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An agency of Industry Canada

CA 2541539 C 2010/04/20

(11)(21) **2 541 539**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(22) Date de dépôt/Filing Date: 2006/03/29
(41) Mise à la disp. pub./Open to Public Insp.: 2006/11/12
(45) Date de délivrance/Issue Date: 2010/04/20
(30) Priorité/Priority: 2005/05/12 (GB GB-0509701.9)

(51) Cl.Int./Int.Cl. *B65G 25/00* (2006.01)

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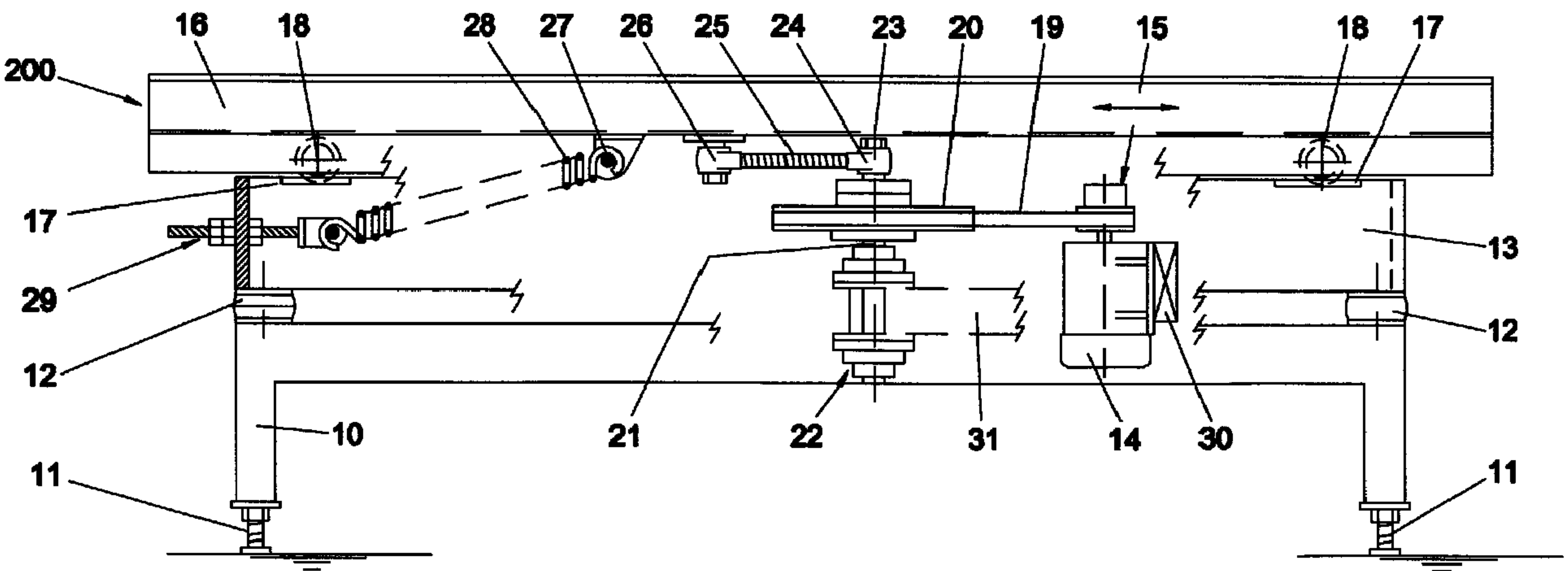
(54) Titre : CONVOYEUR HORIZONTAL DIFFERENTIEL ET MECANISME D'ENTRAINEMENT
(54) Title: DIFFERENTIAL HORIZONTAL MOTION CONVEYOR AND DRIVE MECHANISM



(57) Abrégé/Abstract:
A differential horizontal motion conveyor and drive mechanism for conveying or feeding a variety of goods. A plurality of configurations is provided in which rotary motion is converted to reciprocating motion by a crankshaft. The horizontal motion conveyor consists of an elongate trough that can functionally operate as an inertial type reciprocating conveyor. That is, to move in one direction, accelerating the conveyed material, then reverse direction as the inertia of the material continues to propel it forward thus conveying it. In another embodiment, it may functionally operate as a slow forward/fast return reciprocating conveyor. That is to carry material forward in a first slow speed, then to accelerate and reverse direction at higher second speed. This second speed sufficient to overcome static frictional forces between the conveyor trough and the material, thus conveying it. In yet another embodiment, the drive mechanism may be attached to a spiral or helical trough, functionally operating in either of the afore mentioned motions, thus vertically conveying said material. The slower of the two desired trough speeds is derived by direct connection to a substantially constant speed motor or other prime mover. The faster of the two desired trough speeds is accomplished by mechanical disconnection from said motor by a mechanical unidirectional clutch/bearing, and acceleration of the conveyor trough by a tension or compression device such as a spring. This provides for a low noise, simple, reliable and economical drive and conveyance system.

Abstract;

A differential horizontal motion conveyor and drive mechanism for conveying or feeding a variety of goods. A plurality of configurations is provided in which rotary motion is converted to reciprocating motion by a crankshaft. The horizontal motion conveyor consists of an elongate trough that can functionally operate as an inertial type reciprocating conveyor. That is, to move in one direction, accelerating the conveyed material, then reverse direction as the inertia of the material continues to propel it forward thus conveying it. In another embodiment, it may functionally operate as a slow forward/fast return reciprocating conveyor. That is to carry material forward in a first slow speed, then to accelerate and reverse direction at higher second speed. This second speed sufficient to overcome static frictional forces between the conveyor trough and the material, thus conveying it. In yet another embodiment, the drive mechanism may be attached to a spiral or helical trough, functionally operating in either of the afore mentioned motions, thus vertically conveying said material. The slower of the two desired trough speeds is derived by direct connection to a substantially constant speed motor or other prime mover. The faster of the two desired trough speeds is accomplished by mechanical disconnection from said motor by a mechanical unidirectional clutch/bearing, and acceleration of the conveyor trough by a tension or compression device such as a spring. This provides for a low noise, simple, reliable and economical drive and conveyance system.

19 Claims 7 Drawing Sheets

Field of the invention;

The present invention relates to a differential horizontal motion conveyor. More particularly, this invention relates to an adaptable drive mechanism for powering a variety of linear motion or inertial type conveyors which makes for a relatively low noise, simple, reliable and economical drive and conveyance system.

Background of the invention;

Material transfer systems or conveyors are commonly utilized in industry to transfer materials or goods from one stage of production to another. There are many types of conveyors, such as belt, roller, bucket, screw, vibrating, reciprocating, differential impulse ...etcetera. The type of conveyor utilized is dependent upon the type material or goods to be conveyed. The present invention seeks to improve upon the prior art of vibratory conveyors, shaker conveyors, shuffle conveyors, reciprocating conveyors, linear motion conveyor, differential impulse conveyor, horizontal motion conveyor and differential motion conveyor. Vibratory conveyors are suitable for some materials, but not for fragile products as the vibrating motion can tend to break the goods. Build-up of particulate matter on the vibratory conveyor trough can also result in loss of product and require frequent cleanings. Therefore, there is significant advantage to a reciprocating conveyor or horizontal motion conveyor in which the conveyed material slides over the conveying surface rather than bouncing.

Inertial type conveyors (shaker conveyors, shuffle conveyors, reciprocating conveyors and the like) such as disclosed in U.S. Pat. Nos. 218,757 , 479,742 , 1,636,303 , 2,049,346 , 2,447,393 , 3,253,700 , 4,019,626 , 4,174,032 , 4,339,029 and 5,178,258 may provide adequate means of conveyance. Generally, the conveyed materials or goods are accelerated forward at a sufficient velocity to impart continued inertial movement of said materials or goods while the reciprocating conveyor trough reverses direction and returns to start the next cycle. However, some of these drive mechanisms tend to be complicated, relatively expensive and prone to mechanical breakdown.

Fast return type conveyors (linear motion conveyor, differential motion conveyor, differential impulse conveyor and the like) such as disclosed in U.S. Pat. Nos. 5,131,525 , 5,351,807 , 6,079,548 , 6,371,282 , 6,601,695 , 6,634,488 , 6,708,815 and 6,719,124 also provide adequate means of conveyance by use of a different reciprocating motion. Generally, the conveyed materials or goods are moved forward slowly by the reciprocating conveyor trough. The trough then rapidly returns in the opposite direction. The speed of which is sufficient to allow the goods to slide along the trough. However, some of these mechanisms also tend to be complicated, relatively expensive and prone to mechanical breakdown.

Some other of these mechanisms, such as disclosed in U.S. Pat. Nos. 6,079,548 , 6,415,911 , 6,475,477 and 6,464,070, employ servo motors, linear motors and electronic controllers or other electro-mechanical devices to directly and precisely control the speed and acceleration of the back and forth motion of the conveyor trough. These methods may provide adequate means of conveyance, but some tend to be complicated and expensive.

Particularly, the present invention seeks to improve upon the prior art as disclosed in U.S. Pat. No. 5,850,906. This prior art utilizes an electrically operated clutch/brake controlled by an electronic controller. A sensor is used to detect trough position to accurately time the on and off dwell positions of the clutch/brake. A significant advantage of the present invention is the simplicity and relative low cost of a mechanical unidirectional clutch/bearing.

Some of prior art mechanisms are also adaptable for use as a drive mechanism for a helical or spiral conveyor trough, enabling materials or goods to be conveyed vertically, such as U.S. Pat. Nos. 3,246,737 and 5,351,807 . The present invention's drive mechanism is also adaptable in this manor.

Much of the prior art mechanisms are only possible or economically feasible in a limited application size range. For example, drives with multiple shafts and weights are not easily adaptable for small conveyors. Servo or linear motor drives are not easily adaptable for very large conveyors as very large servo or linear motors are not commercially available. The present invention is most adaptable to any application size.

