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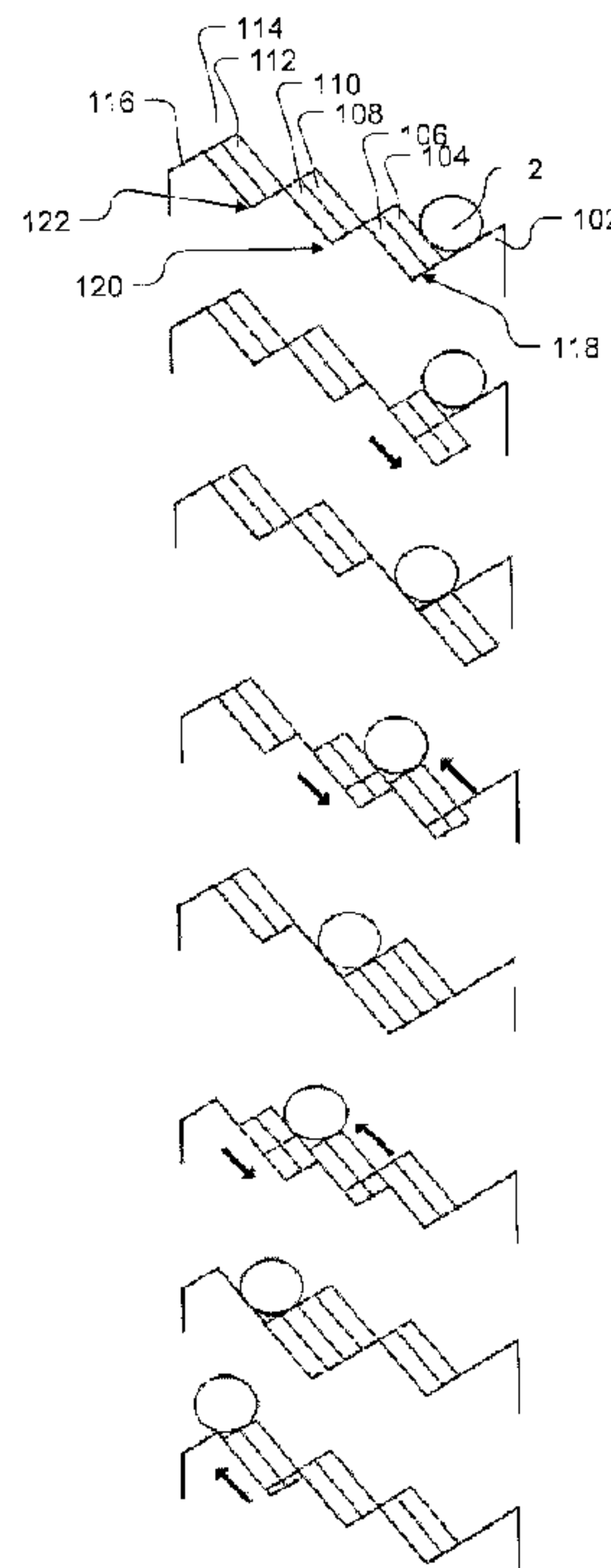
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(54) Titre : SINGULATEUR POUR PIÈCES À TRAVAILLER, À UN OU PLUSIEURS NIVEAUX

(54) Title: WORKPIECE SINGULATOR WITH VARIABLE STAIR DEPTH



(57) **Abrégé/Abstract:**

Embodiments of the present disclosure provide a workpiece singulator with one or more movable stairs. A first one of the movable stairs may include an outer step member and an inner step member that is positioned between the outer step member and a second one of the movable stairs. The step members may be movable synchronously as a single stair to transport larger workpieces and asynchronously to transport smaller workpieces on the outer step member. Optionally, the workpiece singulator may further include a sensor configured to detect the size and/or position of a workpiece. In some embodiments, the workpiece singulator may be coupled with a controller configured to control the position of the outer step member independently of the position of the inner step member. In various embodiments, a workpiece singulator as disclosed herein may be operable to selectively singulate workpieces of different sizes.



## **Abstract**

Embodiments of the present disclosure provide a workpiece singulator with one or more movable stairs. A first one of the movable stairs may include an outer step member and an inner step member that is positioned between the outer step member and a second one of the movable stairs. The step members may be movable synchronously as a single stair to transport larger workpieces and asynchronously to transport smaller workpieces on the outer step member. Optionally, the workpiece singulator may further include a sensor configured to detect the size and/or position of a workpiece. In some embodiments, the workpiece singulator may be coupled with a controller configured to control the position of the outer step member independently of the position of the inner step member. In various embodiments, a workpiece singulator as disclosed herein may be operable to selectively singulate workpieces of different sizes.

## **WORKPIECE SINGULATOR WITH VARIABLE STAIR DEPTH**

### **Background**

**[0001]** Step feeders are used to singulate and transfer workpieces from one location to another. Some step feeders include moving stairs interposed between fixed stairs, with the moving stairs driven by a motor and crank shaft. A log, cant, or other workpiece is deposited onto the lowest of the moving stairs, and the moving stair is driven upward to lift the workpiece to a fixed stair. The next moving stair lifts the workpiece from the fixed stair to the next consecutive fixed stair, and so on, until the workpiece reaches the desired location. Other step feeders have two sets of moving stairs. In step feed feeders of this type, one set of moving stairs is moved up while the other set is moved down.

**[0002]** In both cases, the moving stair that raises the workpiece has a fixed depth. Shallow stairs are suitable for singulating small workpieces, but larger workpieces may fall off the stairs during transport. Deeper stairs are more useful for singulating larger workpieces, but they may allow smaller workpieces to be carried on the moving stair in groups of two or more, making the stairs less suitable for singulating small workpieces.

### **Brief Description of the Drawings**

**[0003]** Embodiments will be readily understood by the following detailed description in conjunction with the accompanying drawings. Embodiments are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings.

**[0004]** Figures 1A-1B illustrates a schematic side view of a workpiece singulator with variable stair depth;



- [0005]** Figures 2A-2B illustrate schematic side views of operations of a workpiece singulator with variable stair depth;
- [0006]** Figure 3 illustrates a schematic side view of movable stair ranges;
- [0007]** Figures 4A-4B illustrate schematic side views of workpiece singulator systems; and
- [0008]** Figures 5A-5C illustrate schematic side views of workpiece singulator systems, all in accordance with various embodiments.

### **Detailed Description of Disclosed Embodiments**

**[0009]** In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which are shown by way of illustration embodiments that may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope. Therefore, the following detailed description is not to be taken in a limiting sense, and the scope of embodiments is defined by the appended claims and their equivalents.

**[0010]** Various operations may be described as multiple discrete operations in turn, in a manner that may be helpful in understanding embodiments; however, the order of description should not be construed to imply that these operations are order dependent.

**[0011]** The description may use perspective-based descriptions such as up/down, back/front, and top/bottom. Such descriptions are merely used to facilitate the discussion and are not intended to restrict the application of disclosed embodiments.

**[0012]** The terms “coupled” and “connected,” along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. Rather, in particular embodiments, “connected” may be used to indicate that two or more elements are in direct physical or electrical contact with each other. “Coupled” may mean that two or more elements are in direct physical or electrical

contact. However, “coupled” may also mean that two or more elements are not in direct contact with each other, but yet still cooperate or interact with each other.

**[0013]** For the purposes of the description, a phrase in the form “A/B” or in the form “A and/or B” means (A), (B), or (A and B). For the purposes of the description, a phrase in the form “at least one of A, B, and C” means (A), (B), (C), (A and B), (A and C), (B and C), or (A, B and C). For the purposes of the description, a phrase in the form “(A)B” means (B) or (AB) that is, A is an optional element.

**[0014]** The description may use the terms “embodiment” or “embodiments,” which may each refer to one or more of the same or different embodiments. Furthermore, the terms “comprising,” “including,” “having,” and the like, as used with respect to embodiments, are synonymous.

**[0015]** Embodiments of methods, apparatuses, and systems for singulating workpieces are provided herein. In various embodiments, the workpieces may be logs, cants, boards, or other such items. In exemplary embodiments, a computing device may be endowed with one or more components of the disclosed apparatuses and/or systems and may be employed to perform one or more methods as disclosed herein.

