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(71) Applicant: **Moretto S.P.A.**
35010 Massanzago, PD (IT)

(72) Inventors:
- **Moretto, Renato**
  35010 Massanzago
  Padova (IT)
- **Critelli, Federico**
  35010 Vigonza
  Padova (IT)

(74) Representative: **Reniero, Cirillo Silvano**
c/o Dr.Reniero & Associati S.r.l.
Via D. Manin, 5
37122 Verona (IT)

(54) **Device and plant for removing dust from granular materials**

(57) The present invention relates to a dust removing device for granular material comprising: a casing (2) delimiting a supply chamber (3) arranged to feed granular material to be freed from dust, and being formed with an input opening (3a); a dust removing chamber (4) designed to remove dust from the granular material and in fluid communication with the supply chamber (3); a disposing chamber (5) for granular material freed from dust formed with an output opening (5a), thereby allowing an uninterrupted flow of granular material to be freed from dust to occur between the supply chamber (3) and the disposing chamber (5); a pressurized washing air supply opening (5b); and a washing air discharging duct (14); a source (12) of pressurized air; a delivery duct (13) between the pressurized air source (12) and the pressurized air supply opening (5b); a return piping (17) between the washing air discharging duct (14) and the washing air source (12); one or more filters (16) in the return piping; and fluidifying fluid (6) for the granular material to be freed from dust located in the dust removing chamber (5), and conveying and dosing arrangment (11, 11a) designed to convey and meter the granular material to be freed from dust and located between the supply chamber (3) and the dust removing chamber (5).

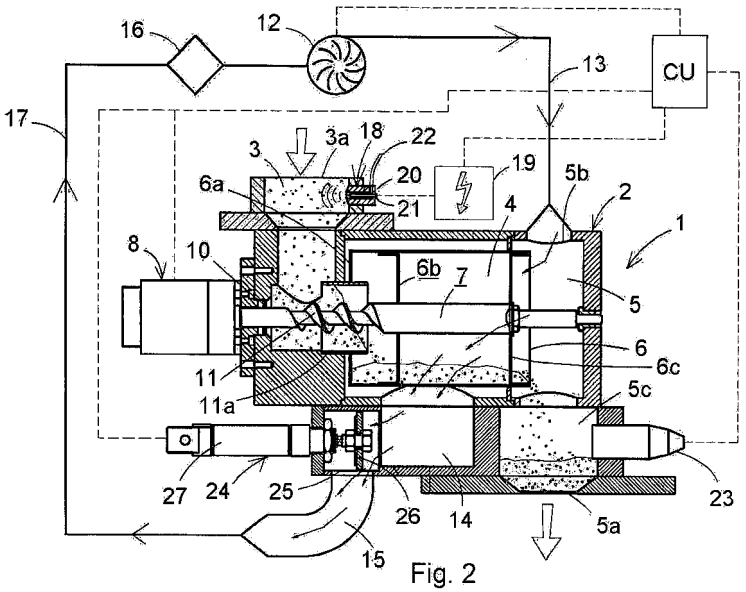

Fig. 2

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Description

[0001] The present invention relates to a device and a plant for removing contaminating agents, typically dust, from granular materials, particularly from granular plastics materials.

[0002] In the field of the transformation processing of plastics materials, the raw material is usually in the form of granules, this being the most suitable shape for transport and storage in containers of different dimensions, e. g. silos and hoppers, as well as for any transformation processing at each processing step such as dehumidification and blending processes that precede moulding in an injection press.

[0003] Typically, the granular plastics material is stored in sacks of about 25 liters in the case of relatively small amounts, or in sacks of about 1000 liters or in silos when dealing with large quantities. Form the storage place the granular plastic material is withdrawn, generally, by means of conventional pneumatic conveyor systems to be supplied to suitable processing or transforming machines, such as injection presses and/or extruders.

[0004] During transport from the storage place to a transforming machine, the granular material is subject to the risk of being contaminated by various foreign agents.

[0005] In the first place, granules of plastics material can mix with dust and/or other contaminating agents almost permanently present in a working environment with consequent risk of the granular material, and thus the moulded objects obtained therefrom, becoming contaminated, such a contamination often resulting in the mounded material becoming deteriorate in its chemical-physical properties.