Summary of the invention;

The differential horizontal motion conveyor includes a reciprocating elongate trough which through varying speeds and acceleration of the back and forth motions can move goods along its length. The drive mechanism includes an electric motor or other prime mover of which the output shaft is connected to a mechanical unidirectional clutch/bearing. This clutch/bearing is in the general form of a standard ball bearing in which the outer race is allowed to spin freely in one direction in relation to the inner race, but locks up to the inner race in the opposite direction. The clutch/bearing is attached to a belt pulley. A belt connects this to another larger belt pulley integrated with an eccentric crank. A connecting rod converts circular motion into longitudinal reciprocating motion. The opposite end of the connecting rod is connected to the conveyor trough causing it to reciprocate. The conveyor trough may be supported by a plurality of wheels transversely located along its length. Alternatively, it may be supported by linear bearings or pivot arms attached to a base. A tension or compression device such a metal spring is installed between the frame and the trough longitudinally in the direction of travel. Alternatively, in another embodiment, the spring could be installed between the frame and a secondary crank lobe. The dwell (in degrees of rotational offset from the main crank) would be dependent upon the desired motional characteristics of the conveyor trough. The entire assembly may be mounted on a relatively heavy frame supported by rubber or spring mounts to substantially dissipate vibration and inertial energy of the conveyor trough reciprocation. Alternatively, a counterweight attached to a secondary crank 180 degrees apart from the main crank, causing the counterweight to move in an opposite direction of the trough, could also serve to dissipate inertial energies.

In the first embodiment of the present invention, a spring is connected between the trough and the frame, so that it acts upon the trough in the direction of product flow. A mechanical adjustment device such as a threaded rod could be used to adjust spring tension. As electricity is applied to the motor, the rotational force is transferred through the belt mechanism to the crankshaft. The crank causes the trough to move rearward in a relatively slow speed as dictated by the motor speed. This rearward motion also increases the tension of the spring. As the trough completes backward motion and begins to reverse direction, the spring now begins to assist the motor in moving the trough forward. At approximately the half way point of the forward trough motion, the spring tension causes the trough to accelerate quicker than the motor speed would dictate. This is facilitated by the unidirectional clutch bearing mechanically disconnecting the motor rotational force from the crank. This is accomplished by the outer race of the clutch/bearing turning faster than the inner race. The product is now being accelerated forward along with the trough. As the trough reaches the end of forward motion and reverses direction, the inertial momentum of the product propels it forward, thus conveying it. As the trough is moving rearward, the spring tension now acts to decelerate it. As the speed of the outer race of the clutch/ bearing slows to the speed of the inner race, the clutch is re-engaged and the motor rotational force is mechanically re-connected to the crank. The cycle now begins anew. In this embodiment, the present invention would be functionally operating as an inertial reciprocating shaker type conveyor.

In a second embodiment of the present invention, a two way air cylinder could be installed in place of the spring. A two way electro-pneumatic solenoid valve could control the air cylinder. An adjustable air regulator could control the force exerted to accelerate and decelerate the trough. With air pressure supplied to one side of the of the air cylinder, and the other side open to atmospheric pressure, the trough would convey product in the forward direction. As the valve is actuated, air pressure would be reversed on the cylinder. The trough would now reverse direction of accelerations and decelerations causing the product to be conveyed in the reverse direction. In this embodiment, the present invention would be functionally operating as a reversible inertial reciprocating shaker type conveyor.

In a third embodiment of the present invention, secondary crankshaft lobes could be added to the main crankshaft. The first lobe being 180 degrees rotationally offset from the main, connected to a counterweight. This counterweight would move in equal but opposite direction with respect to the trough and act to counter vibrational and inertial forces. A second lobe, being rotationally offset approximately 90 degrees opposite of the direction of rotation, would be the attachment point of one end of the trough acceleration/deceleration spring. The other end of the spring would be attached to the frame in the direction of product travel. As electricity is applied to the motor, the trough would initially move rearward at a slow speed as dictated by the motor speed. The trough would then change directions moving the product forward at the same slow speed. Just past the half way point of forward motion, the spring would cause the clutch/bearing to release and begin to accelerate the crank. The outer race of the clutch/bearing would now be allowed to spin faster than the inner race. The trough would not accelerate substantially in the forward direction, due to the rotational nature of the crankshaft. As the trough completes forward motion in a slow speed the product is carried along with it. As the trough begins rearward motion, the crankshaft is now accelerated to a high speed. This causes a rearward trough motion of sufficient velocity to break the static frictional attachment of the product to the trough. Therefore, the trough moves rearward, but the product does not. As the trough approaches the end of rearward motion, the spring tension causes the crankshaft to decelerate. This in turn, causes the clutch/bearing to re-engage. The outer race of the clutch/bearing now spinning at a speed equal to the inner race. The rate of speed of the trough is now again dictated by motor speed and the cycle begins anew. This slow forward/ fast backward trough motion would serve to convey the product. In this embodiment, the present invention would functionally operate as a slow forward/fast return reciprocating horizontal motion type conveyor.

In a forth embodiment of the present invention, holes could be cut into the conveyor trough. These holes could be used to allow smaller particles to fall through while larger particles do not and are further conveyed. This arrangement could be used to classify or sort product. In this embodiment, the present invention would functionally operate as an inertial shaker screening type conveyor.

In a fifth embodiment of the present invention, the drive mechanism, configured in either an inertial shaker or slow forward/fast reverse motion, could be connected to a spiral or helical conveyor trough. Rather than horizontal motion, the crank and spring would be connected to act upon the rotational motion of the spiral conveyor trough thus having reciprocating motion about a central axis. This would serve to convey product vertically. In this embodiment, the present invention would functionally operate as a reciprocating helical conveyor.

It is an object of the present invention to provide an improved differential horizontal motion conveyor and adaptable drive mechanism. It is a related object to provide a conveyance device that is, in comparison to prior arts, inexpensive and reliable.

It is a particular feature of the invention that the drive mechanism provides for adaptability of different reciprocating motions. That is to allow for inertial or slow forward/fast return type trough motion. It is another feature that product conveyance rates can be easily varied by adjusting spring tension and/or motor speed by way of an electronic speed controller such as a variable frequency drive. It is yet another advantage of the invention to be easily reversible utilizing an air cylinder and electro-pneumatic solenoid valve.

Substantially smooth mechanical motion is a particular advantage of the present invention. This leads to relatively low levels of wear and tear and substantially long life of the mechanical components. The smooth operation also makes it possible to simply address the issue of countering vibration and inertial forces. In many applications, a relatively heavy frame suspended on rubber or spring mounts will suffice for eliminating or substantially reducing vibration and inertial forces. For applications where a heavy frame is impractical or undesirable, a counterweight system could be employed. Yet another advantage of the invention is the adaptability and economic feasibility for any application size. The simple drive mechanism can be adapted to drive a device as small as a scale feeder on a weigher/bagger. Alternatively, it could be adapted to drive a device as large as a massive conveyor for scrap metal or ore. Relatively low noise generation is another advantage of the invention.

Another particular advantage of the present invention is simplicity and thus, relative low cost. Maintenance and repair costs are likewise relatively low. A further feature of the invention is the efficiency of the drive mechanism, in which relatively modest power consumption is required to convey product. In yet another feature of the present invention, the drive mechanism could be used to drive a horizontal or slightly inclined trough, screen, sizer or separator. It could also be used to drive a vertical spiral or helical conveyor trough.

A further advantage of the differential horizontal motion conveyor is the ease with which the trough and other elements could be disassembled for cleaning, repairs and maintenance.

These and other objects, features and advantages of the present invention will become obvious from the following detailed description and accompanying drawings, wherein numbers correspond to components within the preferred embodiments.

Brief description of the drawings;

FIG. 1 is a side elevation view of one embodiment of the differential horizontal motion conveyor with the drive mechanism configured to cause the trough to act as a shaker type conveyor.

FIG. 2 is a top view of **FIG. 1**.

FIG. 3 is an cross section view or the clutch/bearing assembly and its interconnection between the motor shaft and belt pulley.

FIG. 4 is a top view of a reversible embodiment of the shaker type conveyor as shown in **FIG. 2**. The pneumatic system is shown in schematic form.

FIG. 5 is a side view of **FIG. 4**.

FIG. 6 is a top view of another embodiment of the conveyor drive system configured to cause the trough to act as a slow forward/ fast return reciprocating type conveyor.

FIG. 7 is a side view of **FIG. 6**.

FIG. 8 is a side view of an optional counterweight mechanism added to the conveyor as shown in **FIG. 1**.

FIG. 9 is a top view of **FIG. 8**.

FIG. 10 is a functional illustration of another embodiment of the present invention in which the conveyor trough is configured as a screening conveyor.

FIG. 11 is a top view of **FIG. 10**

FIG. 12 is functional illustration of another embodiment of the present invention in which the drive mechanism is used to drive a spiral conveyor.

FIG.13 is a detail of the drive linkage of **FIG. 12**.

Description of the preferred embodiments

Referring now to **FIGS. 1-3**, one embodiment a differential horizontal motion conveyor **200** configured to operate as a shaker type reciprocating conveyor. The trough **16** is caused to reciprocate forward and reverse as shown by the double sided arrow. The trough **16** consists of a planar bottom and flanges extending upward on either side and at the back. The height of these flanges to be sufficient to prevent product spillover from the sides or back. Therefore, product or goods deposited at any point onto the trough **16** would be caused to be conveyed forward and thus fall off the forward end of the planar bottom. The accelerations and decelerations within the controlled reciprocating motions of the trough **16** would cause product or goods deposited onto it to be conveyed forward (to the left). A stand **10**, with adjustable feet **11** for leveling can be used to support the conveyor. The design of this stand is generally known to a person commonly skilled in the art. This stand **10** could be adjusted so that the planar surface of the trough **16** is substantially horizontal, downhill or slightly inclined with respect to product travel.

