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(54) Title: SYSTEM AND METHOD FOR DOSING OF NON-FREE FLOW MATERIALS

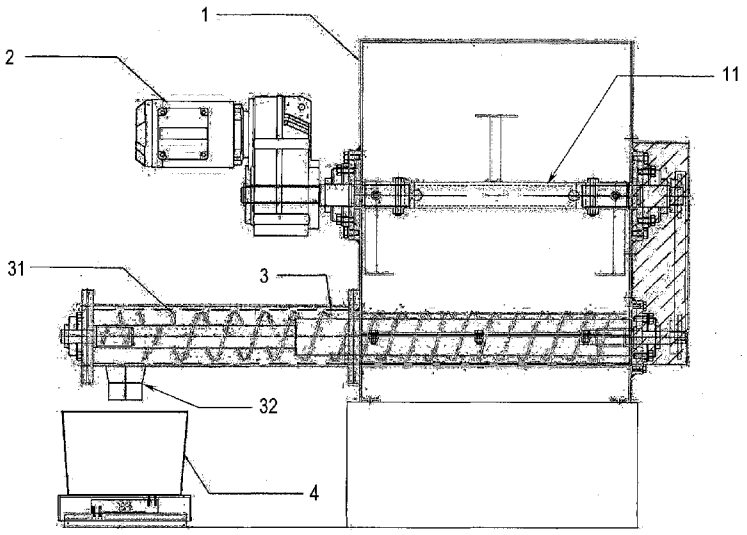

Figure 1

(57) Abstract: In one embodiment, a system for dosing of non-free flow materials comprises a storage hopper that receives the raw material and a regulating spreader associated with the storage hopper. The regulating spreader is associated with a specially configured screw feeder. The screw feeder also comprises a plurality of sections with differing flight configurations that ensures that the overall feed rate and low cycle time can be achieved without compromising on the cut- off accuracy. The fed raw material comes out into a weighing hopper comprising a collection chute, a load cell and a discharge gate. A programmable logic control (PLC) device is coupled to the system, said PLC device is programmed with a unique logic to control the feeding of non-free flow materials. In an alternate embodiment, the system comprises a huge bag handling assembly that is associated with the storage hopper and a flat belt conveyor assembly instead of the screw feeder.

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TITLE OF THE INVENTION: SYSTEM AND METHOD FOR DOSING OF NON-FREE FLOW MATERIALS

FIELD OF THE INVENTION

The present invention relates to a system and method for handling non-free flow materials. Particularly, the present invention relates to a system and method for handling fibres and fibrous composites.

BACKGROUND OF THE INVENTION

Accurate dosing of non-free flow materials such as fibres and fibre composites within a stipulated time is required in several industries such as roofing sheet manufacture, ready mix concrete/plaster, brake lining, and clutch plate industries. Conventionally, such systems comprise either a belt feeder or a screw feeder. Alternately, the required quantity of non-free flow material to be dosed is manually weighed and added by hand. However, the conventional processes of dosing are generally inconsistent and often cause inaccuracy in the mixing ratios, which affects the quality of the end product. Conventional manual process also requires continuous monitoring and therefore is cumbersome and time consuming.

Additionally, normal screw feeders cannot handle certain types of non-free flow materials because they will get jammed. In other cases when the screw feeder can handle such materials, it is difficult to achieve the required accuracy, because of the inherent limitation that the material flow being discharged even at the lowest speed is in larger chunks than the required accuracy.

There is therefore a need in the art for a system and method for dosing of non-free flow materials that overcomes the above mentioned drawbacks and has the below mentioned objectives.

OBJECTIVES OF THE INVENTION

An objective of the present invention is to provide a system and method for dosing of non-free flow materials, that is automated and eliminates errors that occur in the conventional manual process.

Another objective of the present invention is to provide a system and method for dosing of non-free flow materials, that is efficient and results in dosing of non-free flow materials with required accuracy within required time.

Yet another objective of the present invention is to provide a system and method for dosing of non-free flow materials that maintains the mixing ratio accurately and consistently throughout as against conventional methods, and thus yields end products which are of good quality.

SUMMARY OF THE INVENTION

In order to overcome the drawbacks of the prior art and accomplish the above mentioned objectives, a system and method for dosing of non-free flow materials is disclosed. Said system comprises a mechanism for dosing of non-free flow materials that ensures even feeding of required dosage of non-free flow materials in an automated manner and at regulated speeds as per requirement.

In one embodiment, the system comprises a storage hopper that receives the raw material being fed into the system. The storage hopper is in turn associated with a regulating spreader. The regulating spreader is associated with a specially configured screw feeder comprising a continuous flight that goes around the screw feeder in a helical pattern and a fine feeding system comprising a fine feeding plate associated with a feeding mouth. The screw feeder also comprises a plurality of sections with differing flight configurations that ensures that the overall feed rate and low cycle time can be achieved without compromising on the cut- off accuracy. The raw material that is fed into the system comes out through the feeding mouth into a weighing hopper. The weighing hopper comprises a collection chute to collect the feed materials, a load cell for measuring the weight of the fed non-free flow materials and a discharge gate to discharge the non-free flow materials for further processing.