[0006] Moreover, during handling of the material, the granular plastics material may be subject to substantial heat and mechanical stress, e. g. owing to friction while being pneumatically conveyed, which can result in particles in the form of dust granules being detached, which are added to the amount of dust already present in the mass of granular material. Dust particles thus formed are, so to speak, a "deteriorated" form of the polymer material, i. e. their chemical-physical properties, e. g. its softening temperature, its viscosity and the like, are often quite different from those of the plastics material from which they were originated. Useless to say that the presence of said dust particles in the final moulded product is undesirable, since it affects the technical characteristics thereof.

[0007] The problem due to the presence of contaminating dust particles in the granular plastics materials becomes then particularly serious when moulded objects or products with high purity characteristics are to be obtained, i. e. products in which no manufacturing faults or flaws are to be found, such as for example in medical devices, or products with optical features, e. g. lenses or lamps.

[0008] Several systems for removing contaminating dust from granular materials, termed "dust removers" have been proposed in the past and are currently available on the market, which are usually installed upstream of a transforming machine.

[0009] Said dust removers are a component of a dust removing plant and consist of one or more inclined grids onto which a granular material to be treated, i. e. from which any dust particles are to removed, is caused to fall by gravity. Due to impact against the grid or grids, any dust particles part from the granular material, and are then kept floating and moved away from the granular material by means of a flow rate of so called washing air blown through the grids. The washing-air flow rate, loaded with dust particles, is then filtered to be possibly recycled back into the dust removing plant, whereas the dust particles thus separated from the washing air are gathered in a suitable container.

[0010] In order to make the dust removal of a granular material easier, an electric charge unloading apparatus is sometimes provided upstream of the dust removing plant, whose function is that of destroying or weakening any electrical binding force between dust particles and granules of plastics material.

[0011] Traditional dust removing plants, although satisfactory from some points of view, are affected by a number of serious disadvantages.

[0012] First of all, they are essentially static devices, and thus they require an additional control system of the supplied granular material flow rate, in order to avoid obstructions caused by excessive accumulation of granules to be fed onto the fixed grids, which would result in a reduction in the decontamination or dust removing efficiency.

[0013] Moreover, as stated above, the granular plastics material to be decontaminated is caused to drop onto a plurality of grids, tipically two or three grids, and thus the air flow rate designed to float and drawing away any contamination dust particles flows through a plurality of static throttling elements, with consequent relevant losses of pressure. These dust removing plants then require a large input air flow rate with consequent higher energy consumption.

[0014] There is, therefore, the need of a dust removing plant suitable for eliminating or drastically reducing the disadvantages mentioned above in connection with the state of the art.

[0015] The main object of the present invention is to provide a dust removing plant of a dynamic type which is suitable for fluidifying the granular material to be removed thereby assisting in promoting collisions between granules, and thus the separation form granules of any contaminating agents in the form of dust.

[0016] Another object of the present invention is to provide a dust removing plant which includes a dosing system for dosing granular material to be decontaminated from dust in order to obtain a constant and controlled output flow rate of material free from dust.

[0017] A further object of the present invention is to

provide a dust removing plant including a plurality of dust removing devices, as well as a method of controlled supply of washing air to said devices.

[0018] Not least object of the present invention is to provide a dust removing plant that can be manufactured at competitive costs, simple to install also in connection with pre-existing conveying and processing plants for plastics materials.

[0019] According to a first aspect of the present invention, a dust removing device for granular material is provided, which comprises:

- a casing delimiting a supply chamber arranged to feed granular material to be freed from dust, and being formed with an input opening; a dust removing chamber designed to remove dust from the granular material and in fluid communication with said supply chamber; a disposing chamber for granular material freed from dust formed with an output opening, thereby allowing an uninterrupted flow of granular material to be freed from dust to occur between said supply chamber and said disposing chamber; a pressurized washing air supply opening; and a washing air discharging duct;
- a source of pressurized air;
- a delivery duct between said pressurized air source and said pressurized air supply opening;
- a return piping between said washing air discharging duct and said washing air source; and
- filtering means in said return piping,

the dust removing device further comprising fluidifying means for the granular material to be freed from dust located in the dust removing chamber, and conveying and dosing means designed to convey and meter the granular material to be freed from dust and located between the supply chamber and the dust removing chamber.