A relatively heavy frame **13**, for supporting the drive components and trough, is mounted on rubber mounting pads **12** or springs. The combination of the heavy mass of the frame **13** and the flexibility of the mounts **12** works to eliminate or substantially reduce vibrational and inertial energies caused by the reciprocating motion of the trough **16**. In applications where a substantially heavy frame is impractical or undesired, a counterweight mechanism such as shown in **FIGS. 8** and **9** combined with a lighter frame and more solid mounting could be alternately used. The trough, tray or pan **16** is mounted to the frame **13** by a support mechanism which allows the trough **16** to move back and forth in a substantially horizontal motion. This support mechanism consists of roller guides **17** ,attached to the underside of the trough **16** longitudinally in the direction of trough reciprocation, and rollers **18** mounted to the frame in the same orientation. The rollers **18** and roller guides **17** (of a generally upside down "U" shape cross section) provide action as both a guide roller and load roller. Alternately linear bearings or pivot arms could be used as the trough support mechanism between the trough **16** and frame **13**.

An electric motor **14** or any other suitable prime mover supplying rotational energy would power the drive mechanism. The motor **14** is suitably attached to cross member **30**, which in turn is attached to the frame **13**. The motor **14** could be of a substantially constant set speed or speed adjusted by an electronic controller ,such as a frequency drive, dependent on application. The output shaft of this motor would be connected to the clutch/bearing and pulley assembly **15**. Refer to **FIG. 3** for an cross sectional view of this assembly. The motor output shaft **51** has a standard key-way machined into it. The motor shaft key **52** is inserted into the key-way. The shaft **51** and key **52** are inserted into the inner race of the clutch/bearing **53** and secured so as not to allow any movement between them. The clutch/bearing **53** operates in the following manor. If torque is applied to the outer race in one direction, it is allowed to spin freely with relation to the inner race acting as a bearing. If torque is applied to the outer race in the opposite direction, it locks up in relation to the inner race acting as a solid coupling. This clutch/bearing could be such as Formsprag CS or CSK series. The outer race of the clutch/bearing and outer race key **54** are inserted into the inner race of the primary pulley **55** and secured in such a manor so as not to allow any movement between them.

Referring back to **FIGS. 1** and **2**, a belt **19** is installed between the clutch/ bearing and pulley assembly **15** and the crank pulley **20** thus transferring rotational energy. The belt **19** could be a single 'V' belt, timing belt, or a plurality of belts dependent on application. The crank pulley **20** is mounted onto the crank pulley shaft **21** , which is supported by a multiple bearing assembly **22** . The crank pulley **20** is larger in diameter than the primary pulley to provide for speed reduction and torque multiplication. The multiple bearing assembly **22** is suitably attached to cross member **31**, which in turn is attached to the frame **13**. The crank shaft lobe **23** is suitably attached to the top of the crank pulley **20** in the same plane but off center to the crank pulley shaft **21**. A connecting arm consisting of rod end bearings **24** and **26** at either end of connecting rod **25** is connected between the crank shaft lobe **23** and trough attachment shaft **27**. This mechanism converts the rotational motion of crank lobe **23** to reciprocating linear motion of trough attachment shaft **27**. The trough attachment shaft **27** is suitably connected to the trough **16**

,causing it to reciprocate.

A spring **28** is connected between the trough attachment shaft **27** and the spring tension adjustment assembly **29** which in turn is mounted to the frame **13**. The spring **28** could alternately be a rubber band, a pressurized air cylinder or any other suitable adjustable tension device. The spring tension adjustment assembly **29** consists of a threaded rod inserted into a drilled hole in the frame **13**. Tension adjustment would be achieved by an adjustment nut on the outboard side of the frame **13** threaded onto the threaded rod. Other forms of tension adjustment devices could be interchanged with this assembly without changing the intent or basic operation of the present invention. The spring **28** acts to accelerate the trough **16** in the forward direction and to decelerate it in the reverse direction. In the forward stroke, spring tension causes the clutch/bearing to disengage the trough **16** from motor rotational forces. Tension pulling the trough **16** forward causes the crank pulley **20** and thus also the primary pulley **55** of the clutch/bearing and pulley assembly **15** to spin faster than the motor shaft. In the rearward stroke, the spring tension would cause the trough **16** and therefore the primary pulley **55** and outer race of the clutch/bearing **53** to decelerate. When the outer race is decelerated to a speed equal to the inner race, the clutch/bearing is re-engaged and trough **16** speed is again dictated by motor **14** speed.

The effect of this motion is to accelerate product forward to a certain inertial velocity on the forward stroke of the trough **16**, such that the product continues forward motion through inertia while the trough slides under the product during the rearward stroke. This varying speed reciprocating trough **16** motion serves to convey the product.

FIG. 4 and **FIG. 5** illustrate another embodiment of the present invention whereby reversibility of product flow direction is desired. The reversible differential horizontal motion conveyor **210** is the same as the conveyor **200** in **FIGS. 2** and **3**, except with the following modifications. The trough **16** does not have a flange extending upward from the back. This is to allow product to flow in the backward as well as forward direction. A two way air cylinder **67** is installed in place of the spring **28** in **FIGS. 2** and **3**. The base of the air cylinder **67** is attached to the frame **13**. The air cylinder actuator rod **68** is connected to the trough attachment shaft **27**. Air lines **65** and **66** are connected between the ports of the air cylinder **67** and the output ports of the two way electro-pneumatic valve **64**. An air supply line **61** of sufficient air volume and pressure supplies air to the input ports of the valve **64**. A combination regulator and check valve **62** is used to ensure equal force in either forward or reverse mode.

With the valve **64** de-energized, the air cylinder **67** provides tension in the forward direction and acts substantially similar to the spring **28** in **FIGS. 2** and **3**. That is, to convey the product in a forward direction. As valve **64** is energized, the air supply to the air cylinder **67** is reversed. Tension is now provided in the rearward direction of the trough 16. This results in conveyance of the product in the reverse direction. The amount of tension that the cylinder provides is adjustable in either direction by regulating the air supply pressure . The valve **64** could be energized and de-energized by a manual switch or by an automatic controller as dictated by the application. This pneumatic configuration is common and well known by persons commonly skilled in the art.

Referring to **FIGS. 6** and **7**, another embodiment of the drive mechanism **220** of the present invention configured to operate a conveyor trough in a slow forward/fast return type motion. The motor **70**, clutch/bearing and pulley assembly **71**, motor shaft **72**, belt **73**, crank pulley **74**, crank shaft main lobe **78**, connecting arm **80**, rod end bearings **79** & **81**, and the trough attachment shaft

82 function in the same manor as the drive mechanism in the first embodiment shown in **FIGS. 1-3** . The differences begin with the crank pulley **74** being attached to a secondary crankshaft **75** supported by bearings **76** and **77**. This secondary crankshaft **75** has a secondary lobe **85**. The trough acceleration/deceleration spring **92** is attached to a secondary crankshaft lobe **85** by way of connecting arm **91** and bearing **90**. This secondary crankshaft lobe **85** being approximately 90 degrees in rotation offset (opposite of the direction of rotation) from the main crank lobe **78**. The other end of the spring **93** is attached to the frame using a spring tension adjustment assembly **29** .

The dwell between the main crank lobe **78** and the spring secondary lobe **86** is the cause of the difference of the motional characteristics between the first embodiment **FIGS. 1-3** and this embodiment **FIGS. 6** and **7**. The spring tension being approximately 90 degrees rotationally behind the main crank lobe **78** would cause the trough (connected to the trough attachment shaft **82**) to move forward in a first slow speed, then backwards in as faster second speed. The first slow speed would be slow enough not to break the static frictional attachment force between the product and the trough, thus carrying the product along with the trough. The second higher speed would be fast enough to break the static frictional attachment force between the product and the trough so that the trough would slide backwards while the product would not. The slower of the two speeds would generally be dictated by motor speed as the clutch/bearing is engaged. The faster of the two speeds would generally be dictated by spring tension as the clutch/bearing is disengaged. This repeated slow forward/ fast backward trough motion would serve to convey the product.

FIGS. 8 and **9** illustrate an optional counter-weight assembly **222** which may be utilized in any embodiment to counter vibration and inertial forces. The counter-weight assembly **222** is generally only required if a substantially heavy frame is impractical or undesirable in a particular application. A secondary crankshaft lobe **85**, that is 180 degrees in rotation apart from the crank shaft main lobe **78**, is used to reciprocate the counter-weight **89** in a motion that is equal but opposite to the trough. The counter-weight is connected to lobe **85** by a connecting arm **88** . The counter-weight is usually supported by a mechanism similar to whatever mechanism is used to support the trough.

FIGS. 10 and **11** illustrates another embodiment of the present invention in which sorting, screening or "sizing" is the primary objective. The conveyor trough **100** has slots or holes **102** cut into it . This may be done by drilling or punching holes in the trough **100**. The dimensions of the slots or holes would be sized so that smaller particles would fall through while larger ones would not, as required by the specific application. Mixed product **103** containing particles of different sizes would be deposited at the rear of the screening conveyor trough **100**. A differential reciprocating motion would cause the particles **103** to be conveyed forward. As the particles pass over the slots or holes **102** smaller particles **105** would fall through while larger ones **104** would not and would continue being conveyed. The sorted particles could be conveyed where needed by a secondary conveyors **106** and **107**. This process is well known to any person commonly competent in the art and is only used to illustrate the adaptability of the drive mechanism of the present invention.

FIG. 12 shows another embodiment of the present invention in which vertical conveying is the objective. The drive mechanism **110** is used to drive a spiral or helical conveyor trough **112**. The spiral trough **112** is reciprocated back and forth around a central axis. The drive mechanism **110** is connected by a lever **111** to the central axis **115** of the spiral conveyor trough. Product could be deposited on the lower end of the spiral trough by a feed conveyor **113**. Differential reciprocating motion of the conveying surface of the spiral conveyor trough **112** would propel the product upwards. A "take-away" conveyor **114** could be used to further convey product once it has completed the vertical portion of travel upon the spiral conveyor trough **112**. **FIG. 13** shows an top view detail of the connection of the lever **111** to the central axis **115** of the spiral conveyor. This process is also well known by any person commonly knowledgeable in the art. It is referenced again only to show the adaptability of the drive mechanism of the present invention.