Both the regulating spreader and the screw feeder are driven by a first motor. The first motor is driven by a variable speed drive that runs at varied optimum speeds depending on the quantity of non-free flow materials being fed and the required tolerance level. A programmable logic control (PLC) device is coupled to the system, said PLC device is programmed with a unique logic to control the feeding of non-free flow materials.

In an alternate embodiment, the system comprises a huge bag handling assembly that is associated with the storage hopper and a flat belt conveyor assembly instead of the screw feeder.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the elevated view of an embodiment of the system for dosing of non-free flow materials.

Figure 2 illustrates the top view of an embodiment of the system for dosing of non-free flow materials.

Figure 3 illustrates an embodiment of the specially configured screw feeder of the system for dosing of non-free flow materials.

Figure 4 illustrates the elevated view of an alternate embodiment of the system for dosing of non-free flow materials.

Figure 5 illustrates the side view of an alternate embodiment of the system for dosing of non-free flow materials.

DETAILED DESCRIPTION OF THE DRAWINGS

Throughout this specification, the use of the word "comprise" and variations such as comprises and comprising may the inclusion of element(s) not specifically recited.

As illustrated in Figures 1 and 2, an embodiment of a system for dosing of non-free flow materials comprises a storage hopper (1) that preferably comprises a funnel shaped mouth, which receives the raw material being fed into the system. The storage hopper (1) is in turn associated with a regulating spreader (11). The regulating spreader (11) is associated with a specially configured screw feeder (3) comprising a continuous flight (33) that goes around the screw feeder in a helical pattern and a fine feeding system comprising a fine feeding plate (31) associated with a feeding mouth (32). The regulating spreader (11) ensures that the pitch between the continuous flight (33) inside the screw feeder (3) are filled fully and equally.

As illustrated in Figure 3, an embodiment of the screw feeder (3) comprises a plurality of sections, including a first section (34), a second section (35) and a third section (36), wherein the plurality of sections (34, 35, 36) have different flight configurations. The first section (34) is responsible for taking material from the storage hopper (1) and spreading the material. The second section (35) is configured to spread the material over a longer distance with shorter height, when compared to the first section (34). The third section (36) is configured to split the material in to multiple and smaller quantities. This combination of the plurality of sections (34, 35, 36) with differing flight configurations, ensures that the overall feed rate and low cycle time can be achieved without compromising on the cut- off accuracy. Depending on the material characteristics and the range of set points required, the length of the screw feeder (3) and the ratio between the plurality of sections (34, 35, 36) can be adjusted.

Both the regulating spreader (11) and the screw feeder (3) are driven by a first motor (2). The first motor (2) is driven by a variable speed drive that runs at varied optimum RPM (Rotation per minute) depending on the quantity of non-free flow materials being fed and the required tolerance level. Also, the variable speed drive enables the first motor (2) to operate in a plurality of modes as per requirement wherein one mode differs from another with respect to the amount of material delivered per unit time. Preferably, there are three modes- coarse mode, normal fine mode and super fine mode. Alternatively, the speed of the first motor (2) can also be continuously regulated with an analogue reference.

A programmable logic control (PLC) (Not shown) device is coupled to the system. The PLC device is associated with a plurality of relays, a high accuracy weight indicator and an ac

drive (an electronic system that receives digital commands from the PLC and controls / varies the speed of the motor). The PLC device is programmed with a unique logic to control the feeding of non-free flow materials at variable speeds.

The raw material that is fed into the system comes out through the feeding mouth (32) into a weighing hopper (4). The weighing hopper (4) comprises a collection chute to collect the feed materials, a load cell for measuring the weight of the fed non-free flow materials and a discharge gate to discharge the non-free flow materials for further processing.

When the weighing hopper (4) reaches close to a set point that has been programmed in the PLC , the system switches mode of operation to fine mode and reduces the speed of the screw feeder (3) and the regulating spreader (11). For example, if the set point is 300 grams and the material to be processed is fibrous composites, the speed controller has an ability to deliver 250 grams in 15 seconds (coarse), 40 grams in 5 seconds (fine) and 10 grams in 10 seconds (super fine) to cut-off with +/-2 grams accuracy.

A method for dosing of non-free flow materials using the disclosed system comprises the following steps-

a. setting the required level for each batch through an operator interface module;
b. feeding the non-free flow materials to the storage hopper (1);
c. driving the regulating spreader (11) associated with the storage hopper (1) to enable regulated feed of materials from the storage hopper (1) to the specially configured screw feeder (3);
d. collecting the materials received through the feeding mouth (32) in the weighing hopper (4);
e. collecting the materials received through the weighing hopper (4) in the collection chute;
f. measuring the weight of materials collected in the collection chute by the load cell; and
g. discharging the measured materials by the discharge gate for further processing.

The operator interface module is preferably a computer or a man machine interface. Typically, the system is able to deliver approximately +/- of 2 grams or better when 200 grams of non-free flow materials are fed into it; the complete process takes only 30 seconds per batch.

In an alternate embodiment, when large quantities of input material are to be handled, the disclosed system comprises a huge bag handling assembly that is associated with the storage hopper (1) and a flat belt conveyor assembly. (Figures 4 and 5) The huge bag handling assembly comprises a huge bag handling device (12) comprising a bag shaking and poking device to facilitate uniform feeding of non-free flow materials into the storage hopper (1) and a plurality of pneumatic cylinders (121) connected to the huge bag handling device (12). Preferably, there are three pneumatic cylinders.