[0020] According to another aspect of the present invention, a dust removal plant is provided, which comprises:

- a plurality of dust removing devices referred to above;
- at least one source of pressurized washing air;
- a common pressurized washing air delivery piping extending from said at least one source to each dust removing device;
- a common washing air return piping extending from each dust removing device to said at least one source;
- at least one filtering means in said common return piping,
- said dust removing devices of said plurality of dust removing devices being connected in parallel between said common delivery piping and said common return piping; and
- a common programmable electronic control unit designed to control said at least one pressurized air source and each of said dust removing devices.

[0021] Further features and advantages of the present invention will better appear from the following detailed description of currently preferred embodiments thereof given by way of non-limiting and indicative examples, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view with parts cross-section of a dust removing device according to the present invention;

Figure 2 is a front view with parts in cross-section of the dust removing device of Fig. 1 including an air feeding, filtering and disposing system for washing air; and

Figure 3 shows a diagrammatic view of an embodiment of a dust removing plant including four dust removing devices of Figures 1 and 2.

[0022] In the accompanying drawings equal or similar portions and components have been labelled with the same reference numerals.

[0023] With reference first to Figures 1 and 2, a dust removing device, generally indicated with reference numeral 1, includes an external shell or casing 2, in which three chambers are delimited, i. e. a supply or feed chamber 3 of granular material, an intermediate chamber 4 for dust removing or washing of granular material supplied from chamber 3, and a disposing chamber 5 for discharging granular material free from dust.

[0024] More precisely, the supply chamber 3 has an upper inlet opening 3a, typically in fluid communication, e. g. by falling, with a hopper (not shown in the drawings) storing granular material and communicates at a lower and lateral portion thereof with the intermediate decontamination chamber 4. The disposing chamber 5 is located downstream of the dust removing chamber 4, is in direct communication therewith, and has a lower output opening 5a for the granular material free of dust that is usually in fluid communication with a transforming machine (not shown in the drawings), e. g. an injection press of any suitable type. Fluidification means, e. g. a sifter 6 having a foraminate lateral side, preferably cylindrical in shape and made of stainless steel sheet, are located in the intermediate dust removing chamber 4. The sifter 6 is designed to receive granular material to be decontaminated from the supply chamber 3 and to discharge it free of dust into the output chamber 5.

[0025] To this end, the sifter 6, in use, is mounted for rotation about a substantially horizontal axis and it can be set in rotation by a driving shaft 7 controlled by driving means of any suitable type, e. g. a ratio-motor 8 electrically connected with a programmable electronic control unit CU. The ratio-motor 8 is preferably arranged outside the casing 2, e. g. adjacent to the supply chamber 3 whose lateral side 3b has then a through hole 9 through which the driving shaft 7 extends, the hole 9 being sealed

around the driving shaft 7 by suitable gasket means, e. g. a felt ring 10 to avoid leakages of granular material from the dust removing device 1.

[0026] Preferably, the driving shaft 7 extends through the three chambers 3, 4 and 5 and has one end thereof operatively connected and supported by the ratio-motor 8 outside the supply chamber 3, and its other end mounted for rotation in the casing 2 at the discharging chamber 5.

[0027] In a section of the driving shaft 7 extending between the supply chamber 3 and the dust removing chamber 4, the driving shaft supports, or is integral with, dosing and conveying means, e. g. a conveyor means like such as a motor-driven screw 11 surrounded by a respective work duct 11a which also extends between the supply chamber 3 and the dust removing chamber 4. Such screw 11 with its respective work duct 11 a constitutes a volumetric-type dosing and conveying system arranged for metering and conveying the granular material between the two chambers 3 and 4. Its dimensions are such that, for each rotation of the driving shaft 7, and thus of the screw 11, a predetermined amount of granular material is conveyed from the supply chamber 3 to the chamber 4, or more precisely to the sifter 6 located therein.