It should be understood that , while the preferred embodiments of the present invention have been described in detail, the scope of the invention is not limited to these embodiments. Various modifications could occur to persons commonly skilled in the art. However, it should be absolutely understood that such modifications or other adaptations may be made without departing from the spirit of the present invention, as set forth in the following claims.

What is claimed is:

1. A differential horizontal motion conveyor for transporting a variety of goods, comprising :

a trough imparted with a differential reciprocating motion to cause goods deposited upon its surface to be conveyed;

a drive mechanism for reciprocating said trough, consisting of, a substantially constant speed rotational power source, a mechanical unidirectional clutch mechanism, a speed reducing/torque multiplying means, a crank , and connecting arm;

a mechanical energy storage means to urge said trough to a velocity greater than that imparted upon said trough by said drive mechanism;

2. The differential horizontal motion conveyor as defined in claim **1** , further comprising:

a substantially heavy frame atop of flexible mounting means to support the aforementioned components and to substantially dissipate vibrational and inertial energies generated by said trough and said drive mechanism.

3. The differential horizontal motion conveyor as defined in claim **1** , further comprising:

a supporting means for said trough which allows for substantially horizontal longitudinal reciprocating motion.

4. The differential horizontal motion conveyor as defined in claim **1** , further providing:

adjustment means for varying the speed of said rotational power source.

5. The differential horizontal motion conveyor as defined in claim **1** , further providing:

adjustment means for varying the force of said mechanical energy storage means.

6.The differential horizontal motion conveyor as defined in claim **1** , further providing:

a means of reversing the force of said mechanical energy storage means to allow for reversing of the direction of product travel along the trough.

7. The differential horizontal motion conveyor as defined in claim **1** , further comprising:

a counterweight powered by said rotational power source attached to secondary crank thereby moving in an opposite direction with relation to said trough for the purpose of substantially dissipating vibrational and inertial energies generated by said trough and said drive mechanism.

8. A drive mechanism for powering a reciprocating conveyor, the reciprocating conveyor including a trough movable in an accelerating forward direction and a decelerating backward direction to move goods along the trough, the drive mechanism comprising:

a substantially constant speed rotational power source;

a mechanical unidirectional clutch in which the inner race is rotatively secured to the output shaft of said rotational power source;

a speed reducer/torque multiplier in which the input is secured to the outer race of said unidirectional clutch; a crank that is rotatively secured to the output of said speed reducer/torque multiplier; a connecting arm interconnected between said crank and said trough so that rotational motion is converted to reciprocating motion;

a mechanical energy storage means, interconnected between said trough and a frame, to urge said trough to a velocity greater than that imparted upon said trough by said rotational power source;

9. The drive mechanism as defined in claim **8** , further comprising;

adjustment means for varying the speed of said rotational power source.

10. The drive mechanism as defined in claim **8** , further providing:

adjustment means for varying the force of said mechanical energy storage means.

11. The drive mechanism as defined in claim **8** , further providing:

a means of reversing the force of said mechanical energy storage means to allow for reversing of the direction of product travel along the trough.

12. The drive mechanism as defined in claim **8** , further comprising:

a counterweight powered by said rotational power source attached to secondary crank thereby moving in an opposite direction with relation to said trough for the purpose of substantially dissipating vibrational and inertial energies generated by said trough and said drive mechanism.

13. A drive mechanism for powering a differential motion linear conveyor, the differential motion linear conveyor including a trough movable in a forward direction at one speed and a backward direction at a greater second speed to move goods along said trough, the drive mechanism comprising:

a substantially constant speed rotational power source; a unidirectional clutch in which the inner race is rotatively secured to the output shaft of said rotational power source;

a speed reducer/torque multiplier in which the input is secured to the outer race of said unidirectional clutch;

a crankshaft that is rotatively secured to the output of said speed reducer/torque multiplier;

a primary crankshaft lobe for moving said trough;

a connecting arm interconnected between said primary crankshaft lobe and said trough so that rotational motion is converted to reciprocating motion;

a secondary crankshaft lobe to provide energy for the second speed;

a mechanical energy storage means, interconnected between said secondary crankshaft lobe and a frame, to urge said crankshaft to a velocity greater than that imparted upon said crankshaft by said rotational power source, thereby generating the differential motion necessary to move product along said trough.

14. The drive mechanism as defined in claim **13** , further comprising;
adjustment means for varying the speed of said rotational power source.

15. The drive mechanism as defined in claim **13** , further providing:
adjustment means for varying the force of said mechanical energy storage means.

16. The drive mechanism as defined in claim **13** , further comprising:
a counterweight powered by said rotational power source attached to a third crankshaft lobe thereby moving in an opposite direction with relation to said trough for the purpose of substantially dissipating vibrational and inertial energies generated by said trough and said drive mechanism.

17. The drive mechanism as defined in claim **8** , wherein an attached trough has a spiral or helical configuration such that the reciprocating motions of said trough would be rotational movement about a central axis,

18. The drive mechanism as defined in claim **13** , wherein an attached trough has a spiral or helical configuration such that the reciprocating motions of said trough would be rotational movements about a central axis.

19. The differential horizontal motion conveyor as defined in claim **1** , wherein said trough would be beset with voids along the planar surface, such that particles of a smaller size would pass through the voids and particles of a larger size would not , therefore to separate goods.