The flat belt conveyor assembly comprises a flat belt conveyor (5) and a special feeding spreader (51). The storage hopper (1) is associated with the flat belt conveyor (5) and the regulating spreader (11). The regulating spreader (11) is fixed on the flat belt conveyor (5) to enable regulated feed of materials from the storage hopper (1) to the flat belt conveyor (5). Both the regulating spreader (11) and the flat belt conveyor (5) are driven by the first motor (2).

As disclosed above, the first motor (2) is driven by a variable speed drive that runs at varied optimum RPM (Rotation per minute) depending on the quantity of non-free flow materials being fed and the required tolerance level. Also, the variable speed drive enables the first motor (2) to operate in operate in a plurality of modes as per requirement wherein one mode differs from another with respect to the amount of material delivered per unit time. Preferably, there are three modes- coarse mode, normal fine mode and super fine mode. Alternatively, the speed of the first motor (2) can also be continuously regulated with an analogue reference.

Further, the alternate embodiment also comprises the programmable logic control (PLC) device (as disclosed above) that is coupled to the system. The PLC device is associated with the plurality of relays, the high accuracy weight indicator and the ac drive (an electronic

system that receives digital commands from the PLC and controls / varies the speed of the motor). The PLC device is programmed with a unique logic to control the feeding of non-free flow materials at variable speeds.

The alternate embodiment also comprises a special feeding spreader (51), said special feeding spreader (51) being driven by a second motor (511) wherein the second motor (511) operates at different speeds, which controls the supply of the feed materials from the flat belt conveyor (5) to the weighing hopper (4). During operation of the system in super fine mode, the flat belt conveyor (5) stops running and the special spreader (51) facilitates discharge of the material in very small chunks, into the weighing hopper (4). Thus, it is clear that the flat belt conveyor (5) stops running when the operation mode of the first motor (2) delivers the least amount of material per unit time among the plurality of modes.

Thus, the alternate embodiment differs from the first embodiment in that:

a. a huge bag handling assembly is associated with the storage hopper (1), said huge bag handling assembly comprising a huge bag handling device (12) comprising a bag shaking and poking device to facilitate uniform feeding of non-free flow materials into the storage hopper (1) and a plurality of pneumatic cylinders (121) connected to the huge bag handling device (12);

b. a flat belt conveyor assembly replaces the screw feeder (3), said flat belt conveyor assembly comprising a flat belt conveyor (5) that is connected to the storage hopper (1) and a special feeding spreader (51) that is present at a first end of the flat belt conveyor (5), said special feeding spreader (51) being driven by a second motor (511) wherein the second motor (511) operates at different speeds;

c. the regulating spreader (11) is fixed on the flat belt conveyor (5); and

d. the first motor (2) drives the flat belt conveyor (5) and the regulating spreader (11).

The plurality of pneumatic cylinders (121) may be made of any metal or metal alloy. Preferably the metal or metal alloy comprises stainless steel. The flat belt conveyor (5) may be made of rubber, polyester, nylon or other similar materials. Preferably, the flat belt conveyor (5) is made of rubber. An accuracy of +/- of 40 grams or better can be typically

achieved using the alternate embodiment, when 3 kgs are fed into the system, the complete process takes 70 seconds per batch in this case.

An alternate method for dosing of non-free flow materials using the alternate embodiment of the disclosed system comprises the following steps:

a. setting the required level for each batch through an operator interface module;
b. feeding the non-free flow materials present in huge bags to the huge bag handling device (12) comprising the bag shaking and poking device;
c. shaking and poking the huge bags by the bag shaking and poking device to empty the contents of the huge bags into the storage hopper (1);
d. driving the regulating spreader (11) that is fixed on the flat belt conveyor (5) to enable regulated feed of materials from the storage hopper (1) to the flat belt conveyor (5);
e. driving the special feeding spreader (51) by a second motor (511) to enable regulated feed of materials from the flat belt conveyor (5) to the weighing hopper (4);
f. collecting the materials received through the weighing hopper (4) in the collection chute;
g. measuring the weight of materials collected in the collection chute by the load cell; and
h. discharging the measured materials by the discharge gate for further processing.

Though the disclosed embodiments of the system can be used for dosing of any non-free flow material, it is preferred that the system is used for dosing of fibres and fibrous composites. The embodiments of the disclosed system can be used in any industry where accurate dosing of non-free flow materials is required, with the input being fed in jumbo bags or in minute quantities, such as, but not restricted to roofing sheet manufacture, ready mix concrete/plaster, brake lining, and clutch plate industries. Preferably, the power supply required to operate the variable speed drive is 440 V (three-phase) and 0.75 kW. The preferred operating speed range for the variable speed drive is 15% to 100% of the speed of the motor (preferred speed of the first motor (2) is 1440 RPM). The high accuracy weight indicator is preferably a LED or LCD display. The LED or LCD display may be of any colour available in the market.

While the use of the specially configured screw feeder has been illustrated using dosing of non-free flow materials, the screw feeder can be used for other similar applications as well. Wherever low cycle time and high cut off accuracy have to be combined, which cannot be achieved with a conventional screw feeder.