**[0016]** Embodiments of the present disclosure provide a workpiece singulator with a set of movable stairs. In various embodiments, a workpiece singulator may have a first, a second, and a third movable stair. Each of the movable stairs may have a corresponding positioning range. The upper end of the range may be represented by an extended position, and the lower end of the range may be represented by a retracted position. Optionally, the positioning ranges of consecutive movable stairs may meet or overlap one another. For example, when the first movable stair is in the extended position and the second movable stair is in the retracted position, the workpiece support surfaces of the first and second movable stairs may define an inclined plane. Similarly, when the second movable stair is in the extended position and the third movable stair is in the retracted position, the workpiece support surface of the second and third movable stairs may define another



inclined plane. Workpieces may be moved upwardly on one movable stair onto the next consecutive movable stair.

**[0017]** In various embodiments, a first one of the movable stairs may include a first step member and a second step member. The first and second step members may be coupled with corresponding drives that are independently operable to drive the first step member independently of the second step member. One or more of the other movable stairs may also include two or more step members that are movable independently of one another.

**[0018]** In some embodiments, one or both of the drives may be selectively operable in a first mode and in a second mode. In the first mode, the second step member may be driven synchronously with the first step member, such that the step members collectively function as the movable stair, and the effective stair depth of the movable stair is equal to the combined depths of the step members. In the second mode, the second step member may be driven asynchronously (e.g., with the second step member remaining stationary), such that the first step member functions as that movable stair, and the effective depth of that movable stair is equal to the depth of the first step member. Optionally, while operating in the second mode the second step member may be positioned at the same or similar level as the next consecutive stair/step member.

**[0019]** In various embodiments, the first and second step members may be (or may include) platforms that are independently movable. The first step member may be the “outer” first platform of the movable stair and the second step member may be the “inner” second platform of the movable stair. Thus, the second step member may be disposed between the first step member and the next consecutive movable stair. In some embodiments, the movable stair may include one, two, three, or more than three additional platforms between the first step member and the second step member. The first, second, and/or additional platforms may have corresponding workpiece support surfaces, such as the top end surfaces of the platforms. Optionally, one or more of the additional platforms may be coupled with a corresponding drive configured to move the additional platform(s) independently of

the first and second platforms. In some embodiments the workpiece singulator may have one or more additional movable stairs that include corresponding first, second, and/or additional step members.

**[0020]** In various embodiments, the step members may have workpiece support surfaces that are inclined relative to a horizontal plane, such that the distal end of the workpiece support surface is elevated relative to the proximal end of the workpiece support surface. The inclined angle of the workpiece support surfaces may help to prevent accidental dislocation of the workpieces from the stairs due to gravity and aid the movement of the workpieces toward the next consecutive stair and/or the delivery location. Likewise, the supply location may be inclined to encourage movement of the workpieces onto the bottom-most stair. As a workpiece on a movable stair reaches the next consecutive stair, the workpiece may slide toward the proximal end of the workpiece support surface and onto the next consecutive stair.

**[0021]** In various embodiments, the step members of a movable stair may be driven independently of one another. For example, the first and second step members of a movable stair may be driven independently by a drive assembly that includes a first drive coupled with the first step member and a second drive coupled with the second step member. In some embodiments, each of the step members of two or more movable stairs may have a corresponding drive and be driven independently of the other step members. Alternatively, in other embodiments each of the step members of a movable stair may be driven independently of one another, but in concert with the corresponding step member(s) of another one or more of the movable stairs. For example, the first step member of one movable stair and the first step member of another movable stair may be driven by the first drive, and the second step members of those movable stairs may be driven by a second drive. In such embodiments, the first step members may be linked, such as by a beam, skid, or other type of support, and the second step members may be linked in the same or similar manner. The first and second drives may be coupled with the linkage to drive the corresponding step members. Optionally, the link may be adjustable and/or



removable to allow separate actuators to be coupled with some or all of the step members.

**[0022]** In some embodiments, the workpiece singulator may include a controller that is configured to control the drive assembly and drives thereof. In other embodiments, the workpiece singulator may include a sensor coupled with the controller and configured to detect the presence and/or size of a workpiece on or near the movable stairs. Optionally, the controller may include a programmable workpiece controller (PLC), a computer, or both. For example, the controller may include a computing device endowed with instructions that are operable, upon execution by a processor, to cause the computing device to send instructions to the controller based at least on data from the sensor.

**[0023]** In operation, a movable stair or one or more of the step members thereof may be driven along a reciprocating path from a first level (e.g., a workpiece loading level) to a next consecutive second level (e.g., the level of the next consecutive step member or movable stair). In various embodiments, the step members may be moved independently of one another, such that the step members of a movable stair can be repositioned either synchronously or asynchronously as desired. This may allow the workpiece singulator to be used in one mode to singulate larger workpieces and in another mode to singulate small workpieces (e.g., by using only the first step member of the movable stair to receive and transport the workpiece to a next level).

**[0024]** In various embodiments, one or more workpieces may be delivered to a loading area. One or more of the step members of the first movable stair may be moved downwardly to the retracted position to engage one of the workpieces on the support surfaces of the step member(s). The step member(s) may be driven upwards toward the extended position. As the workpiece is raised on the support surface(s) of the step member(s), the workpiece may be supported against the outer surface of the next consecutive step member(s) until the workpiece reaches the support surface of the next consecutive step member(s). The inclined angle of the support surfaces may help the workpiece to slide or roll onto the support surface of



the next consecutive step member(s), which will raise the workpiece to the next level, and so on, until the workpiece reaches the delivery location.

**[0025]** In various embodiments, the receiving location of the step feeder may be at any height relative to the delivery location of the step feeder (that is, where the step feeder discharges or delivers singulated workpieces). For example, in some embodiments, the receiving location and the delivery location may be at the same height relative to the ground. In other embodiments, the receiving location may be at a different height than the delivery location, such as higher or lower than the delivery location.

**[0026]** Figs. 1A-1B illustrate side views of a workpiece singulator with variable stair depth, and Figs. 2A-2B illustrate schematic side views of operations of a workpiece singulator with variable stair depth, all in accordance with various embodiments.

**[0027]** Referring first to Figs. 1A-2A, workpiece singulator 100 may include a frame 102 with a set of movable stairs. Each of the movable stairs may include two or more step members. In the illustrated embodiment, a first movable stair includes a first step member 104 and a second step member 106, a second movable stair includes a third step member 108 and a fourth step member 110, and a third movable stair includes a fifth step member 112 and a sixth step member 114. However, in other embodiments a movable stair may have only one step member or three or more step members.

**[0028]** In various embodiments, workpiece singulator 100 may be operable in one mode to singulate relatively large workpieces 2 (see e.g., Figs. 1A and 2A) and in another mode to singulate smaller workpieces 4 (see e.g., Figs. 1B and 2B). While workpieces 2 and 4 are illustrated as logs, it is to be understood that workpiece singulators as described herein may also be used to singulate other workpieces such as cants, boards, flitches, stems, or other such items.

**[0029]** As shown for example in Figs. 1A and 2A, in one mode the step members of a movable stair may be used synchronously as a unit to move large workpieces from one level to another. As shown for example in Figs. 1B and 2B, in

another mode the step members of a movable stair may be moved/positioned asynchronously to move smaller workpieces. In some embodiments, the outer-most step may be moved between the retracted position and the extended position of that movable stair. Alternatively, the first/outer-most step may be moved between the retracted position and an intermediate position (e.g., one half or one third of the range of that movable stair) and the second/inner-most step may be moved between the extended position and the same or other intermediate position, as shown for example in Fig. 2B, to transport a smaller workpiece to the next consecutive stair.