[0028] From a constructional viewpoint, the sifter 6 has a partition wall 6a next to the supply chamber 3, through which an end section of the working duct 11 a of screw 11 sealingly extends, and can be advantageously secured to the driving shaft 7 by means of two cross-shaped portions 6b and 6c arranged to support the shaft 7 and drag it in rotation, so that the shifter is rigid in rotation with the driving shaft 7. More particularly, a collecting zone for the granular material supplied and metered by the screw 11 is delimited between the partition wall 6a and the support portion 6b. Granules move from the collecting or gathering zone to dust removing zone between the two support portions 6b and 6c, where due to the sifter 6 being rotated, the granular material is fluidified, wich results in an increase of the collisions among the granules and detachment of any contaminating dust agents. Finally, the dust granular material free of dust moves over the support part 6c into the disposing or unloading chamber 5, from where it is fed to a downstream transforming machine.

[0029] Thus, while keeping a steady speed of rotation of the ratio-motor 8, a constant flow rate of granular material is maintained through the dust removing device 1.

[0030] At the discharging chamber 5, casing 2 has an input opening 5b through which washing air is supplied by way a washing air conveying duct 13 from a pressurized washing air source, e. g. a blower 12 electrically connected to the programmable control unit CU.

[0031] The air entering the dust removing device 1 via the opening 5b flows through the granular material while being fluidified in the sifter 6, captures any contaminating dust particles thereon, and flows then through the foraminate wall of the sifter 6 into a discharge piping 14 in fluid communication with a suction pipe 15.

[0032] Advantageously, the air inlet opening 5b is located downstream of the intermediate dust removing chamber 4 and the air discharge piping 14 is located substantially upstream of the dust removing chamber 4, so that the washing air is supplied in countercurrent with respect to the granular material to be decontaminated. The washing air loaded with powder particles is filtered by means of a filter 16 of any suitable kind which is located on a washing air return duct 17, and recycled in the dust removing device.

[0033] The dust removing device 1, at the inlet opening 3a of the granular material supply chamber 3, comprises an electrostatic-charge neutralization unit 18 designed to neutralize any electrostatic binding charge between granules and powder particles carried by them. Such a neutralization unit 18 comprises a high voltage generator 19, typically a generator of 4-7 kV alternating voltage, which is electrically connected to the control unit CU and supplies one or more ionizing points 20 located inside a sleeve 21. Compressed air is blown through a duct 22, and while flowing close to the ionizing point or points 20 becomes ionised and then meets the granular material entering the dust removing device 1 through opening 3a. Positive ions of the ionized air neutralize positive charges, whereas negative ions neutralize positive charges of inlet granular material.

[0034] Owing to neutralization of the electrostatic charges, the binding forces between plastics material granules and powder particles are destroyed, this being of assistance in the subsequent dust removing operation.

[0035] In another embodiment, not shown in the drawings, of the dust removing device 1, the electrostatic-charge neutralization unit 18 can be located at the washing air inlet opening 5b for the chamber 5. In such a case, the washing air entering the sifter 6 will be directly ionised with no need for further compressed air being supplied to the dust removing device 1, and neutralization of the electrostatic charge on the granules, with consequent separation of the dust particles from the granules, will take place inside the sifter 6.

[0036] The granular material now free from contaminating dust particles flows into the disposing chamber 5, and then falls, by gravity, onto an end portion 5c of the disposing chamber from where it is fed to a downstream processing machine.

[0037] Advantageously, in the end portion 5c level control means, e. g. a capacitive sensor 23 which is electrically connected to the programmable electronic control unit CU, are provided. When the level of dust-free granular material in the end portion 5c of the disposing chamber 5 falls below a predetermined level, the capacitive sensor 23 applies a signal to the control unit CU which, in turn, energizes the dust removing device 1, more particularly the ratio-reducer 8, the blower 12 and the electrostatic charge neutralization unit 18, in order to re-establish the level of dust free material in the end portion 5c.

[0038] As shown in Figure 2, the dust removing device

1 according to the present invention comprises a return valve 24 which is located between the discharge duct 14 and the washing air suction duct 15. Such return valve 24 comprises a valve body 25, inside which a shutter member 26 can move, the shutter member being controlled by a driving means of any suitably type, preferably a pneumatic driving means, e. g. a piston and cylinder unit 27 controlled by the control unit CU and designed to open/close a passage between the discharge duct 14 and the suction air duct 15.