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It will be apparent to a person skilled in the art that the above description is for illustrative purposes only and should not be considered as limiting. Various modifications, additions, alterations, and improvements without deviating from the spirit and the scope of the invention may be made by a person skilled in the art.

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LIST OF REFERENCE NUMERALS

1 - Storage Hopper
11 - Regulating Spreader
12 - Huge Bag Handling device
121 - Plurality of Pneumatic Cylinders
2 - First Motor for regulating spreader and screw feeder/ flat belt conveyor
3 - Screw feeder
31 - Fine feeding plate
32 - Feeding mouth
33 - Continuous flight
34 - First section
35 - Second section
36 - Third section
4 - Weighing hopper
5 - Flat Belt Conveyor
51 - Special feeding spreader
511 - Second Motor for special feeding spreader

We claim:

1. A system for dosing of non-free flow materials, comprising:

a). a storage hopper (1) that receives the raw material being fed into the system, wherein the storage hopper (1) is associated with a regulating spreader (11);

b). a specially configured screw feeder (3) associated with the regulating spreader (11), wherein the screw feeder (3) comprises a continuous flight (33) that goes around the screw feeder (3) in a helical pattern, a fine feeding system comprising a fine feeding plate (31) associated with a feeding mouth (32) and a plurality of sections, including a first section (34), a second section (35) and a third section (36) with differing flight configurations that ensure the overall feed rate and low cycle time can be achieved without compromising on the cut- off accuracy, wherein :

i. the first section (34) takes the raw material from the storage hopper (1) and spreads the material;
ii. the second section (35) is configured to spread the material over a longer distance with shorter height, when compared to the first section (34); and
iii. the third section (36) is configured to split the material in to multiple and smaller quantities;

c). a first motor (2) that drives the screw feeder (3) and the regulating spreader (11), said motor (2) being regulated with a variable speed drive or an analogue reference and capable of operating in a plurality of modes as per requirement, wherein one mode differs from another with respect to the amount of material delivered per unit time;

d). a weighing hopper (4) that receives the raw material coming out of the feeding mouth (32), said weighing hopper comprising:

i. a collection chute to collect the non-free flow materials being fed;
ii. a load cell for measuring the weight of the fed non-free flow materials; and
iii. a discharge gate to discharge the non-free flow materials; and

e). a programmable logic control (PLC) device coupled to the system that enables an operator to set the required level for each batch through an operator interface module, wherein said PLC device is connected to a high accuracy weight indicator and to a plurality of relays.

2. A method for dosing of non-free flow materials using a system as claimed in claim 1, comprising the steps of:

a. setting the required level for each batch through an operator interface module;
b. feeding the non-free flow materials to the storage hopper (1);
c. driving the regulating spreader (11) associated with the storage hopper (1) to enable regulated feed of materials from the storage hopper (1) to the specially configured screw feeder (3);
d. collecting the materials received through the feeding mouth (32) in the weighing hopper (4),;
e. collecting the materials received through the weighing hopper (4) in the collection chute;
f. measuring the weight of materials collected in the collection chute by the load cell ; and
g. discharging the measured materials by the discharge gate for further processing.

3. A system for dosing of non-free flow materials, comprising:

(a) a huge bag handling assembly comprising a huge bag handling device (12) and a plurality of pneumatic cylinders (121), wherein the huge bag handling device (12) comprises a bag shaking and poking device to facilitate uniform feeding of non-free flow materials;
(b) the storage hopper (1) associated with the huge bag handling device (1);
(c) a flat belt conveyor assembly comprising a flat belt conveyor (5) and a special feeding spreader (51), wherein:
i. the flat belt conveyor (5) is associated with the storage hopper (3) and is driven by the first motor (2) being regulated with a variable speed drive or an analogue reference and capable of operating in a plurality of modes;

ii. the flat belt conveyor (5) stops running when the operation mode of the first motor (2) delivers the least amount of material per unit time among the plurality of modes,

iii. the regulating spreader (11) is fixed on the flat belt conveyor (5) to enable regulated feed of materials from the storage hopper (1) to the flat belt conveyor (5), said regulating spreader also being driven by the first motor (2);

iv. the special feeding spreader (51) is present at a first end of the flat belt conveyor (5), said special feeding spreader (51) being driven by a second motor (511), wherein the second motor (511) operates at different speeds to control the supply of the feed materials from the flat belt conveyor (5) to the weighing hopper (4) and the special feeding spreader (51) facilitates discharge of the material in very small chunks into the weighing hopper (4) when the operation mode of the first motor (2) delivers the least amount of material per unit time among the plurality of modes;

(d) the weighing hopper (4) is connected to the special feeding spreader (51), said weighing hopper (4) comprising:

i. a collection chute to collect the non-free flow materials being fed;

ii. a load cell for measuring the weight of the fed non-free flow materials; and

iii. a discharge gate to discharge the non-free flow materials; and

(e) the programmable logic control (PLC) device coupled to the system that enables an operator to set the required level for each batch through an operator interface module, wherein said PLC device is connected to the high accuracy weight indicator and to the plurality of relays.