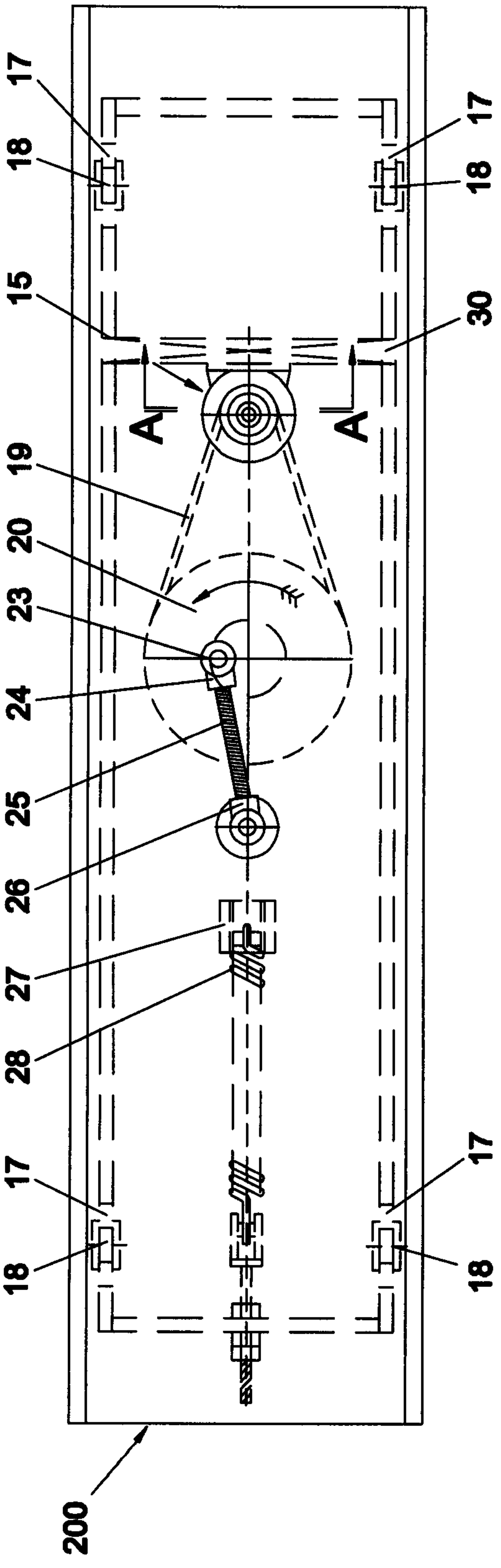

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FIG. 2

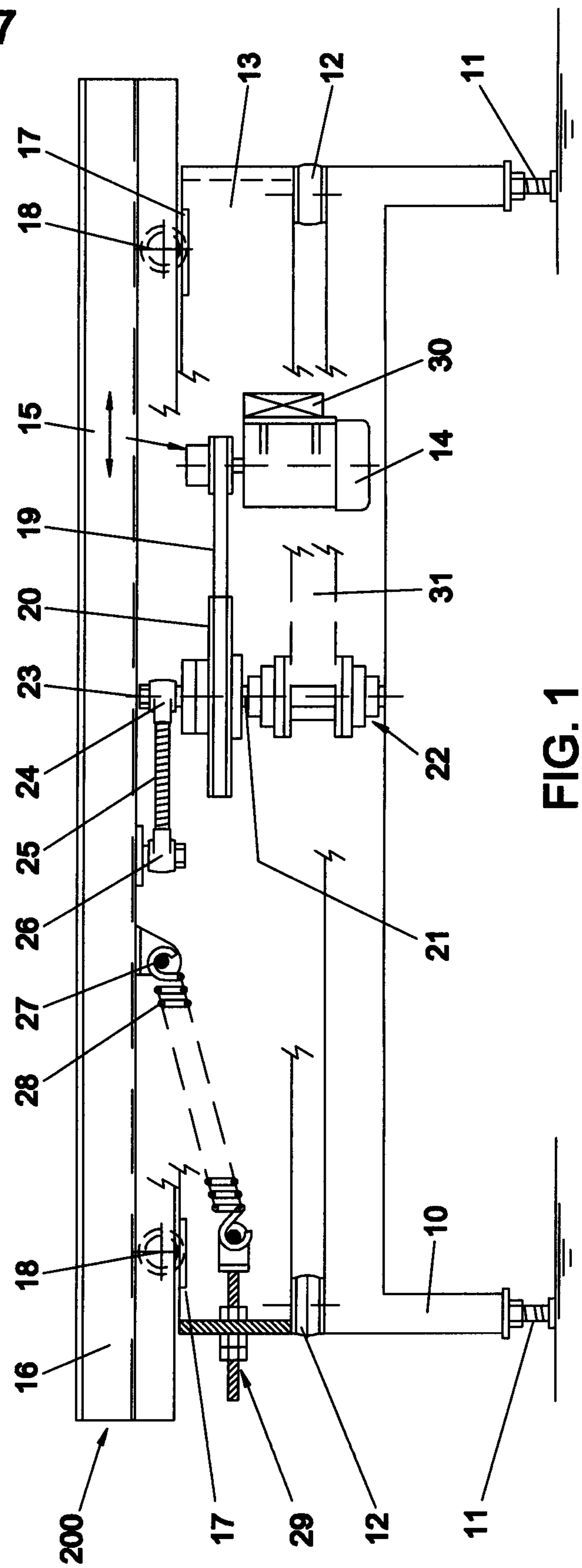
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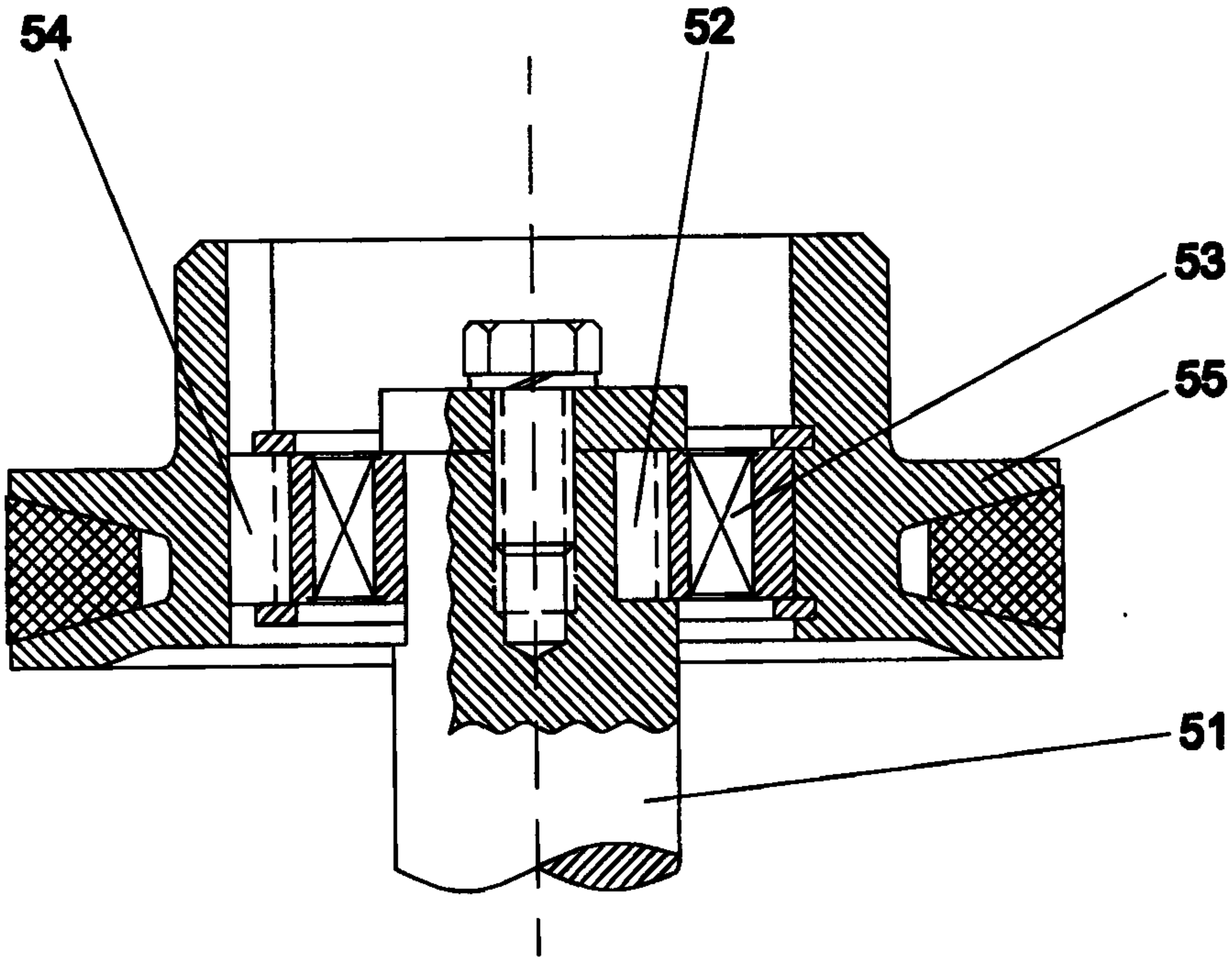
FIG. 1



SCETION A-A

FIG. 3

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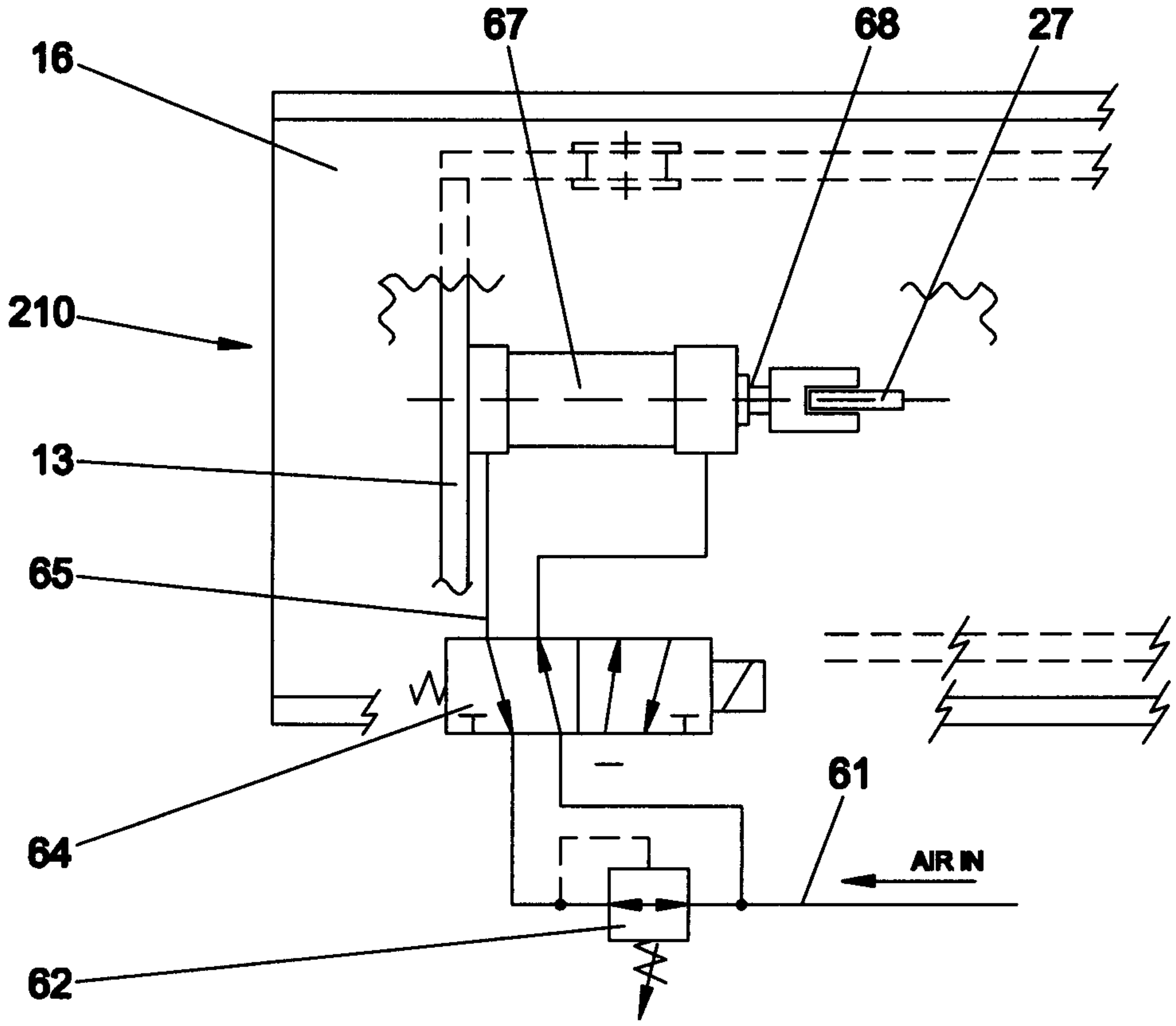