[0039] In general, in a plant for processing granular plastics material a plurality of dust removing devices are provided. A dust removing plant according to the embodiment shown in Figure 3 comprises four dust removing devices 101, 102, 103, 104, which are connected in parallel by means of inlet shunts 101a, 102a, 103a, 104a and outlet shunts 101b, 102b, 103b, 104b for pressurized washing air, and located between a common delivery duct 130, designed to deliver washing air supplied by a blower 120, and a common return duct 170 for the washing air which is intercepted by a filter 160. The dust removing plant comprises one blower 120 only and only one filter 160 to reduce both the overall dimensions and the management and maintenance costs. Preferably, operation of the four dust removing devices 101, 102, 103 and 104 and the blower 120 is controlled by the common programmable electronic control unit CCU.

[0040] Usually, in a dust removing plant provided with a plurality of dust removing devices of the type shown in Figure 3, only rarely all the devices operate simultaneously, and thus the blower 120 and the filter 160 are so dimensioned as to generate and filter an amount of pressurized washing air which is sufficient to supply only a given number of dust removing devices. Thus, air has to be circulated only when required by the dust removing device/s.

[0041] More particularly, the embodiment shown in Figure 3 is illustrated with its dust removing devices 101 and 102 in operation or working condition, whereas the dust removing devices 103 and 104 are in a standstill and inoperative configuration. The control unit CCU senses the working/inoperative condition of the four devices 101, 102, 103, 104 by checking the filling condition of the disposing chamber 51, 52, 53, 54 of each device, such filling condition being sensed by a respective level sensor 231, 232, 233, 234, then it controls the supply of pressurized washing air to the working devices 101 and 102, respectively, and the corresponding opening of return valves 243, 244. The CCU also controls the closure of the return valves 243, 244 of the inoperative dust removing devices 103 and 104, respectively.

[0042] Should granular material be freed from dust by means in the device 103, such a device is switched from an inoperative to an operating condition. The control unit CCU senses the change of state of the dust removing device 103 and waits until one of the working devices, e. g. the device 102, switches from its operative to its inoperative state. At this point, the control unit CCU causes the return valve 242 of the device 102 (which is now inoperative) to close, and causes the return valve 243 of the device 103 (which now is in its operative state) simultaneously to open.

[0043] In the particular case in which in a dust removing plant provided with a plurality of dust removing devices only one or a reduced number of such devices is in its working condition, any air generated delivered by the blower 120 is supplied to such dust removing device. This condition is undesirable as such an excessive air flow would interfere with the granular material flow throughout the dust removing device and the fluidification inside the sifter 6. In order to overcome such inconvenient, a bypass valve 150 is provided in the delivery duct 130, the valve 150 being electrically connected to the control unit CCU and designed to deviate the flow of air in excess supplied by the blower 120.

[0044] The present invention as described above is susceptible to numerous modifications and variations within its protection scope as defined by the claims.

Claims

1. A dust removing device for granular material comprising:

- a casing (2) delimiting a supply chamber (3) arranged to feed granular material to be freed from dust, and being formed with an input opening (3a); a dust removing chamber (4) designed to remove dust from the granular material and in fluid communication with said supply chamber (3); a disposing chamber (5) for granular material freed from dust formed with an output opening (5a), thereby allowing an uninterrupted flow of granular material to be freed from dust to occur between said supply chamber (3) and said disposing chamber (5); a pressurized washing air supply opening (5b); and a washing air discharging duct (14);
- a source (12) of pressurized air;
- a delivery duct (13) between said pressurized air source (12) and said pressurized air supply opening (5b);
- a return piping (17) between said washing air discharging duct (14) and said washing air source (12); and
- filtering means (16) in said return piping,

characterized in that it comprises fluidifying means (6) for said granular material to be freed from dust located in said dust removing chamber (5), and conveying and dosing means (11, 11a) designed to convey and meter said granular material to be freed from dust and located between said supply chamber (3) and said dust removing chamber (5).

2. A device as claimed in claim 1, **characterized in that** said fluidifying means for comprises a sifter member (6) mounted for rotation in said dust removing chamber (4), and driving means (8) for said sifter member (6).

3. A device as claimed in claim 2, **characterized in that** said sifter member (6) comprises a partition wall (6a) arranged upstream of said uninterrupted flow close to said supply chamber (3), and at least one support portion (6b, 6c) for dragging it in rotating.