**[0030]** Fig. 3 illustrates a schematic diagram of movable stair ranges, in accordance with various embodiments. The movable stairs may be operated to move workpieces (e.g., workpieces 2 and/or 4) from a loading area 126 to a destination area 116. In the illustrated embodiment, each of the step members 104, 106, 108, 110, 112, and 114 are movable between a retracted position (shown in dashed lines) and an extended position. The workpiece support surfaces of step members 104 and 106 are at a first level 118 while in the retracted position, and at a second level 120 while in the extended position. The workpiece support surfaces of step members 108 and 110 are at the second level 120 while in the retracted position, and at a third level 122 while in the extended position. The workpiece support surfaces of step members 112 and 114 are at the third level 122 while in the retracted position, and at a fourth level 124 while in the extended position.

**[0031]** Figures 4A-4B and 5A-5C illustrate schematic side views of workpiece singulator systems, all in accordance with various embodiments. In some embodiments, a controller 130 may be operatively coupled with, and configured to control the positions of, the movable stairs/step members. Optionally, one or more sensors 128 may be operatively coupled with controller 130, and controller 130 may be configured to control the positions of one or more of the step members based at least on data from the sensor(s) 128. Sensor(s) 128 may include, but is not limited to, one or more photo-eyes, cameras, scanners, or any other devices suitable for detecting a position and/or size of a workpiece.



**[0032]** In various embodiments, as shown for example in Figs. 5A-C, an actuator 132 may be coupled with one or more of the step members, and controller 130 may be operatively coupled with actuator(s) 132. Again, one or more sensor(s) 128 may be coupled with controller 130.

**[0033]** In some embodiments, a first actuator 132 may be coupled with each outer-most step member (e.g., step members 104, 108, and 112) and configured to control those step members, and a second actuator 132 may be coupled with each inner-most step member (e.g., step members 106, 110, and 114) and configured to control those step members independently of the outer-most step members. Controller 130 may be configured to control the first and second actuators 132 to move the step members of each movable stair in unison (e.g., step members 104 and 106 moved together, step members 108 and 110 moved together, and step members 112 and 114 moved together) to move larger workpieces. Controller 130 may also be configured to control the first and second actuators 132 to move the outer-most step members of each stair asynchronously with the corresponding inner-most step members to move smaller workpieces.

**[0034]** In other embodiments, as shown for example in Fig. 5C, some or all of the step members may be independently coupled with corresponding actuators 132. Controller 130 may be coupled with, and configured to control, each of the actuators 132. Optionally, controller 130 may be configured to determine, based on data from sensor 128, which of the two modes to use. For example, controller 130 may be configured to determine, based on data from sensor 128, that some or all of the workpieces in loading area 126 are smaller workpieces. In response to the determination, controller 130 may operate the workpiece singulator in the small workpiece mode, such that the step members of a movable stair are moved asynchronously. Controller 130 may also be configured to determine, based on data from sensor 128, that some or all of the workpieces in loading area 126 are larger workpieces. In response to the determination, controller 130 may operate the workpiece singulator in the large workpiece mode, such that the step members of a movable stair are moved synchronously as a single unit. Alternatively, controller 130

may be configured to operate the workpiece singulator in response to input/control by a human operator. For example, controller 130 may be configured to operate the workpiece singulator in a mode selected by a human operator, or may have one or more controls usable by a human operator to control one or more of the step members/movable stairs.

**[0035]** In some embodiments, actuators 132 may be (or may include) hydraulic, pneumatic, and/or electric positioning cylinders. In other embodiments, actuators 132 may include rotary actuators with linkages configured to convert rotary motion to linear motion (e.g., crankshafts driven by electric drives or other types of drives). The number, type, and arrangement of actuators 132 may vary among embodiments, and any suitable type of actuators known in the art may be used to drive the step members.

**[0036]** The controller 130 may be configured to selectively operate the step member(s) of one or more of the movable stairs in a small workpiece mode and in a large workpiece mode. In the large workpiece mode, controller 130 may be configured to move all of the step members of a given movable stair together as a single unit to support and raise a relatively large workpiece. In the small workpiece mode, controller 130 may be configured to move fewer than all of the step members of a given movable stair (e.g., only the outer-most step member) to support and raise a smaller workpiece. Optionally, the controller 130 may be configured to operate the outer-most step member of a movable stair to engage and raise the smaller workpiece along part of the range of that movable stair (e.g., from first level 118 to half or one-third the distance between first level 118 and second level 120), and to operate the inner-most step member to engage and raise the workpiece the remaining distance to the next level (e.g., to second level 120). Alternatively, controller 130 may be configured to operate the outer-most step member of a movable stair to engage and raise the smaller workpiece from one level (e.g., first level 118) to the next level (e.g., second level 120).

**[0037]** In other embodiments, controller 130 may be configured to control the step members based at least in part on data from sensor 128 and/or input from a



human operator. For example, controller 130 may be configured to accept an input from a human operator that indicates a desired log size range (e.g., smaller logs or larger logs), and control the step members according to the corresponding mode. As another example, controller 130 and/or actuators 132 may be configured to be directly controlled by a human operator, such as by way of one or more buttons, switches, or other types of input controls.

**[0038]** In some embodiments, the workpiece singulator may be configured to move workpieces onto the destination area 116 (e.g., a delivery platform, conveyor, or bin) one at a time. In other embodiments, controller 130 may be selectively operable to move smaller workpieces onto the destination area 116 either one at a time (e.g., in small workpiece mode) or two or more at a time (e.g., in large workpiece mode).

**[0039]** Although certain embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent embodiments or implementations calculated to achieve the same purposes may be substituted for the embodiments shown and described without departing from the scope. Those with skill in the art will readily appreciate that embodiments may be implemented in a very wide variety of ways. This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that embodiments be limited only by the claims and the equivalents thereof.

## Claims

What is claimed is:

1. A workpiece singulator, comprising:  
a set of movable stairs, a first one of the movable stairs having a first step member with a first workpiece support surface and a second step member with a second workpiece support surface, the second step member being disposed between the first step member and a second one of the movable stairs, and the first and second step members being movable along generally parallel paths, wherein the first one of the movable stairs is configured to transport a workpiece from a first level to a second level, and the second one of the movable stairs is configured to transport the workpiece from the second level to a third level; and  
a drive assembly coupled with the set of movable stairs, the drive assembly selectively operable to move the first step member independently of the second step member.
2. The workpiece singulator of claim 1, further including a controller coupled with the drive assembly, the controller configured to control the drive assembly to move the second step member relative to the first step member to transport workpieces of a first size and to move the first and second step members in unison to transport workpieces of a second size greater than the first size.
3. The workpiece singulator of claim 2, wherein the drive assembly includes a first drive coupled with the first step member and a second drive coupled with the second step member, the controller operable to control the first drive independently of the second drive.
4. The workpiece singulator of claim 3, further including a sensor operatively coupled with the controller and configured to detect the workpieces, the controller



operable to control the first and second drives based at least on data from the sensor.

5. The workpiece singulator of claim 2, wherein the first step member is a first platform and the second step member is a second platform.

6. The workpiece singulator of claim 5, the first one of the movable stairs further including an additional step member disposed between the first step member and the second step member.

7. The workpiece singulator of claim 6, the drive assembly further including an additional drive coupled with the additional step member, wherein the controller is further configured to control the drive assembly to move the additional step member independently of the first step member.

8. The workpiece singulator of claim 3, wherein the second one of the movable stairs further includes a third step member and a fourth step member, and the third step member is disposed between the second step member and the fourth step member.

9. The workpiece singulator of claim 8, the drive assembly further including a third drive coupled with the third step member and configured to move the third step member between the second level and the third level.

10. The workpiece singulator of claim 9, the drive assembly further including a fourth drive coupled with the fourth step member and configured to move the fourth step member between the second level and the third level.