FIG. 4

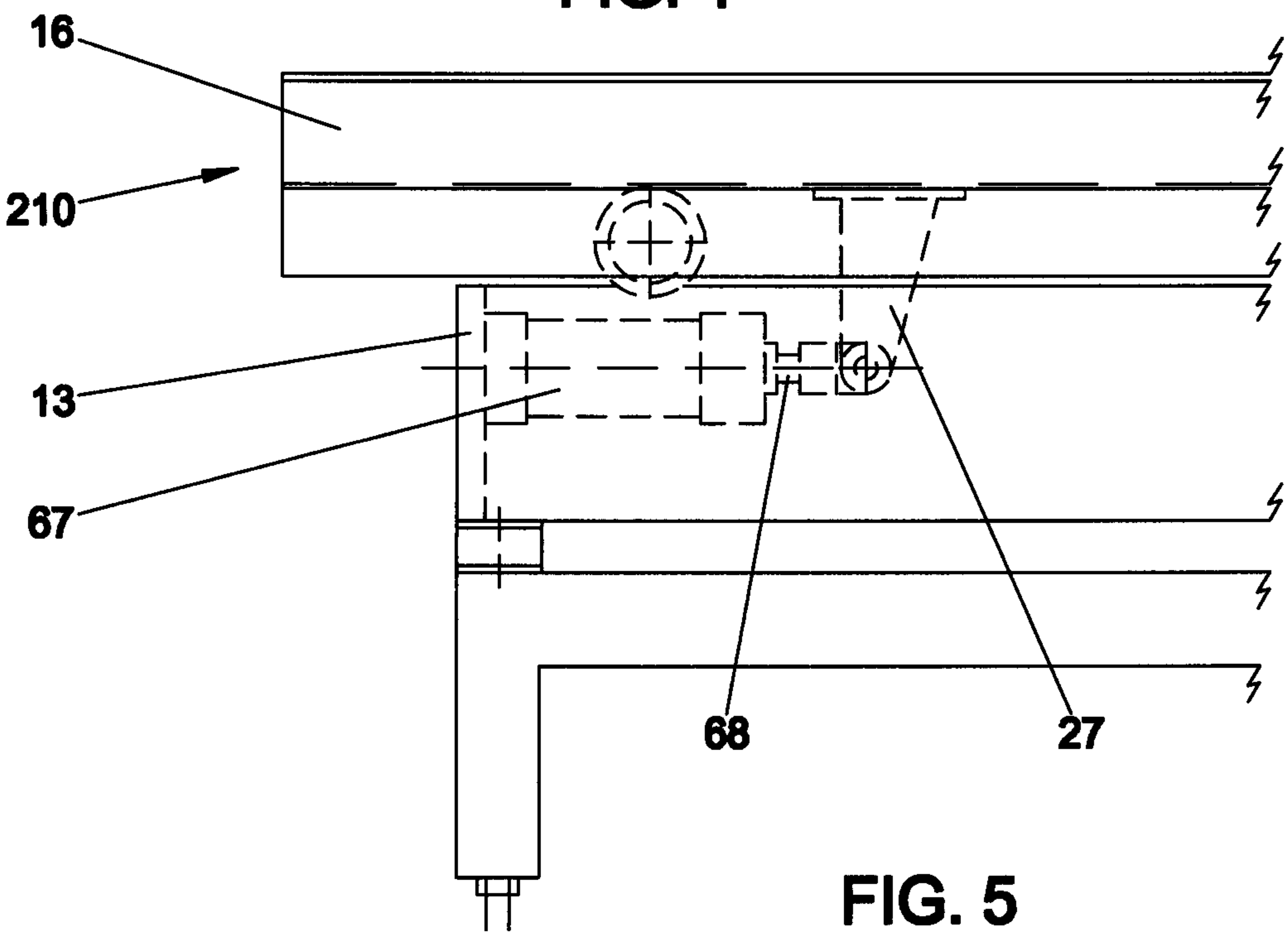

FIG. 5

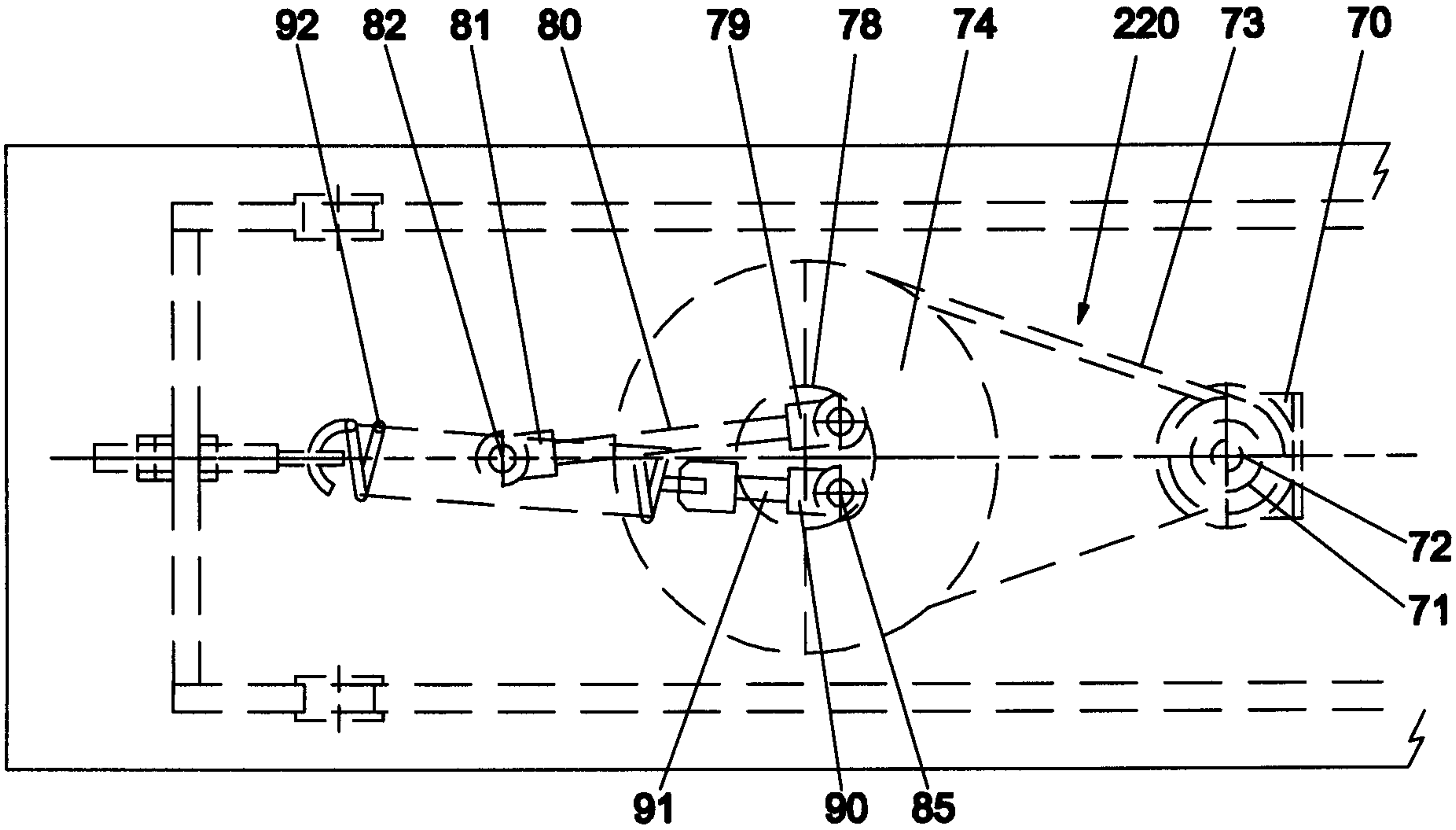
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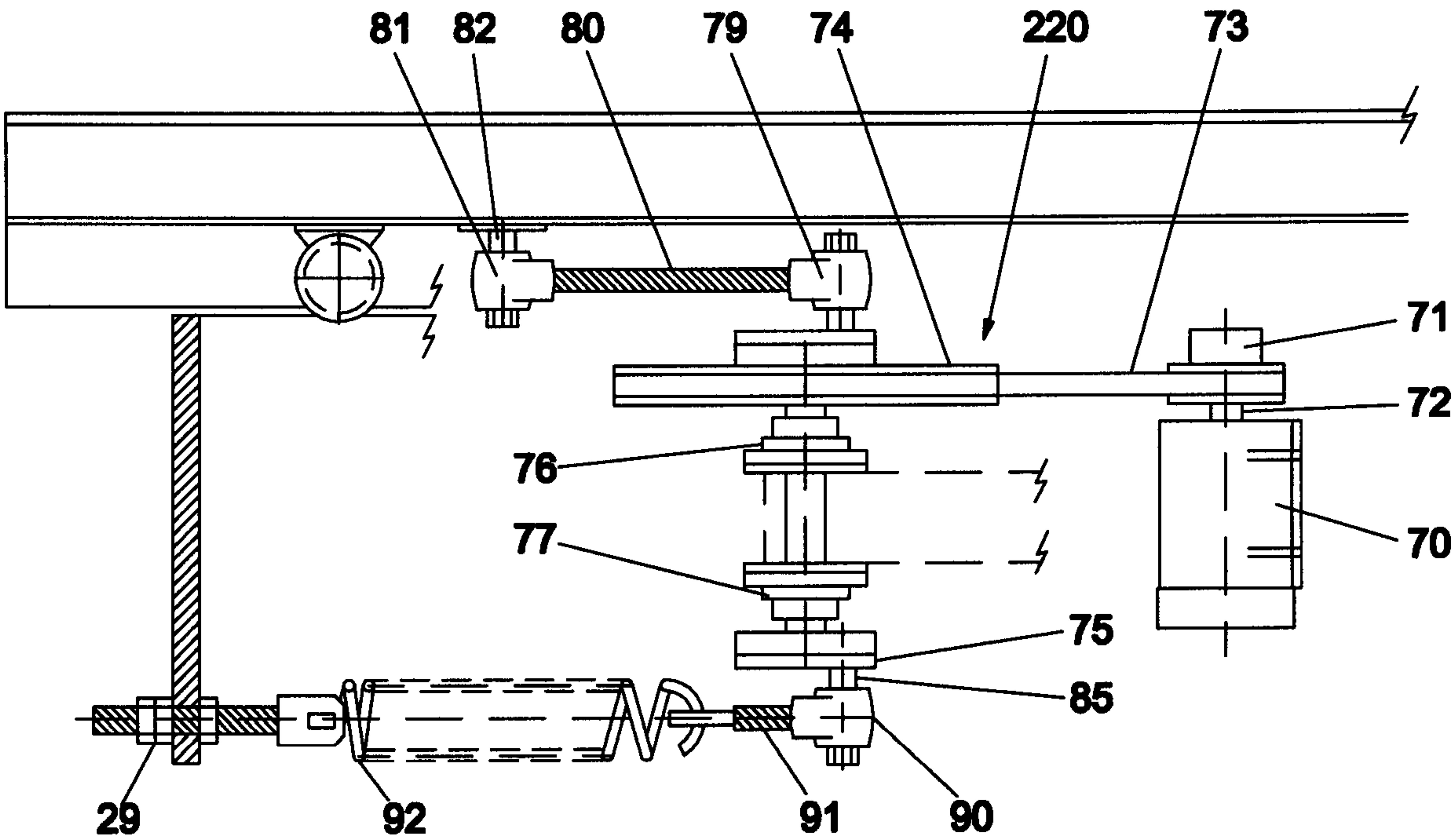
FIG. 6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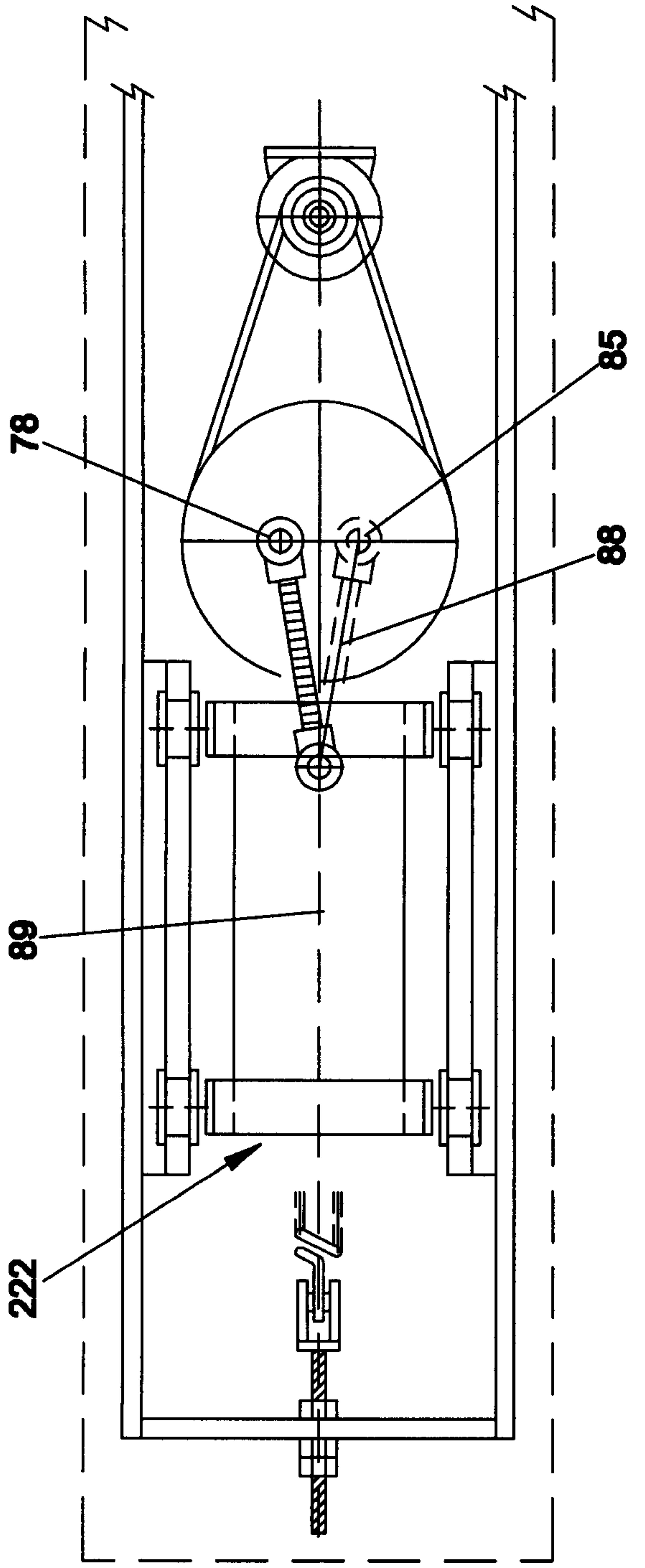

