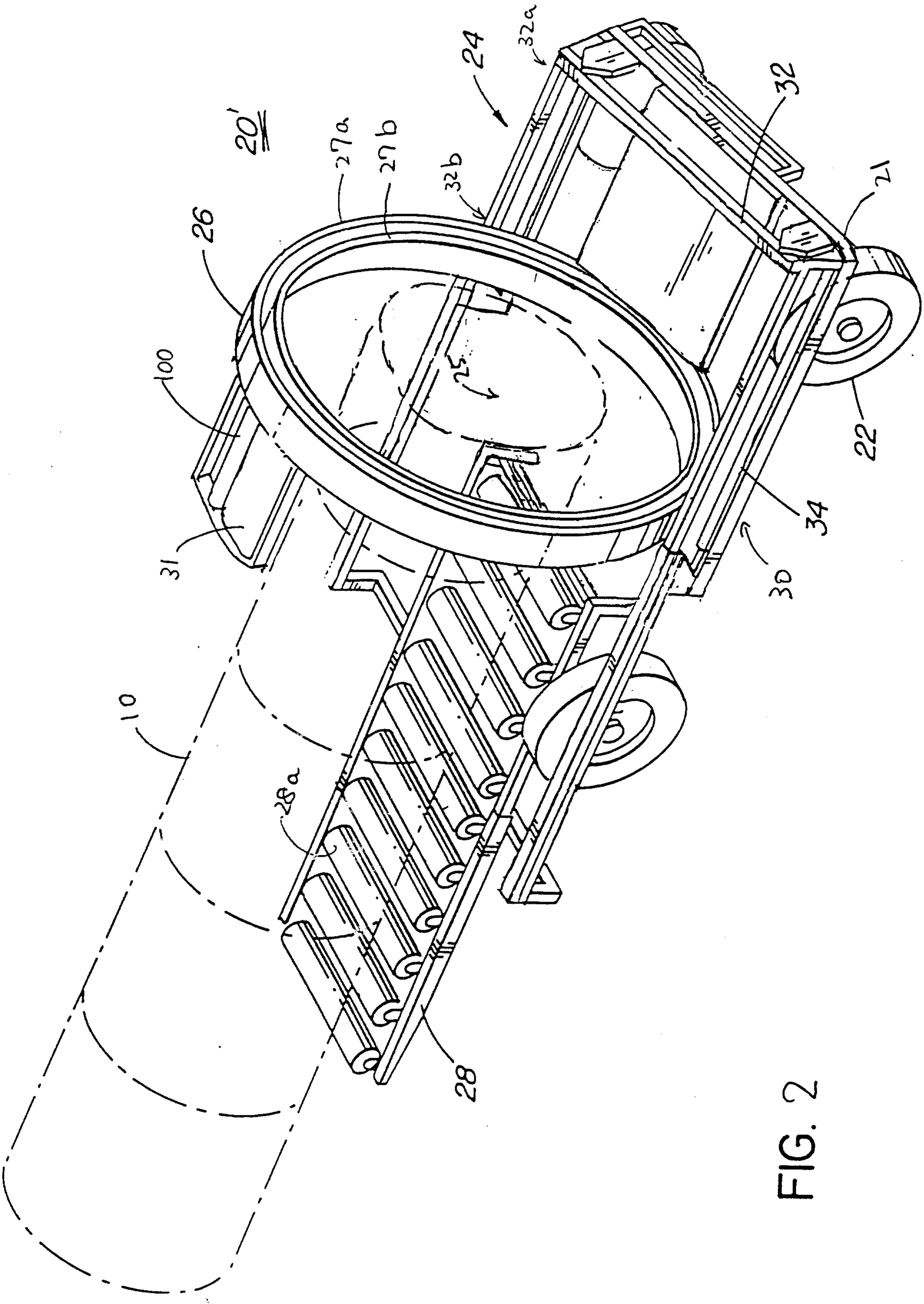



FIG. 2

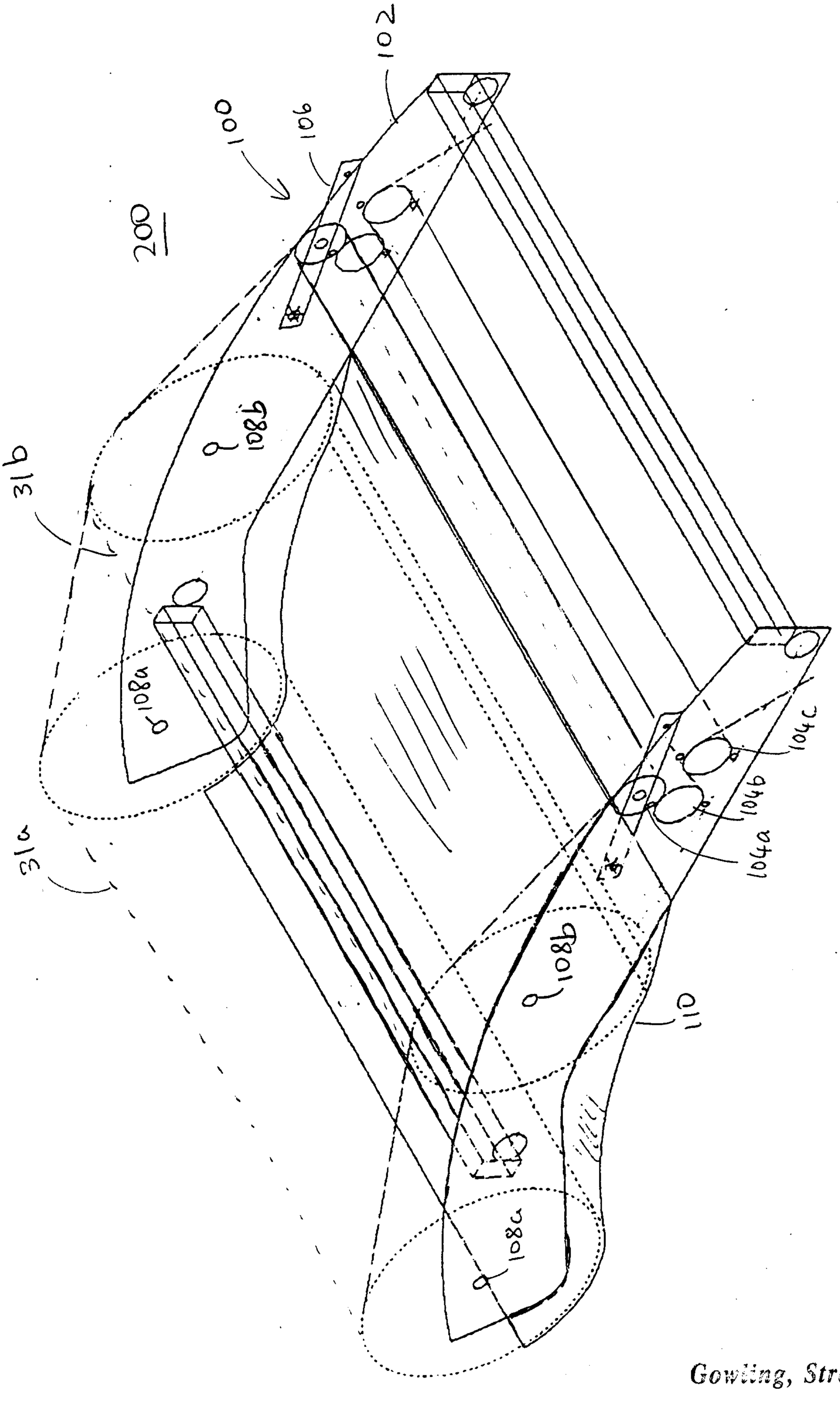