11. The workpiece singulator of claim 10, wherein the controller is coupled with the third and fourth drives, the controller further configured to control each of the drives independently of the other drives.
12. The workpiece singulator of claim 8, wherein the first drive is operatively coupled with the first and third step members and the second drive is operatively coupled with the second and fourth step members.
13. The workpiece singulator of claim 9, wherein the third step member includes a third platform and the fourth step member includes a fourth platform, and the third platform is disposed between the first platform and the fourth platform.
14. The workpiece singulator of claim 13, wherein the drive system is selectively operable to move each of the platforms independently of the other platforms.
15. A method of singulating workpieces of various sizes, the method comprising:
  - providing a set of movable stairs, wherein at least a first one of the movable stairs includes a first step member and a second step member that are movable along generally parallel paths between a first level and a second level, the second movable stair is movable between the second level and a third level, the second step member is disposed between the first step member and a second movable stair, and the first step member is movable independently of the second step member;
  - moving at least the first step member to the first level to receive a workpiece;
  - transporting the workpiece from the first level to the second level on at least the first step member; and
  - transporting the workpiece from the second level to the third level on the second movable stair,wherein the first step member is selectively operable independently of the second step member to transport workpieces of a first size from the first level to the second level, and wherein the first and second step members are selectively



operable in unison to transport workpieces of a larger second size from the first level to the second level.

16. The method of claim 15, wherein the method further includes controlling the first and second step members based at least on the size of the workpiece.

17. The method of claim 16, wherein controlling the first and second step members includes moving the first step member relative to the second step member to transport a workpiece of the first size between the first level and the second level.

18. The method of claim 16, wherein controlling the first and second step members includes moving the first and second step members in unison relative to the second movable stair to transport a workpiece of the second size from the first level to the second level.

19. The method of claim 15, further including moving the first step member downwardly to the first level to receive a workpiece.

20. The method of claim 16, further including detecting the size of the workpiece prior to moving the first step member to the first level.

21. The method of claim 15, wherein the first step member includes a first platform and the second step member includes a second platform, the second platform is disposed between the first platform and the second movable stair, and transporting the workpiece from the first level to the second level on at least the first step member includes moving the first platform upwardly relative to the second movable stair.

22. A movable stair system for transporting workpieces, the system comprising:  
a first movable stair having a first step member with a first workpiece support surface and a second step member with a second workpiece support surface, the

first and second step members being movable along generally parallel paths between a first level and a second level, wherein the first step is operable independently of the second step to transport a workpiece on the first workpiece support surface from the first level to the second level;

a second movable stair configured to be movable between the second level and a third level, wherein the second movable stair is operable to receive the workpiece at the second level and transport the workpiece to the third level;

a drive system coupled with the first movable stair and configured to move the first step member independently of the second step member; and

a controller operatively coupled with drive system and configured to control the drive system to move the first and second step members, the controller selectively operable to cause the drive system to move the first step and second step members asynchronously to singulate workpieces of a first size, and to move the first and second step members in unison to transport workpieces of a larger second size.

23. The system of claim 22, wherein the first step member includes a first platform and the second step member includes a second platform, and the second step member is disposed between the first step member and the second movable stair.

24. The system of claim 23, the drive system including a first drive coupled with the first step member and a second drive coupled with the second step member, wherein the controller is further configured to control the first drive independently of the second drive.

25. The system of claim 23, wherein the second movable stair includes a third step member and a fourth step member, and the third step member is disposed between the second step member and the fourth step member.

26. The system of claim 25, the drive assembly further including a third drive coupled with the third step member and a fourth drive coupled with the fourth step



member, the third and fourth drives configured to move the third and fourth step members, respectively, between the second level and the third level.

27. The system of claim 26, wherein the controller is further configured to control each of said drive assemblies independently of the others of said drive assemblies.

28. The system of claim 27, wherein the third step member includes a third platform and the fourth step member includes a fourth platform, and the third platform is disposed between the second platform and the fourth platform.

29. The system of claim 28, the first movable stair further including one or more additional platforms disposed between said first and second platforms.

30. The system of claim 25, wherein the first drive is operatively coupled with the first and third step members, and the second drive is operatively coupled with the second and fourth step members.