4. A method for dosing of non-free flow materials using a system as claimed in claim 3, wherein:

a. setting the required level for each batch through an operator interface module;

b. feeding the non-free flow materials present in huge bags to the huge bag handling device (12) comprising the bag shaking and poking device;

c. shaking and poking the huge bags by the bag shaking and poking device to empty the contents of the huge bags into the storage hopper (1);
d. driving the regulating spreader (11) that is fixed on the flat belt conveyor (5) to enable regulated feed of materials from the storage hopper (1) to the flat belt conveyor (5);
e. driving the special feeding spreader (51) by the second motor (511) to enable regulated feed of materials from the flat belt conveyor (5) to the weighing hopper (4);
f. collecting the materials received through the weighing hopper (4) in the collection chute);
g. measuring the weight of materials collected in the collection chute by the load cell; and
h. discharging the measured materials by the discharge gate for further processing.

5. A system for dosing of non-free flow materials as claimed in claim 1 or claim 3, wherein the non-free flow materials are fibres or fibre composites.

6. A system for dosing of non-free flow materials as claimed in claim 1 or claim 3, wherein the high accuracy weight indicator is a LCD display or a LED display.

7. A system for dosing of non-free flow materials as claimed in claim 1 or claim 3, wherein the operator interface module is a computer or a man machine interface.

8. A system for dosing of non-free flow materials as claimed in claim 1 or claim 3, wherein the first motor (2) is capable of operating in coarse mode, fine mode and super fine mode.

9. A system for dosing of non-free flow materials as claimed in claim 1 or claim 3, wherein the storage hopper (1) comprises a funnel shaped mouth.

10. A system for dosing of non-free flow materials as claimed in claim 3, wherein there are three pneumatic cylinders (121).

11. A system for dosing of non-free flow materials as claimed in claim 3, wherein the plurality of pneumatic cylinders (121) are made of any metal or metal alloy.

12. A system for dosing of non-free flow materials as claimed in claim 3, wherein the flat belt conveyor (5) is made of rubber, polyester or nylon.

13. A method for dosing of non-free flow materials as claimed in claim 2 or claim 4, wherein the non-free flow materials are fibres or fibre composites.

14. A method for dosing of non-free flow materials as claimed in claim 2 or claim 4, wherein the operator interface module is a computer or a man machine interface.

15. A method for dosing of non-free flow materials as claimed in claim 2 or claim 4, wherein the storage hopper (1) comprises a funnel shaped mouth.

16. A method for dosing of non-free flow materials as claimed in claim 4, wherein the flat belt conveyor (5) is made of nylon, polyester or rubber.