FIG. 9

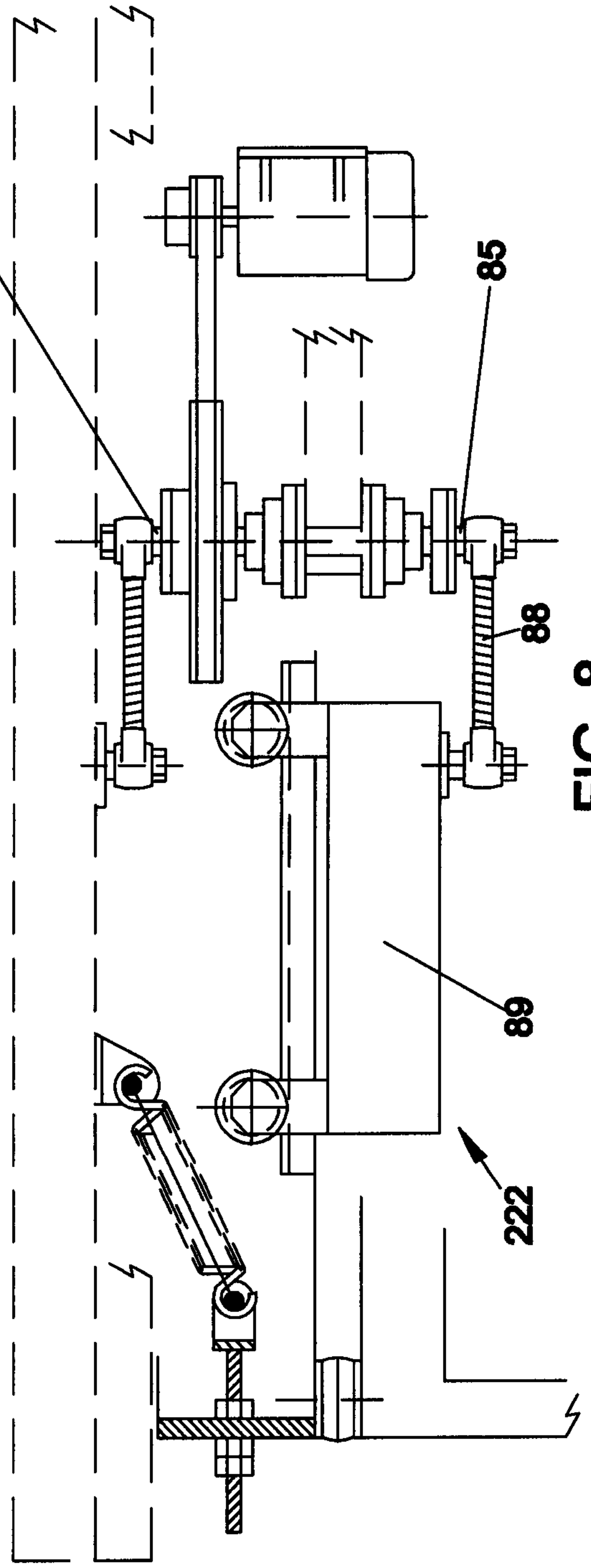

FIG. 8

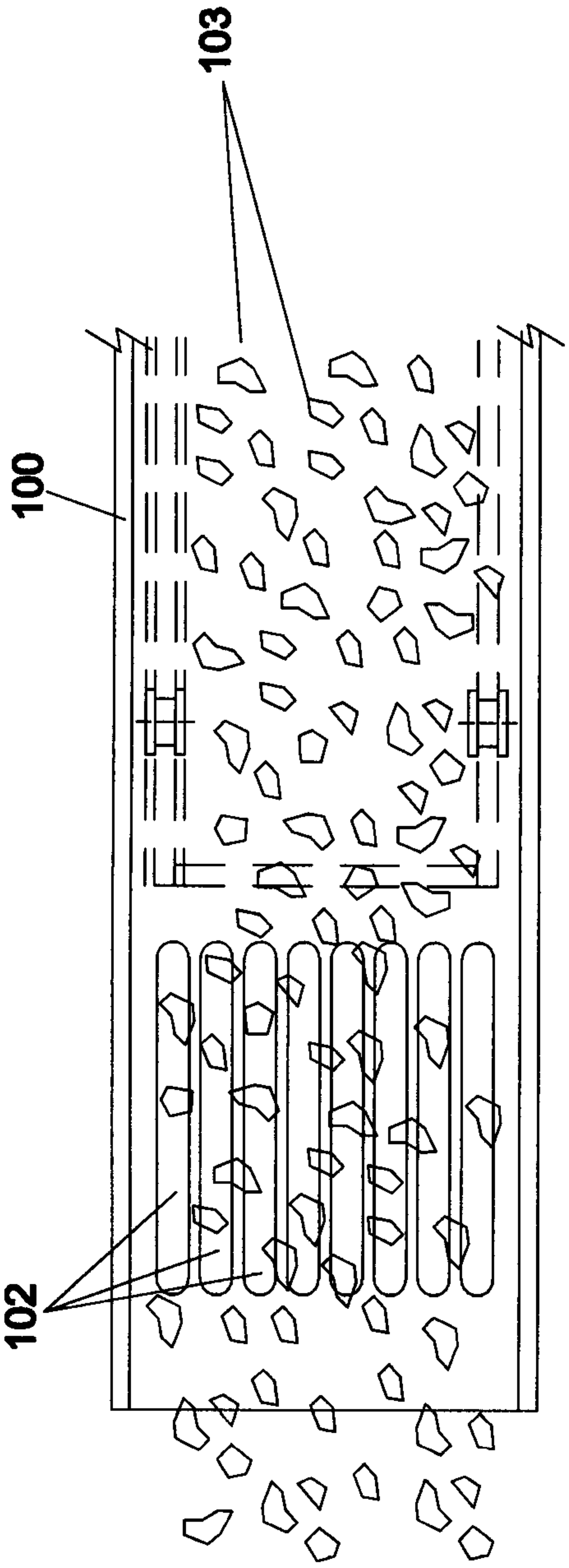

FIG 11

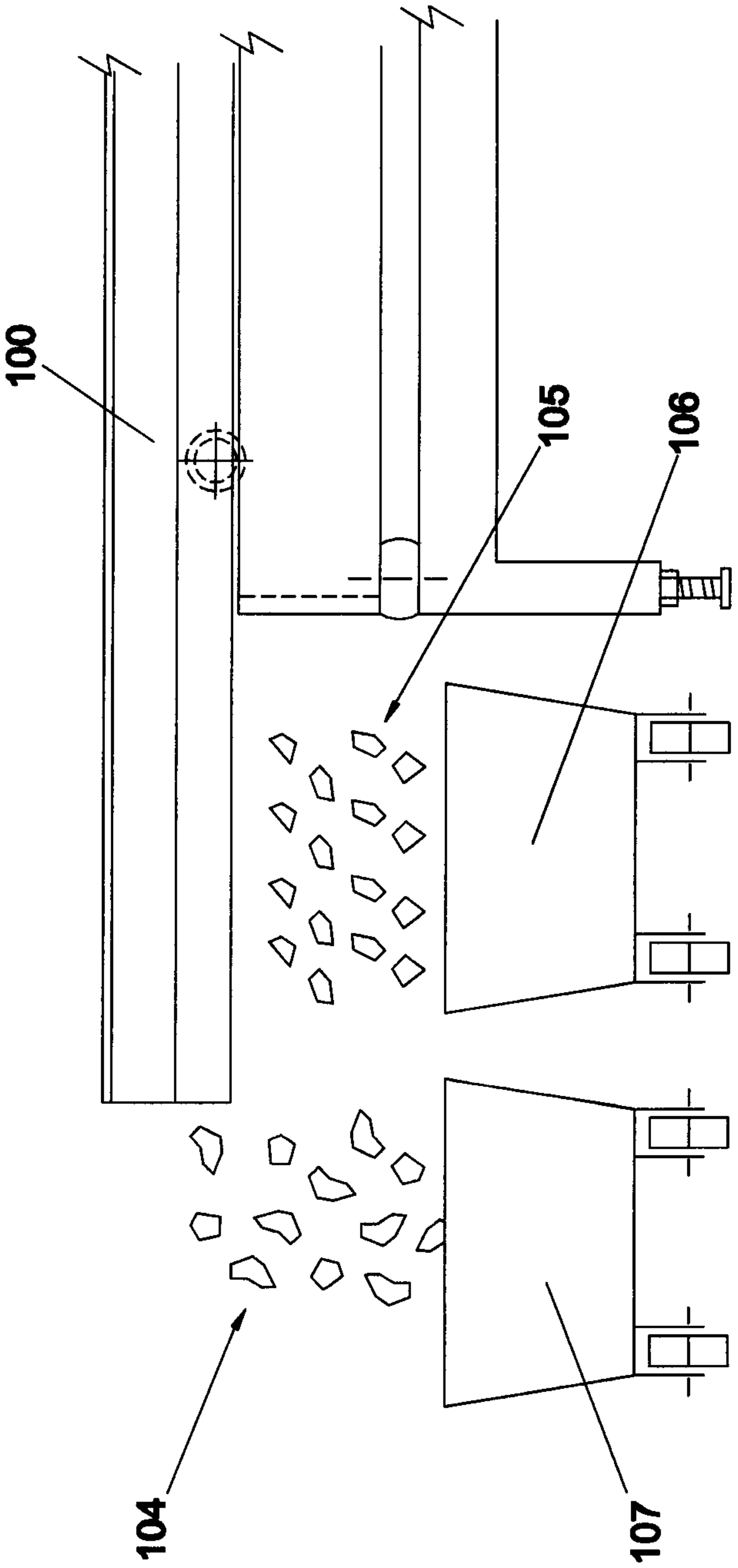

FIG 10