Fig. 3

*Gowling, Strathy & Henderson*

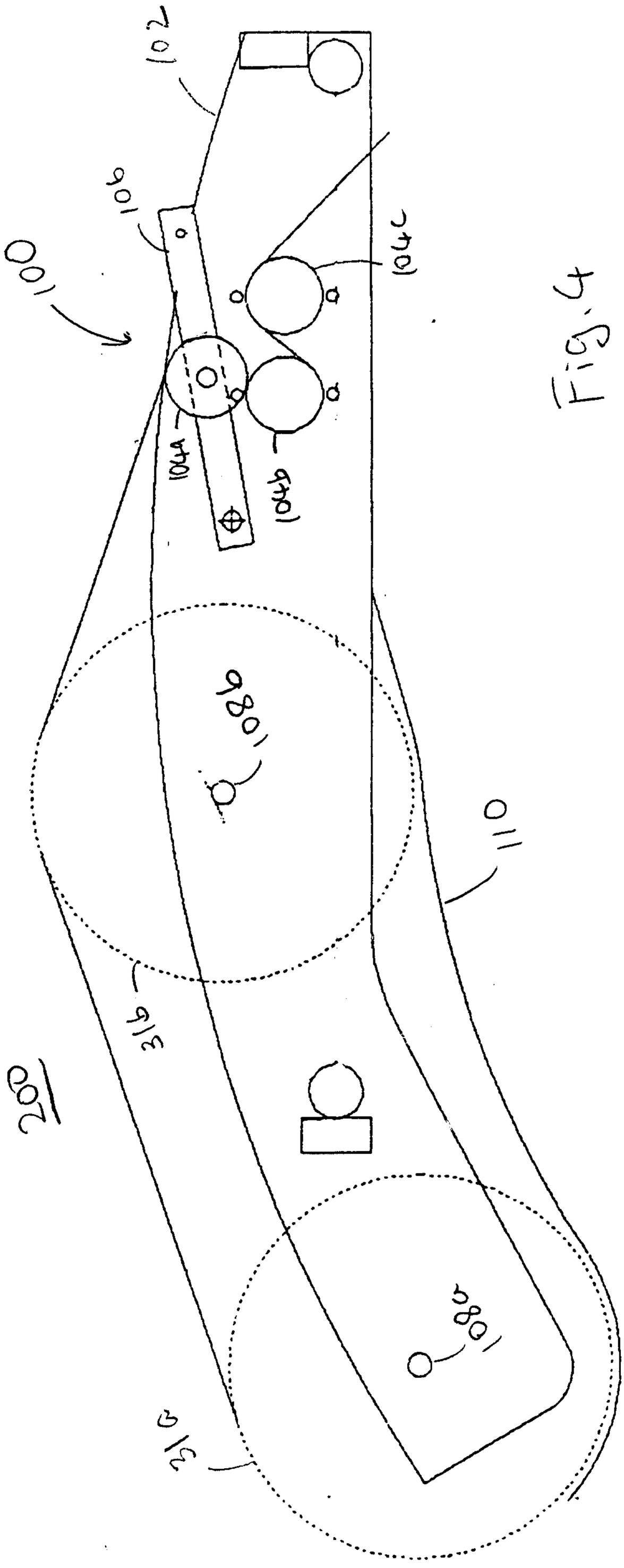