4. A device as claimed in claim 2 or 3, **characterized in that** said driving means comprises a ratio-motor unit (8).

5. A device as claimed in any previous claim, **characterized in that** said convoy and dosing means comprises at least one conveyor means.

6. A device as claimed in claim 5, **characterized in that** said at least one conveyor means comprises a motor-driven screw (11) and a respective working duct (11a).

7. A device as claimed in claim 6, when depending upon claim 3, **characterized in that** said working duct (11a) of said at least one transporting means extends through said partition wall (6a) into said dust removing chamber (7) and is tight sealed with respect to said partition wall.

8. A device as claimed in claim 6 or 7, **characterized in that** said at least one screw conveying means (11, 11a) is rigid in rotation with said sifter unit (6).

9. A device as claimed in any previous claim, **characterized in that** said air inlet opening (5b) is located downstream of said dust removing chamber (4) and said discharging duct (14) is located substantially upstream of said dust removing chamber (4), whereby washing air is supplied countercurrent with respect to the granular the material to be freed from dust in said dust removing chamber (4).

10. A device as claimed in any previous claim, **characterized in that** it comprises a programmable electronic control unit (CU).

11. A device as claimed in any previous claim, **characterized in that** it comprises a electrostatic charge neutralization unit (18) controlled by said programmable electronic control unit (CU).

12. A device as claimed in claim 11, **characterized in that** said neutralization unit (18) comprises a high voltage generator (19) including at least one ionizing point (20).

13. A device as claimed in claim 11 or 12, **characterized in that** said neutralization unit (18) is located at said inlet opening (3a) of said supply chamber (3).

14. A device as claimed in claim 11 or 12, **characterized in that** said neutralization unit (18) is located at said washing air supply opening (5a).

15. A device as claimed in any previous claim, **characterized in that** it comprises level sensing means (23) located at said disposing chamber (5) and designed to apply control signal to said programmable electronic control unit (CU).

16. A device as claimed in claim 15, **characterized in that** said level sensing means (23) comprises a capacitive sensor (23).

17. A device as claimed in any previous claim, **characterized in that** it comprises valve means (24) that are designed to control air flow through said discharging duct (14) and controllable by said programmable electronic control unit (CU).

18. A device as claimed in claim 17, **characterized in that** said valve means (24) comprises a valve body (25), a shutter member (26), and fluid-operated means (27) designed to control said shutter member (26).

19. A dust removing plant **characterized in that** it comprises:

- a plurality of dust removing devices (101, 102, 103, 104) according to any claim 1 to 17;
- at least one source (120) of pressurized washing air;
- a common pressurized washing air delivery piping (130) extending from said at least one source (120) to each dust removing device (101, 102, 103, 104);
- a common washing air return piping (170) extending from each dust removing device (101, 102, 103, 104) to said at least one source (120);
- at least one filtering means (160) in said common return piping (170),
- said dust removing devices of said plurality of dust removing devices (101, 102, 103, 104) being connected in parallel between said common delivery piping (130) and said common return piping (170); and
- a common programmable electronic control unit (CCU) designed to control said at least one pressurized air source (120) and each of said dust removing devices (101, 102, 103, 104).

20. A plant as claimed in claim 19, **characterized in that** it comprises a by-pass valve (150) controllable by

said common programmable electronic control unit (CCU) and designed to deviate any air flow in excess supplied by said at least one pressurized washing air source (120).

21. A method of controllably distributing washing air in a plant according to claim 19 or 20, **characterized in that** it comprises the following stages in sequence:

- energizing said pressurized air source (120);
- detecting the filling condition of each dust removing device (101, 102, 103, 104) by means of suitable level sensor means (231, 232, 233, 234) to discriminate between operative and inoperative dust removing devices;
- feeding pressurized air to the operative dust removing devices and opening of said valve means (241, 242, 243, 244) for each operative dust removing device;
- reiterating sensing of the filling condition of each dust removing device (101, 102, 103, 104) by means of suitable level sensor means (231, 232, 233, 234) to descriminate between operative and inoperative dust removing devices; and
- feeding pressurized air to any dust removing devices, which have meanwhile become operative and opening of respective return valve means (241, 242, 243, 244) and cutting off of pressurized air supply to any dust removing devices which have meanwhile become inoperative and simultaneous closure their respective return valve means (241, 242, 243, 244).