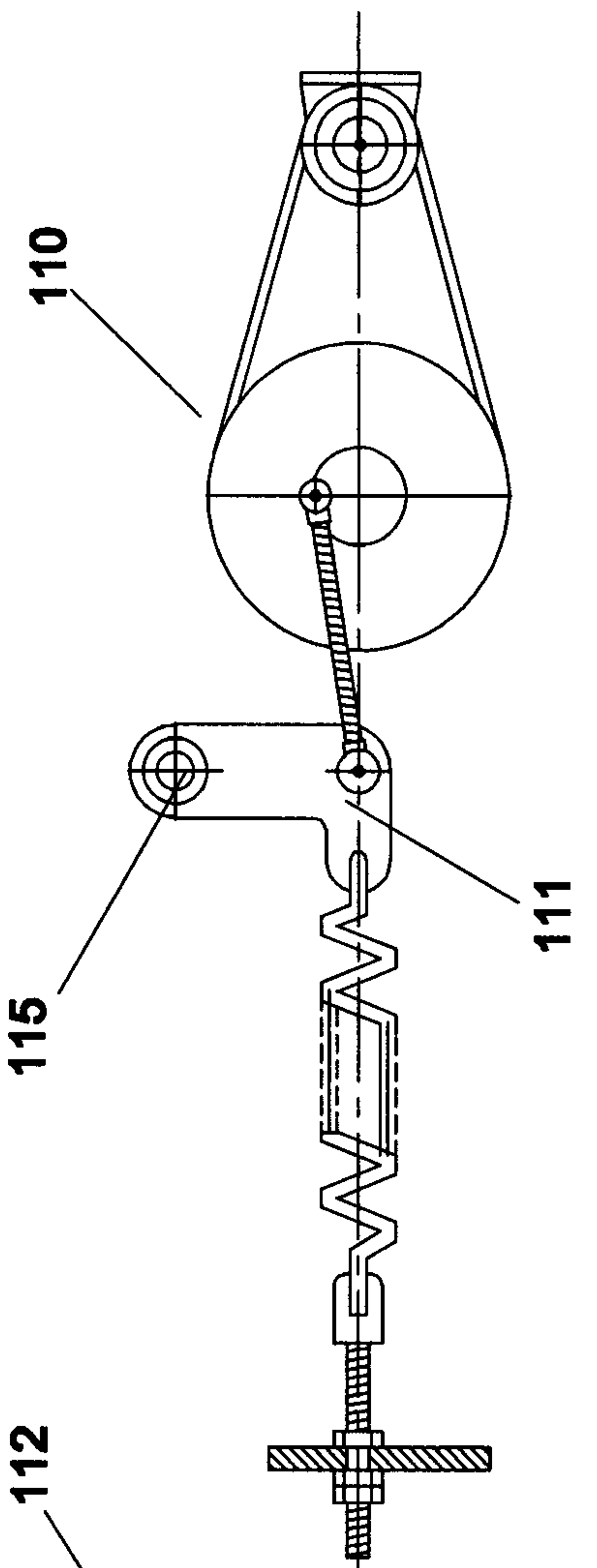

FIG 13

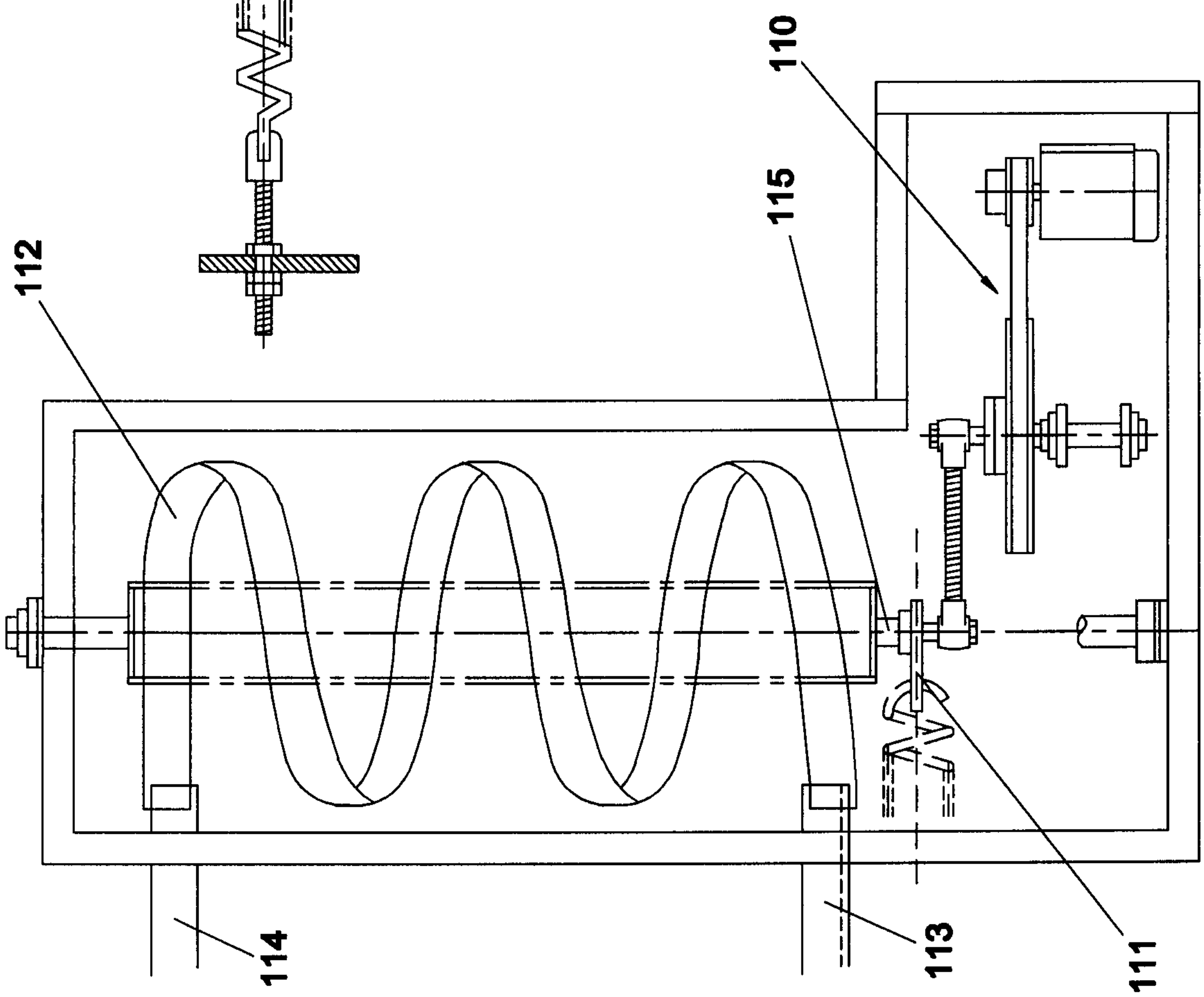

FIG 12


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