Fig. 4

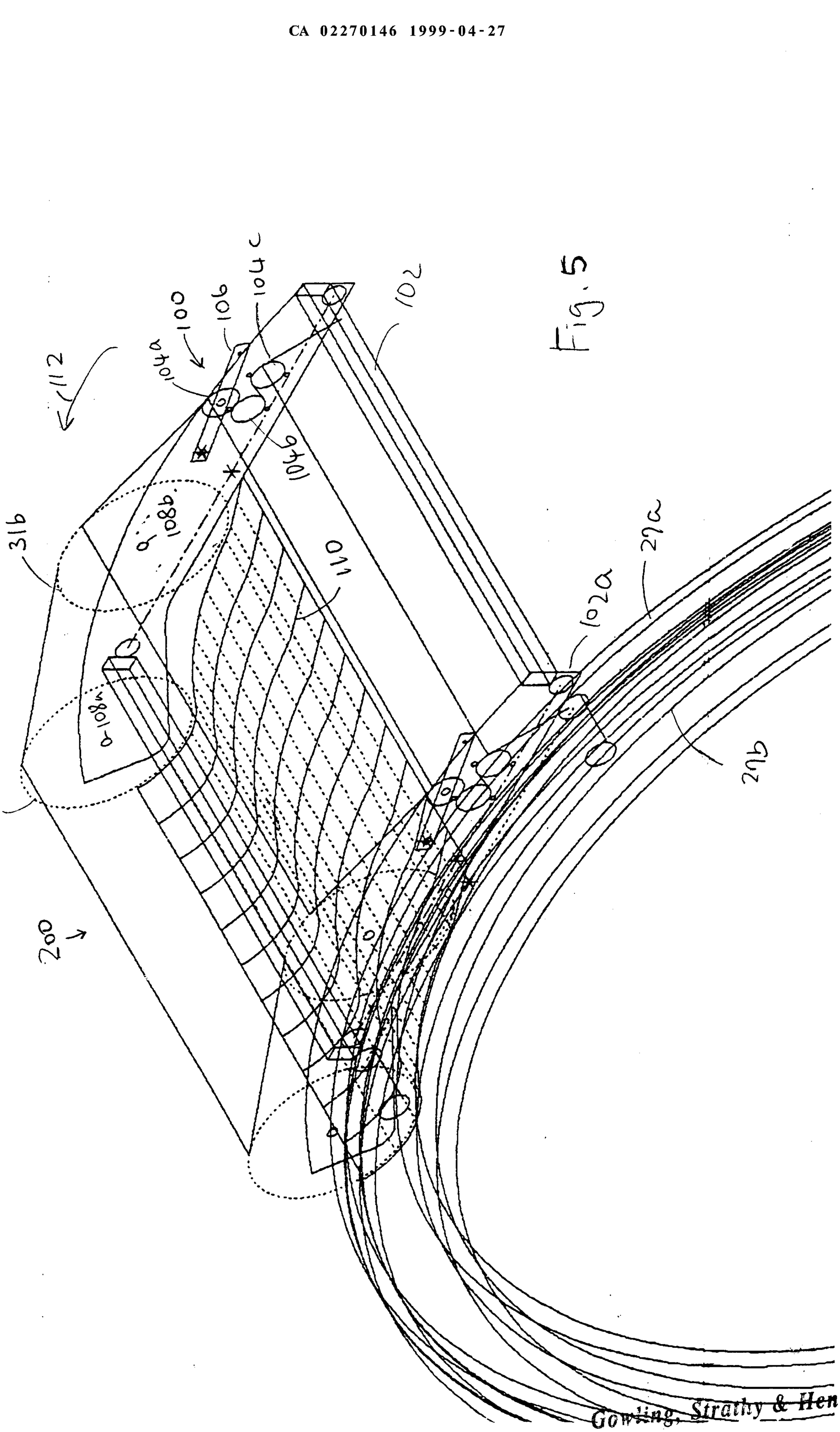

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