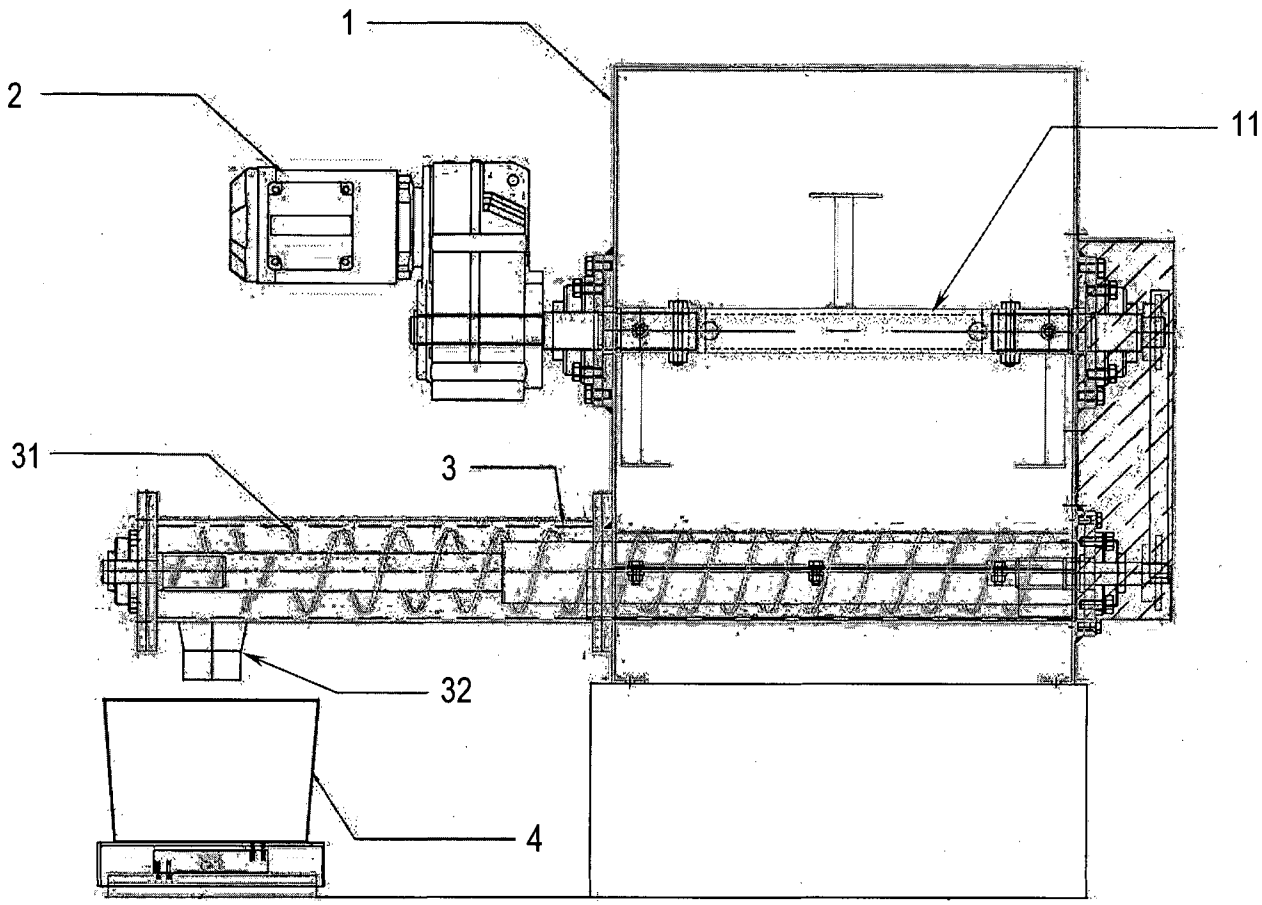

Figure 1

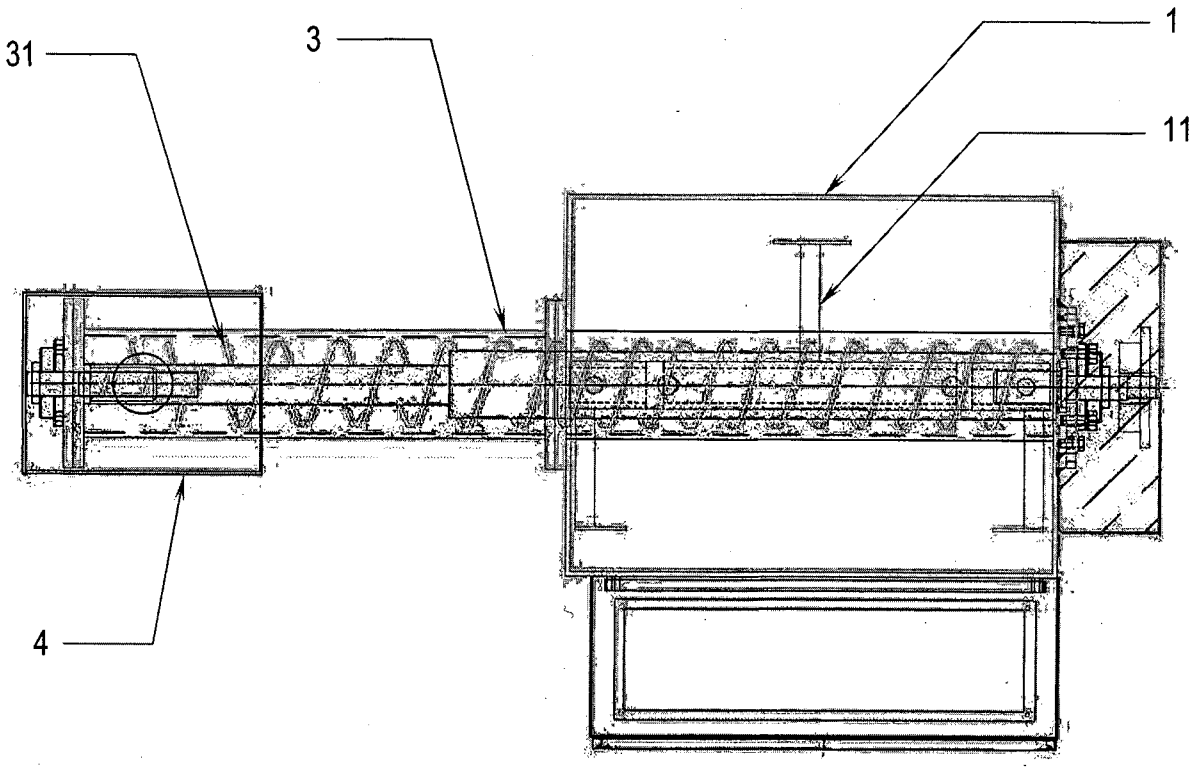