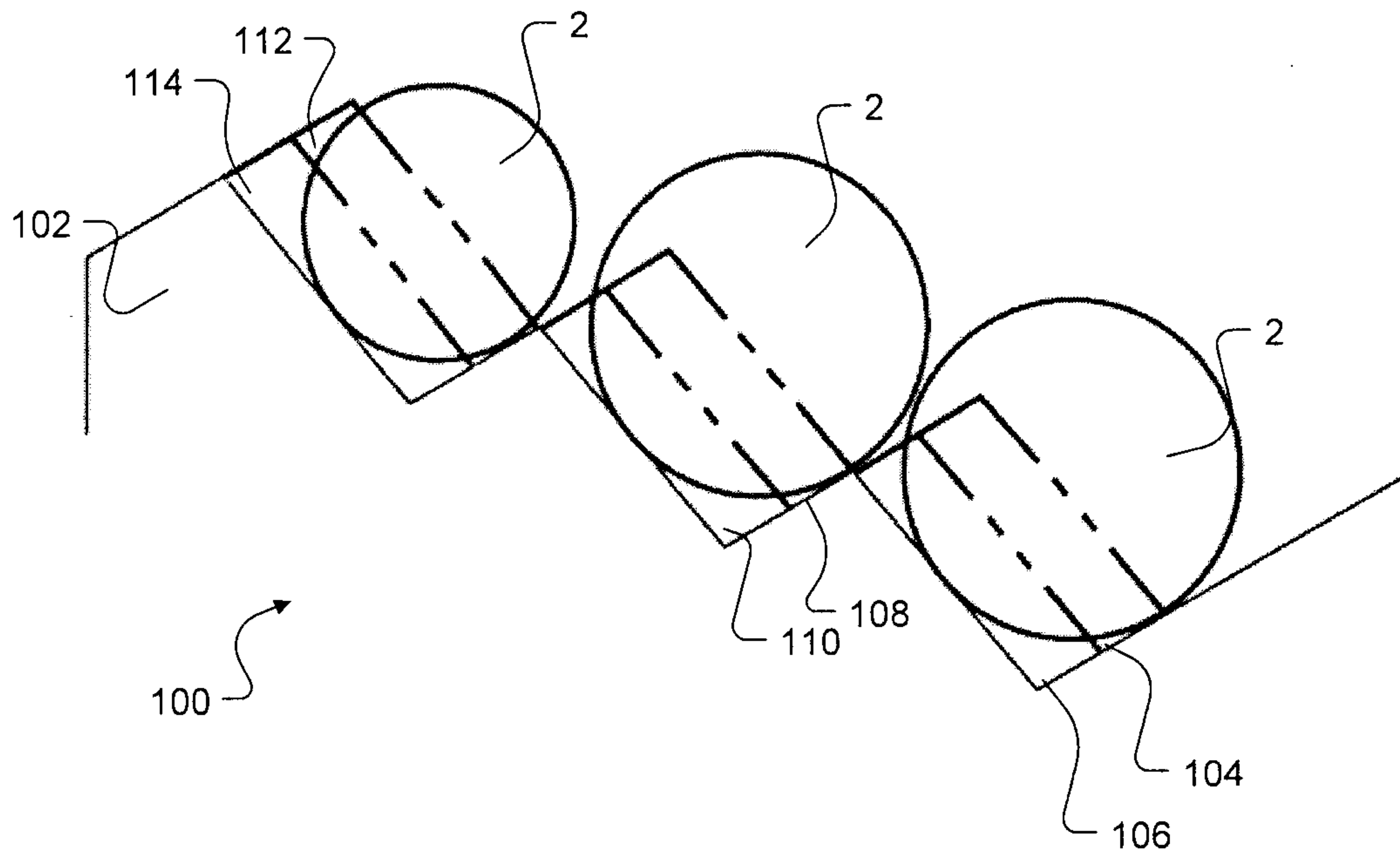


FIG. 1A

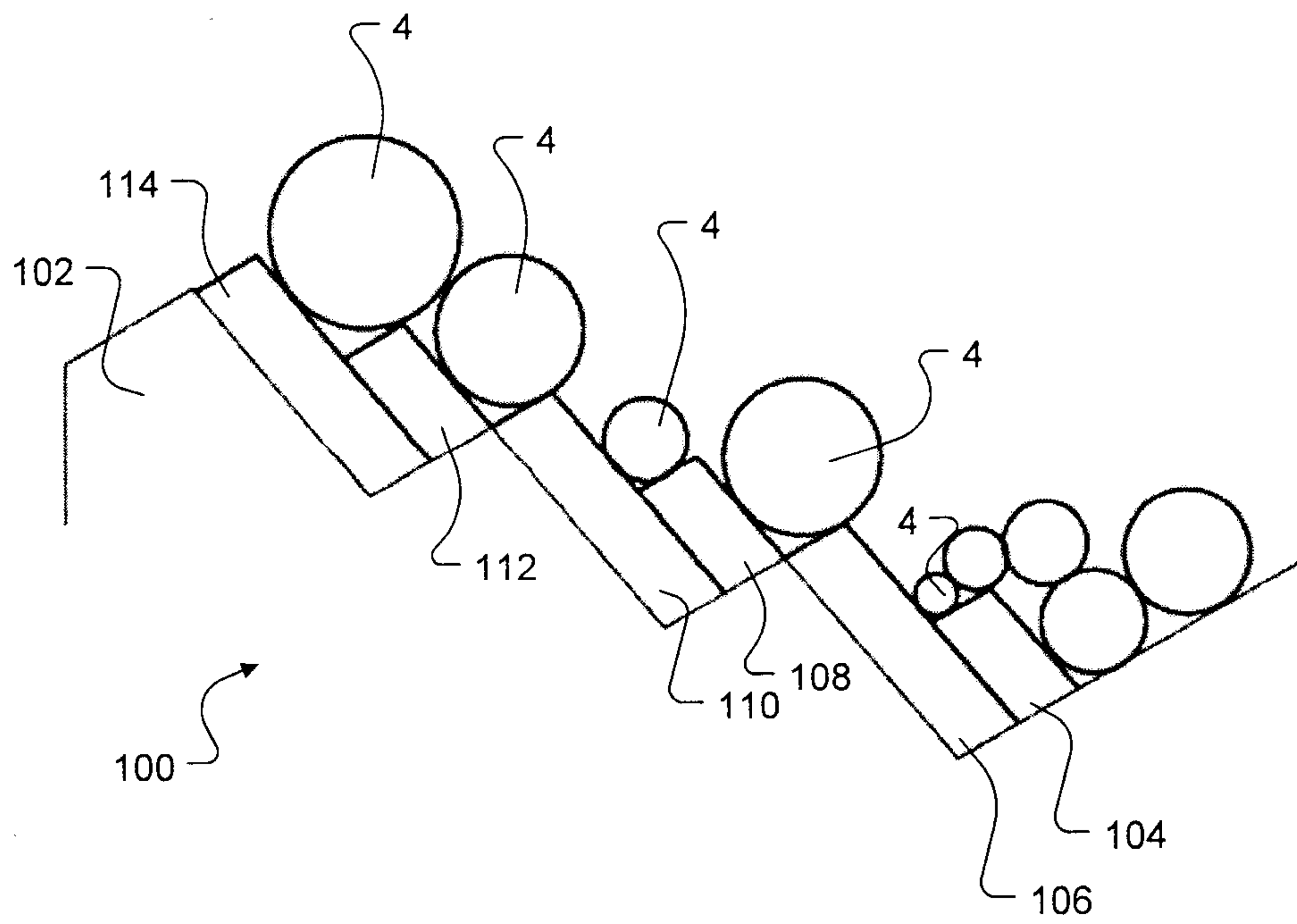


FIG. 1B



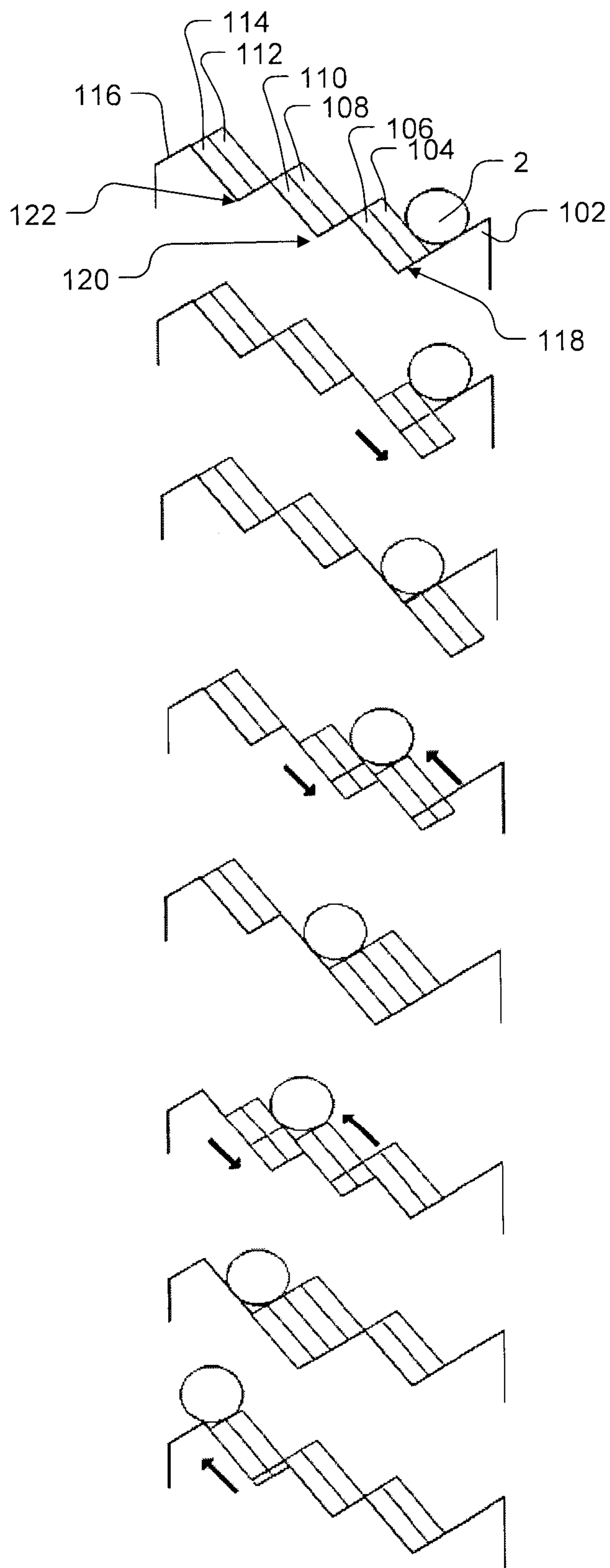