Fig. 5

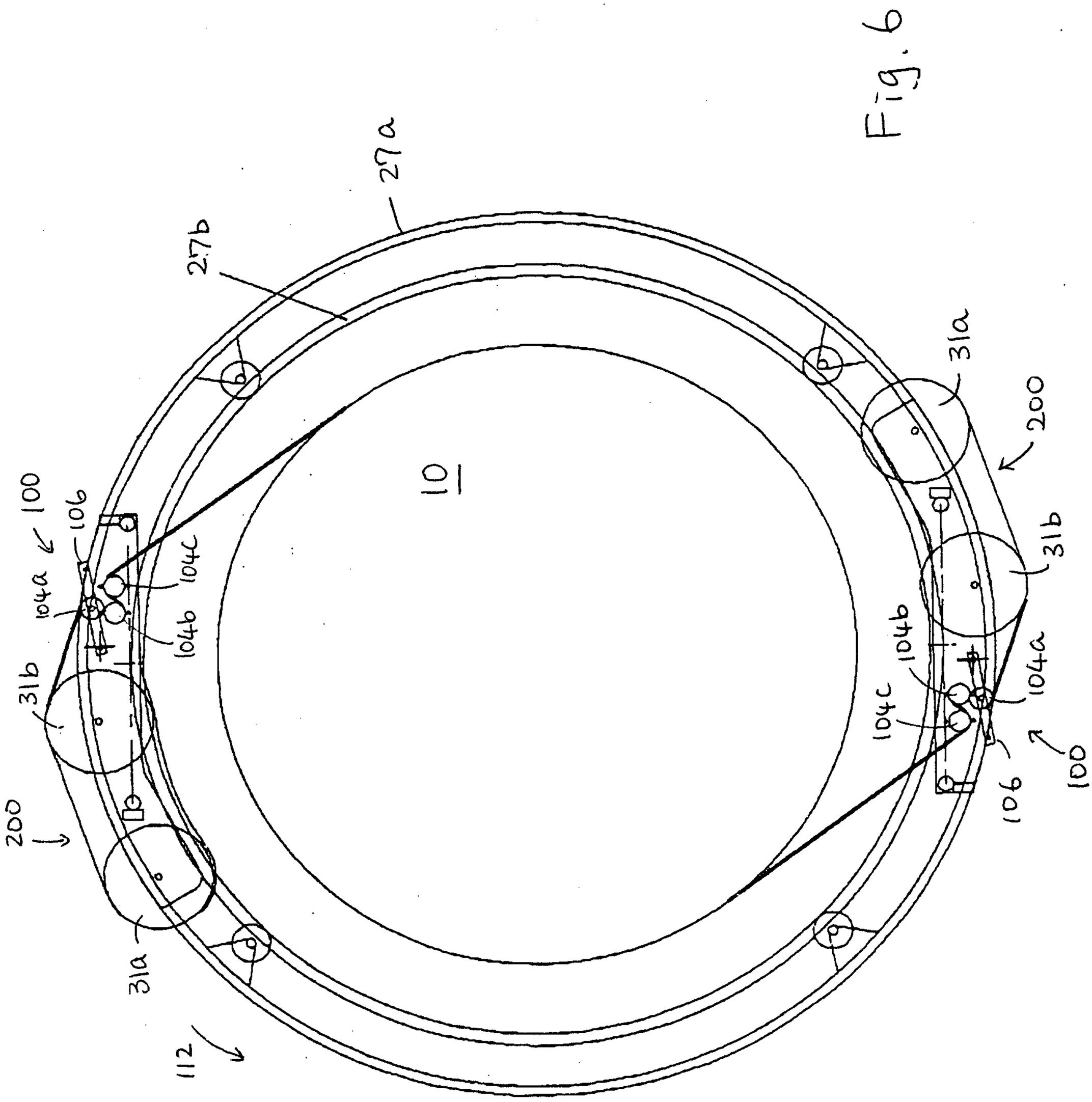