Figure 2

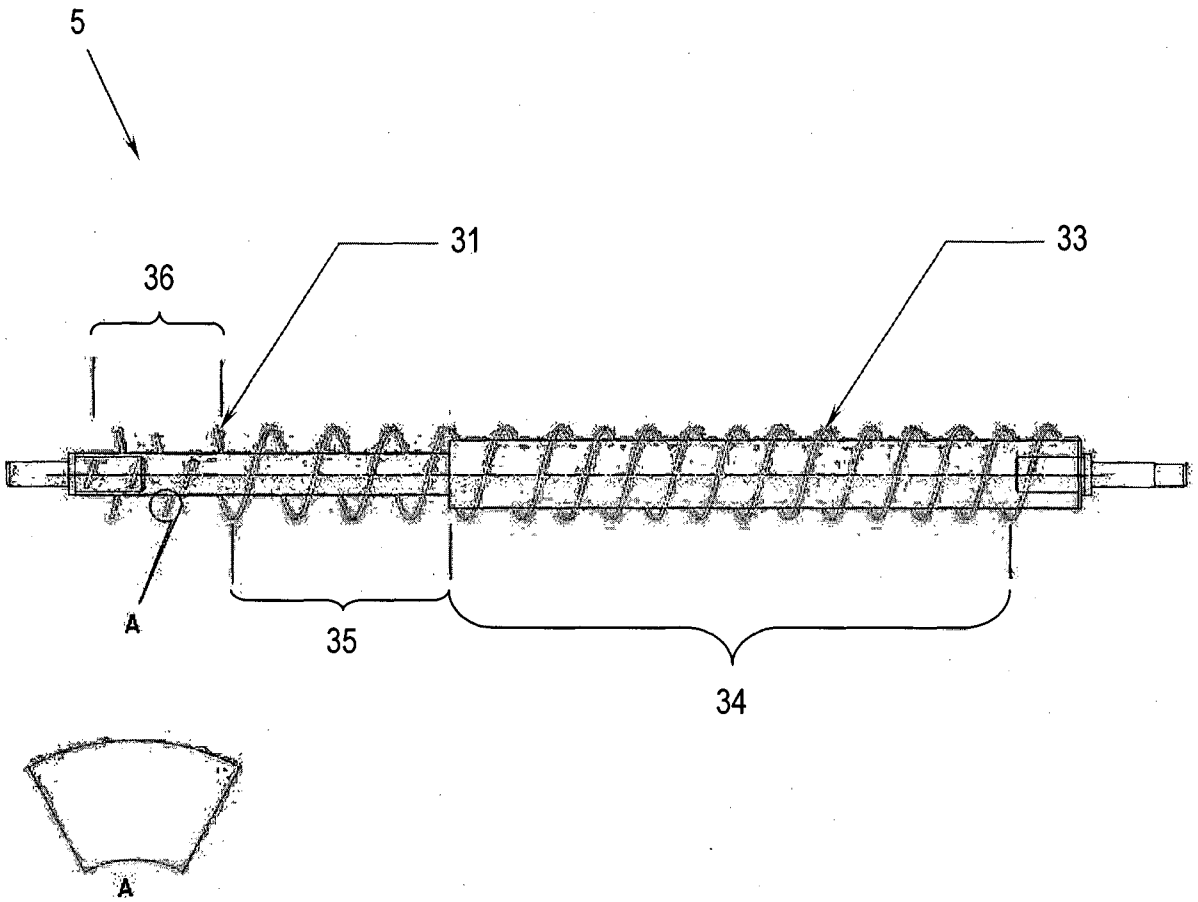

Figure 3