FIG. 2A

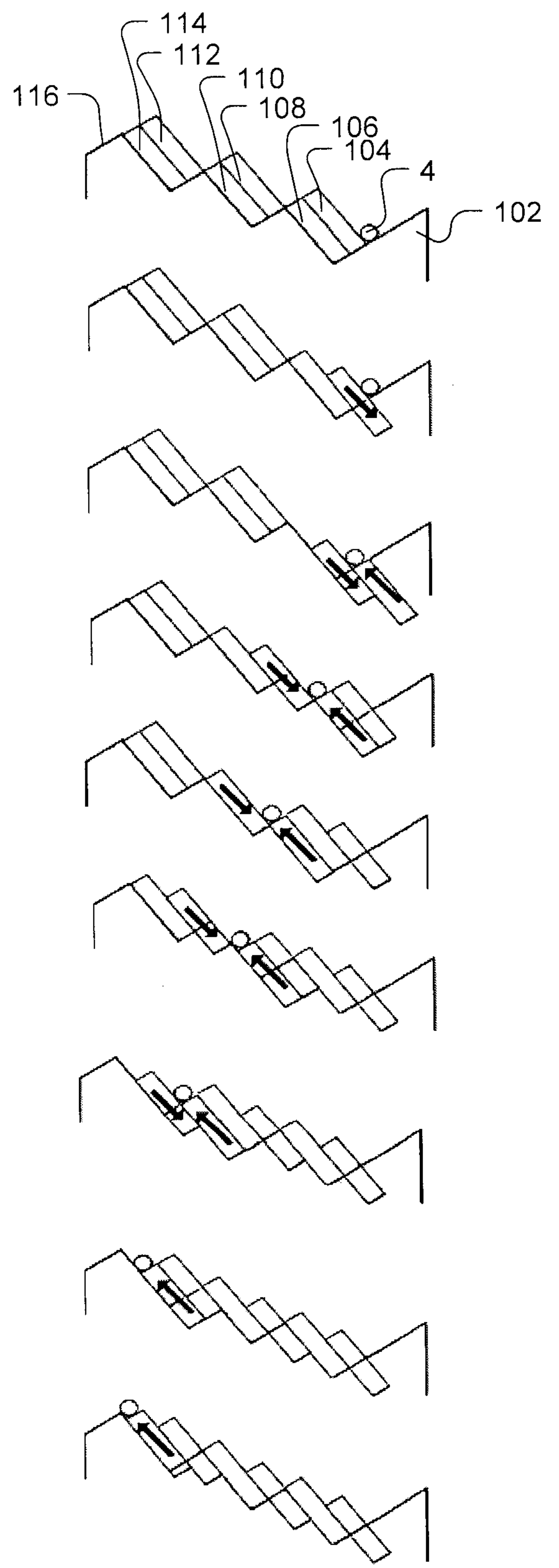


FIG. 2B

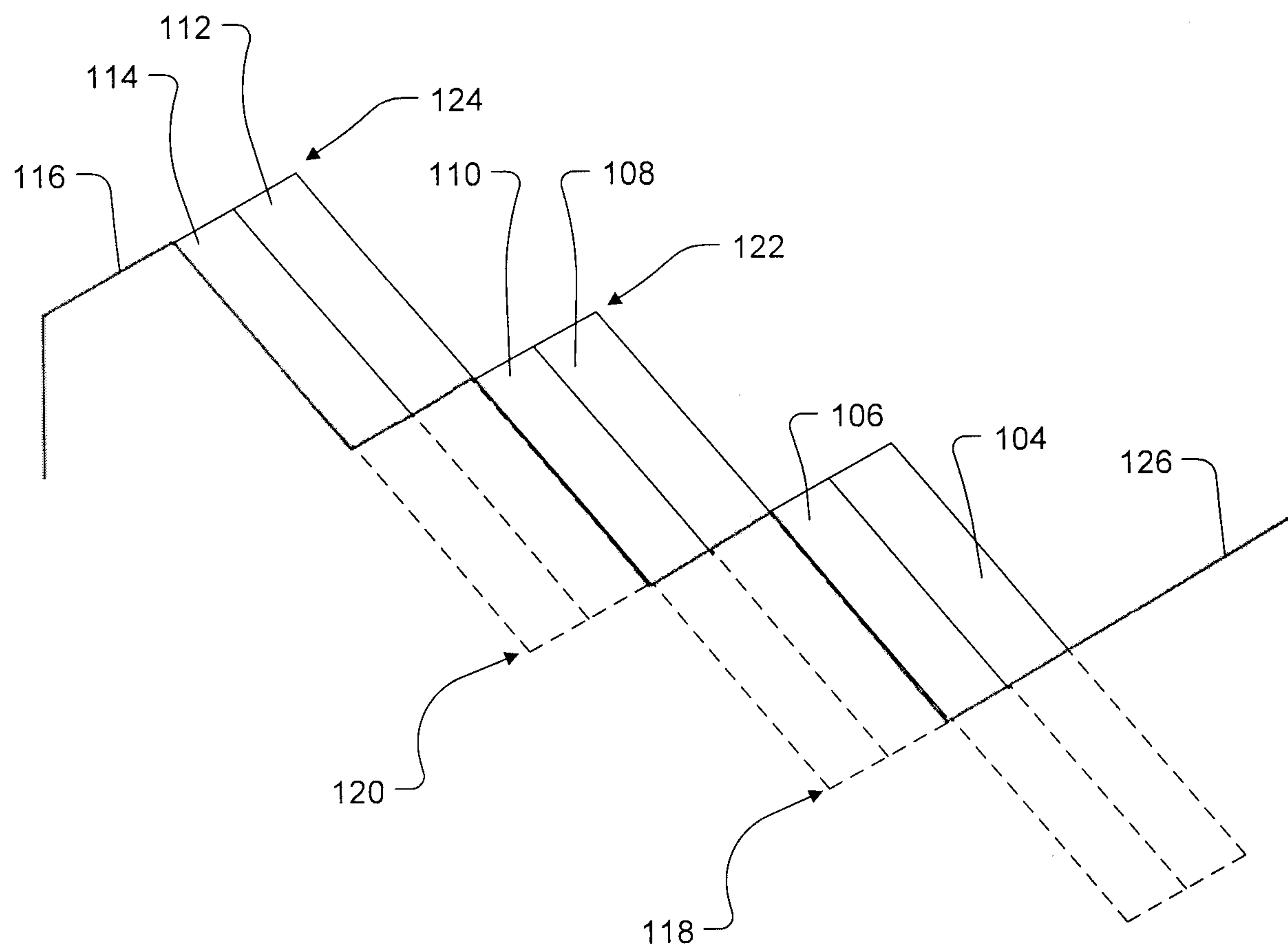


FIG. 3