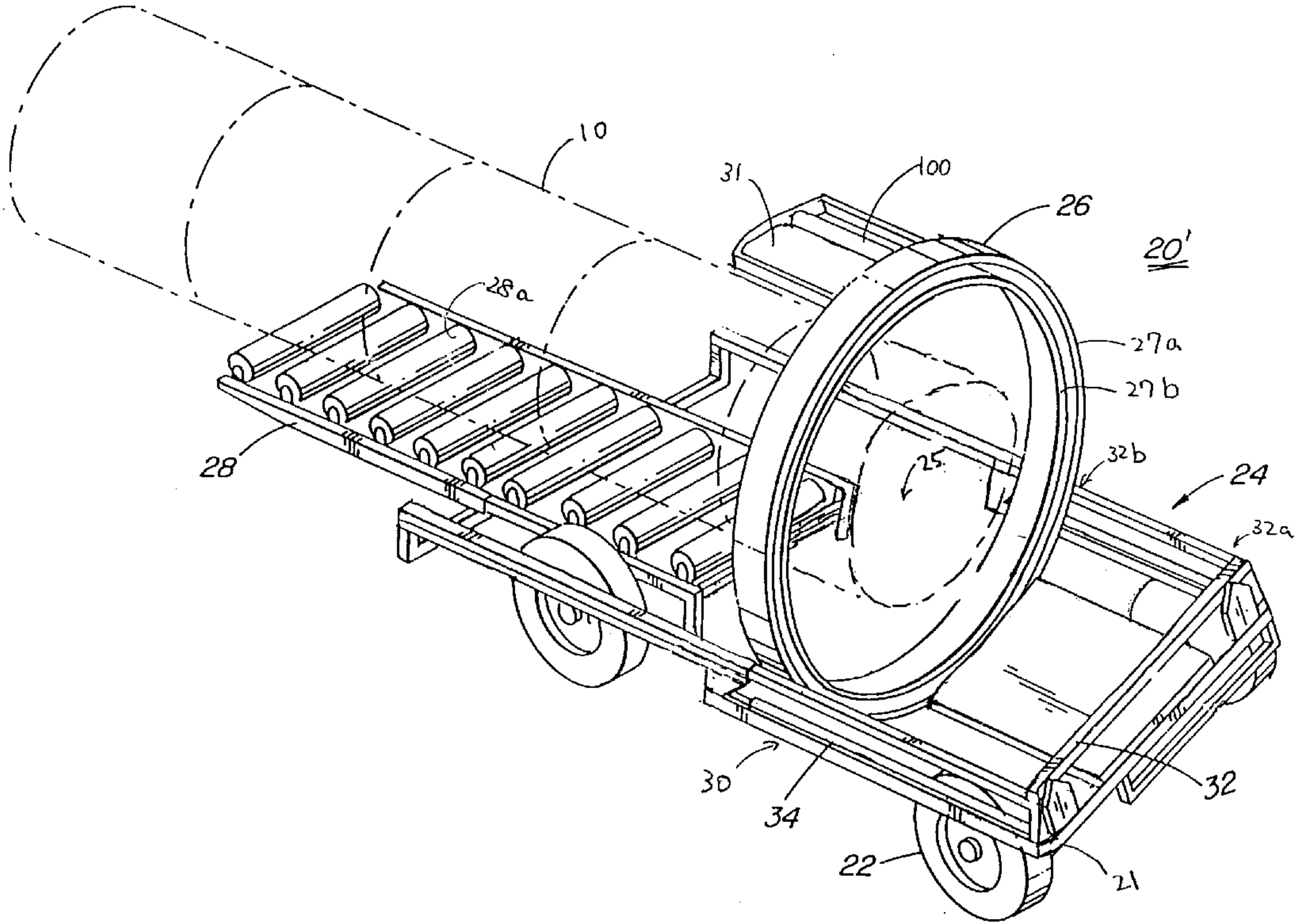



Fig. 6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