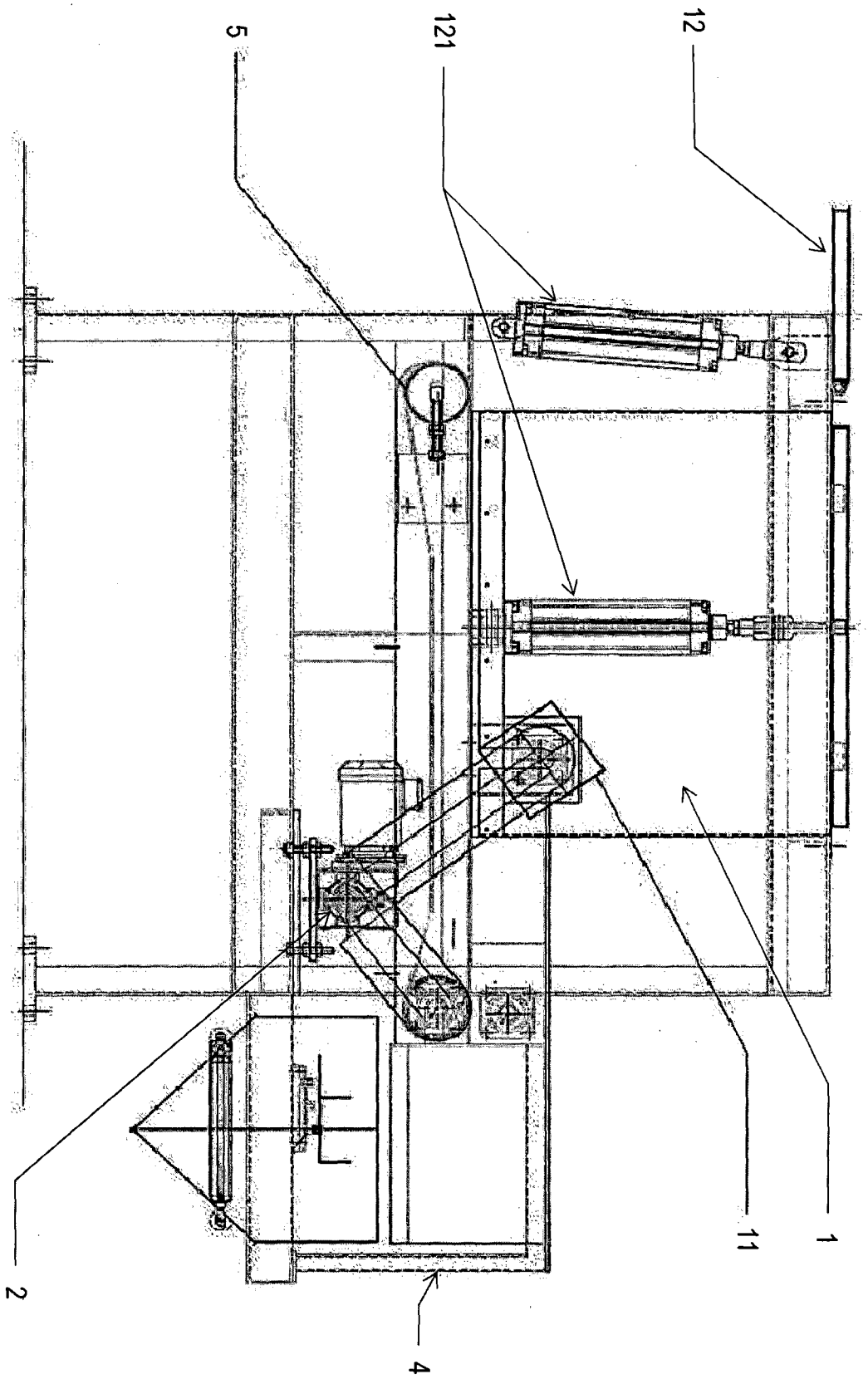

Figure 4

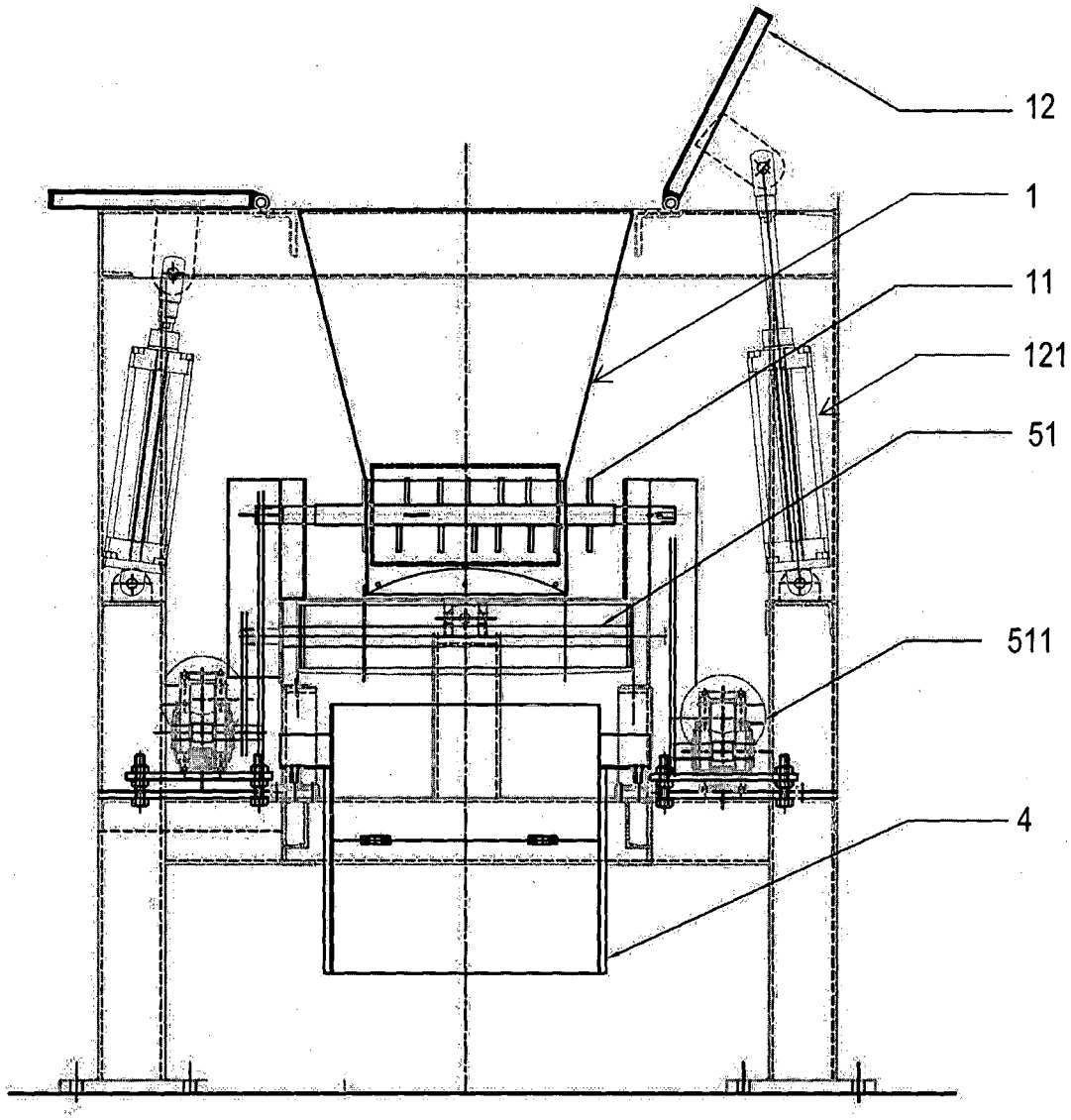

Figure 5