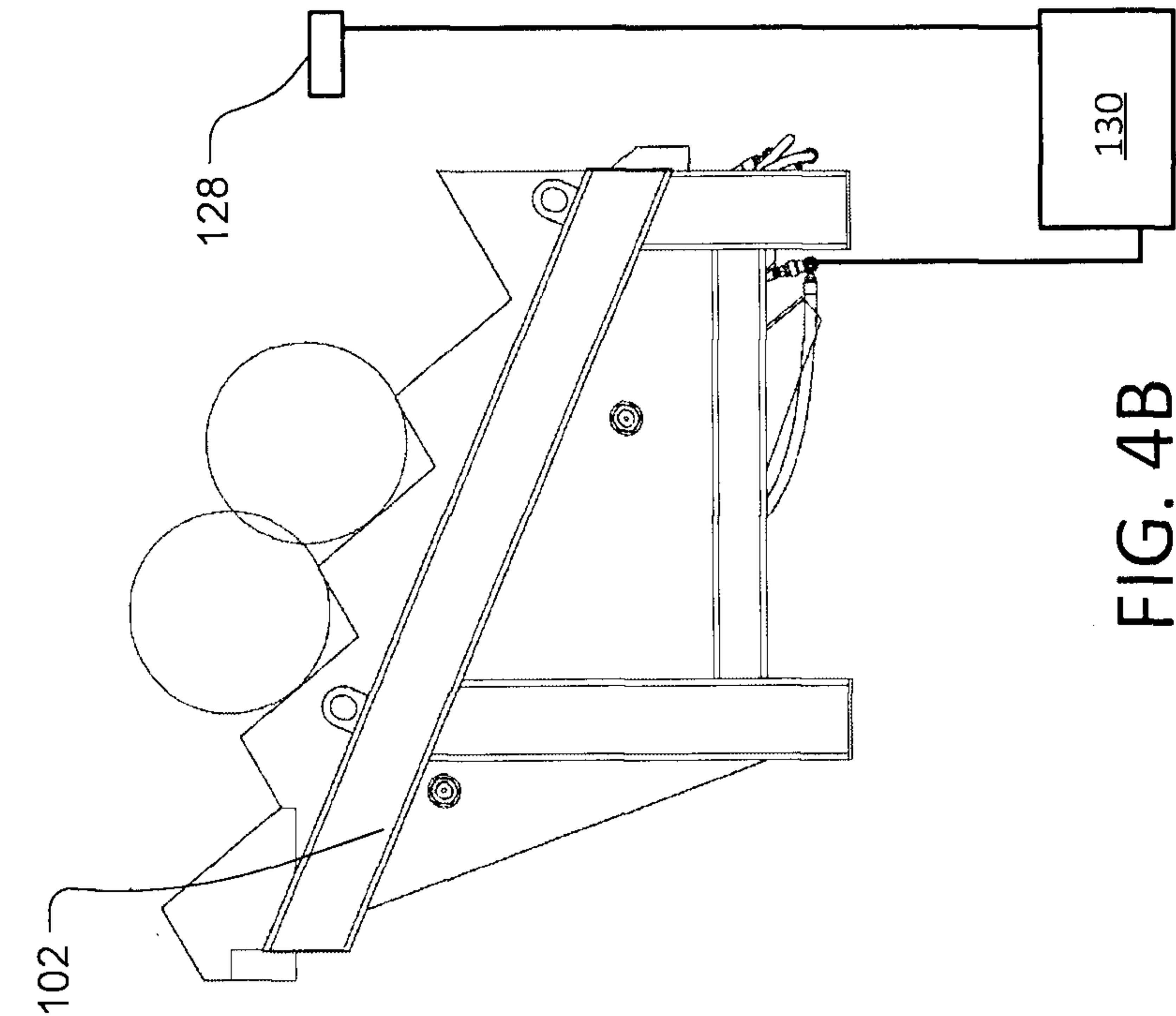


FIG. 4B

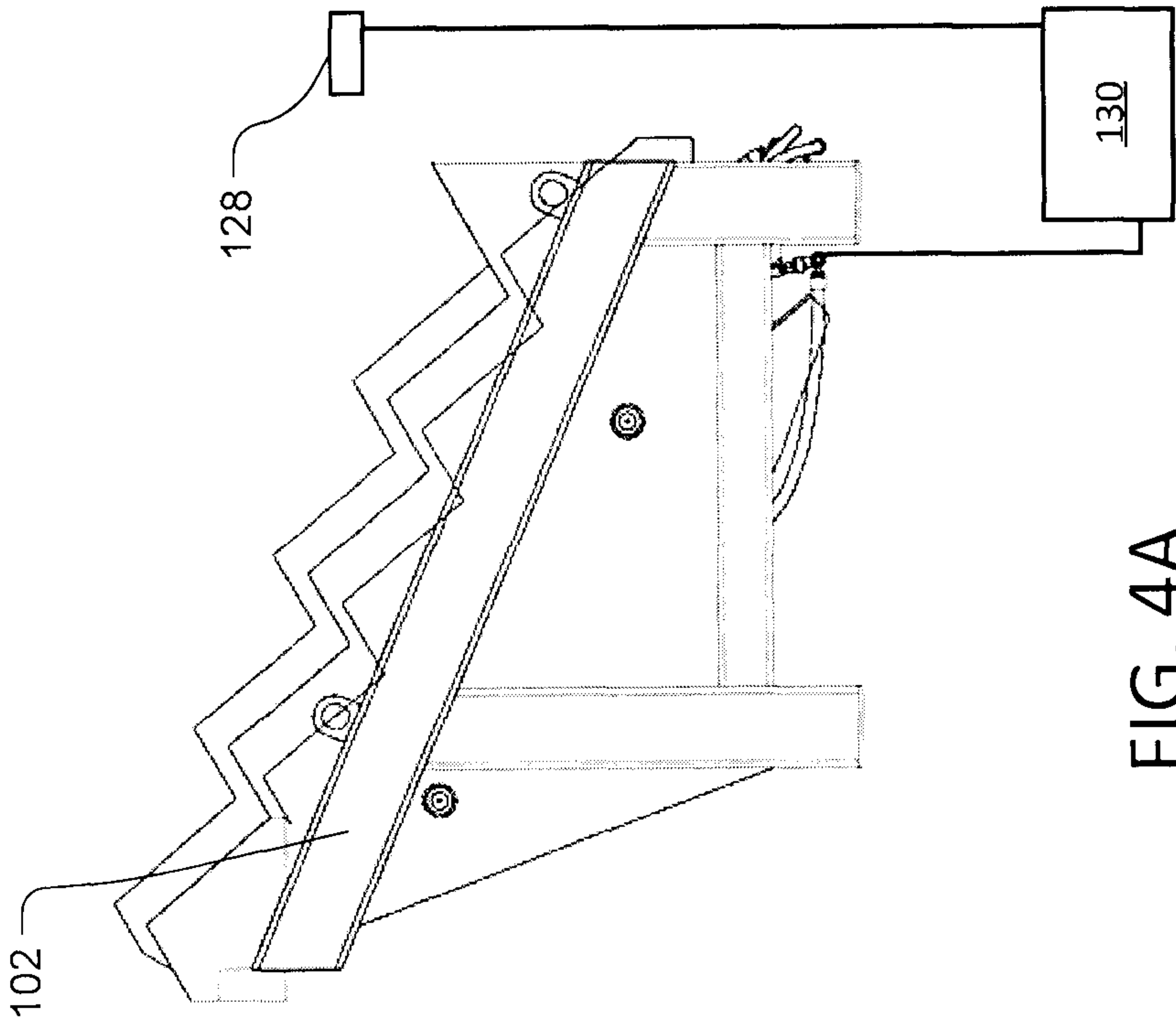


FIG. 4A

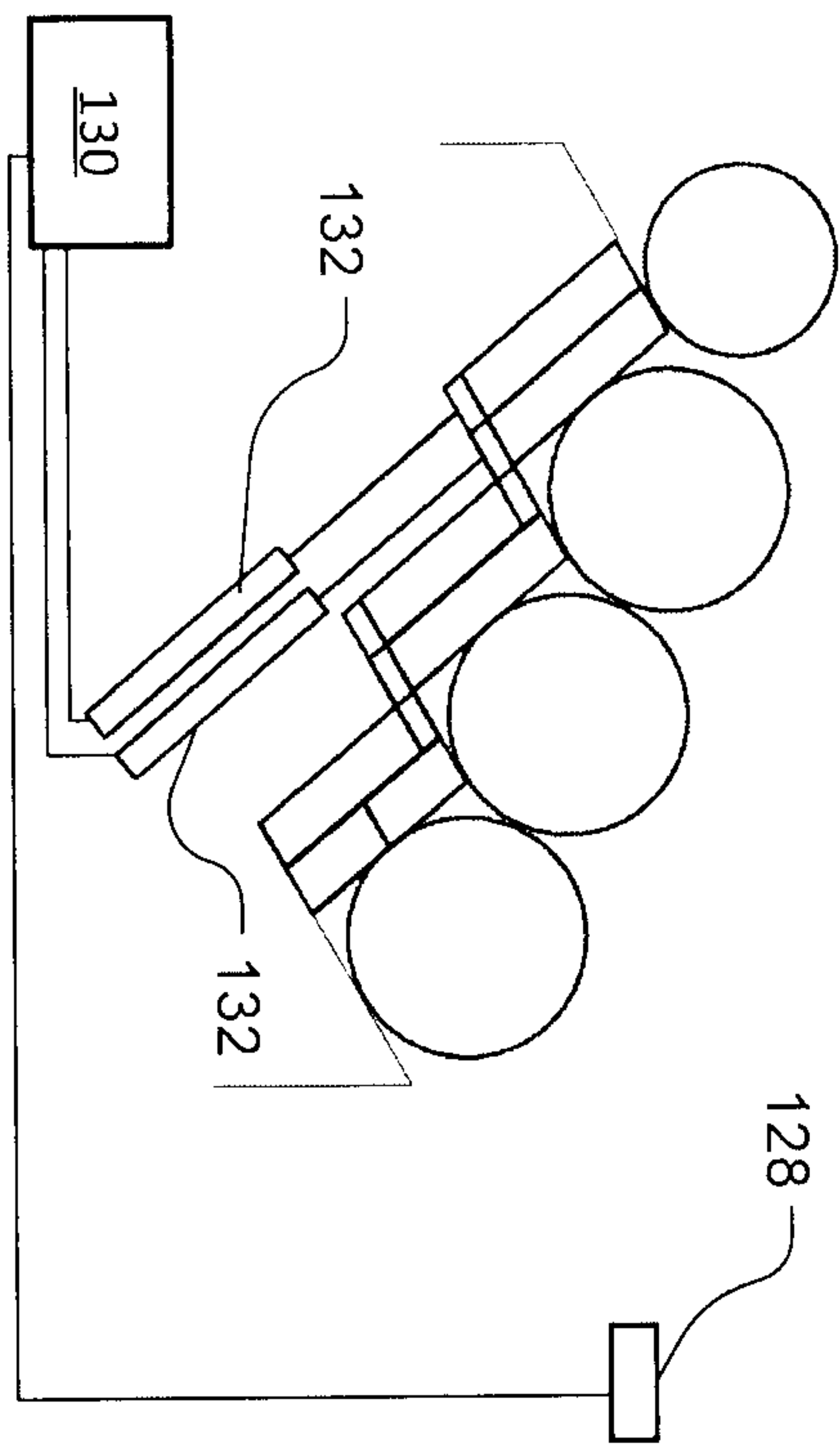


FIG. 5A

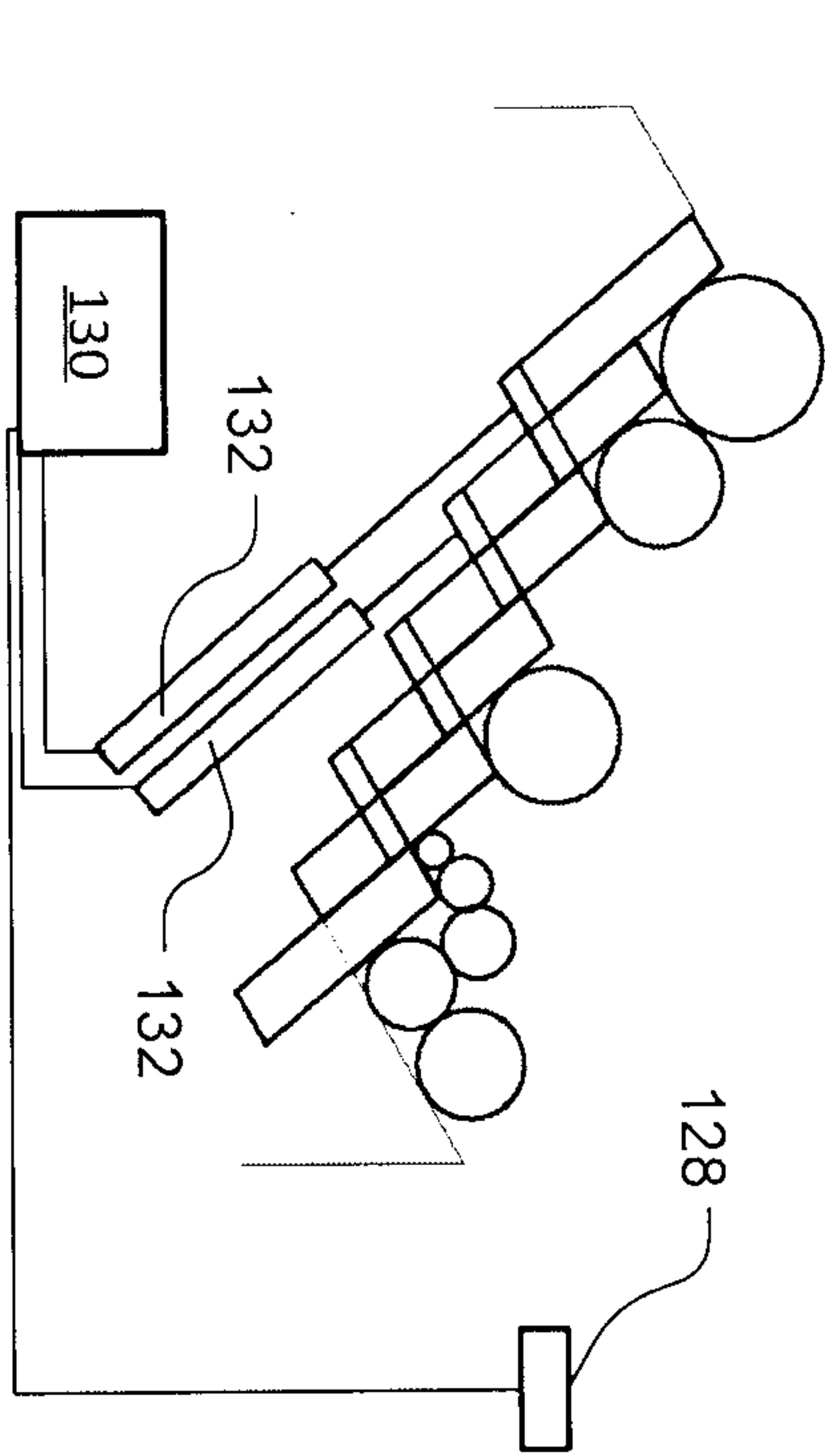


FIG. 5B

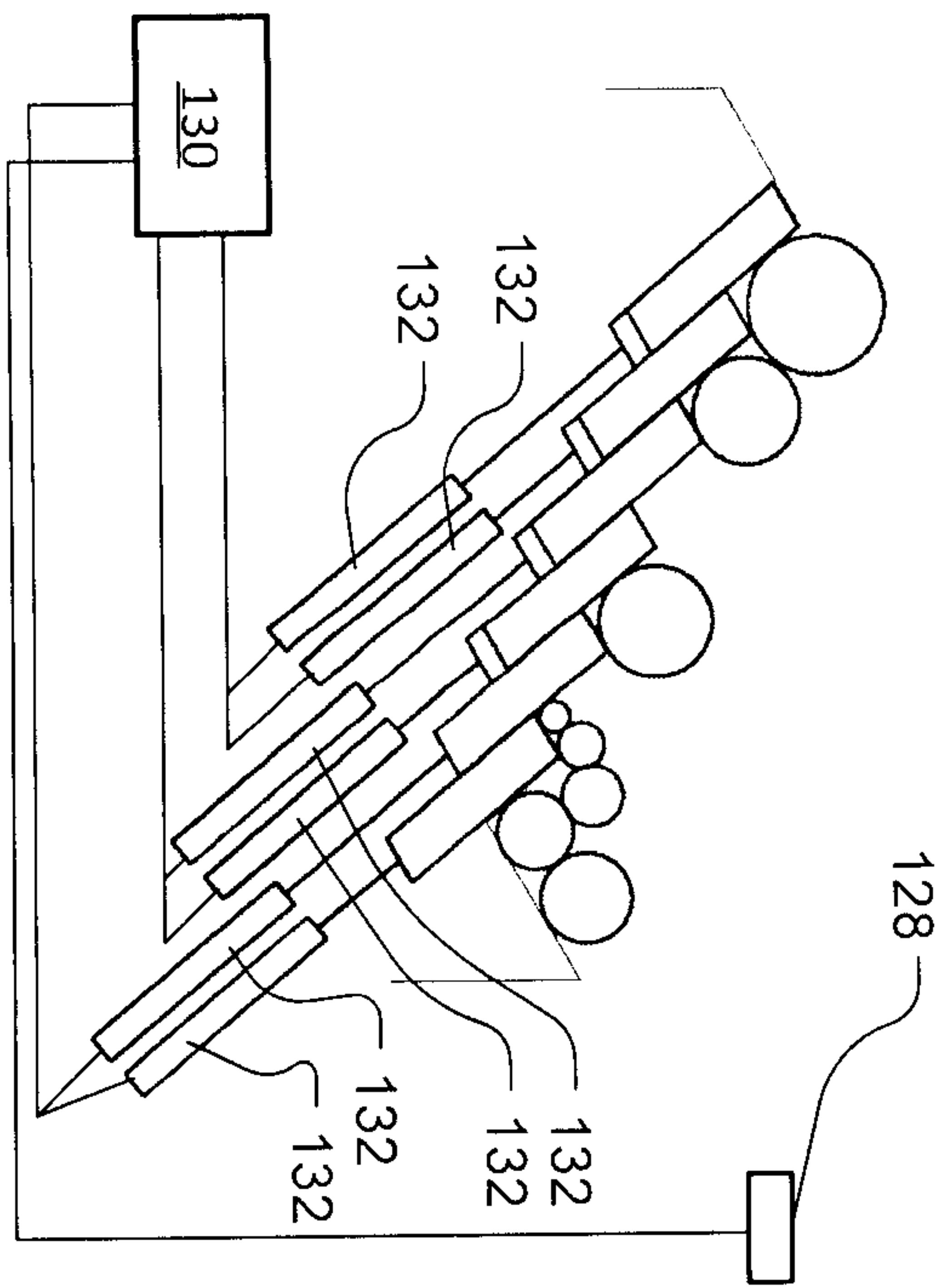


FIG. 5C