22. A method as claimed in claim 21, **characterized in that** said sequence of operative steps is controlled by a programmable electronic control unit (CU).

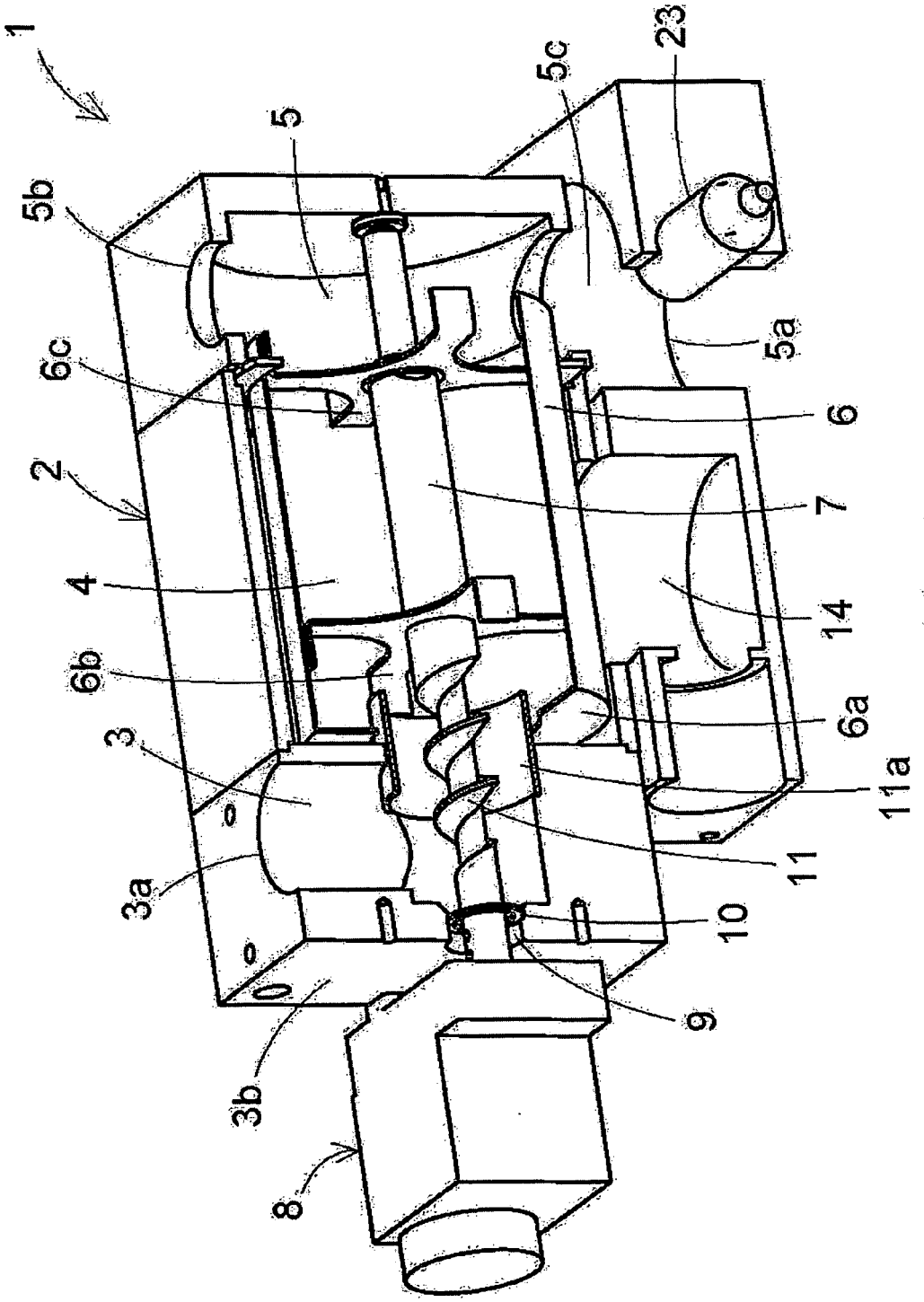

Fig. 1

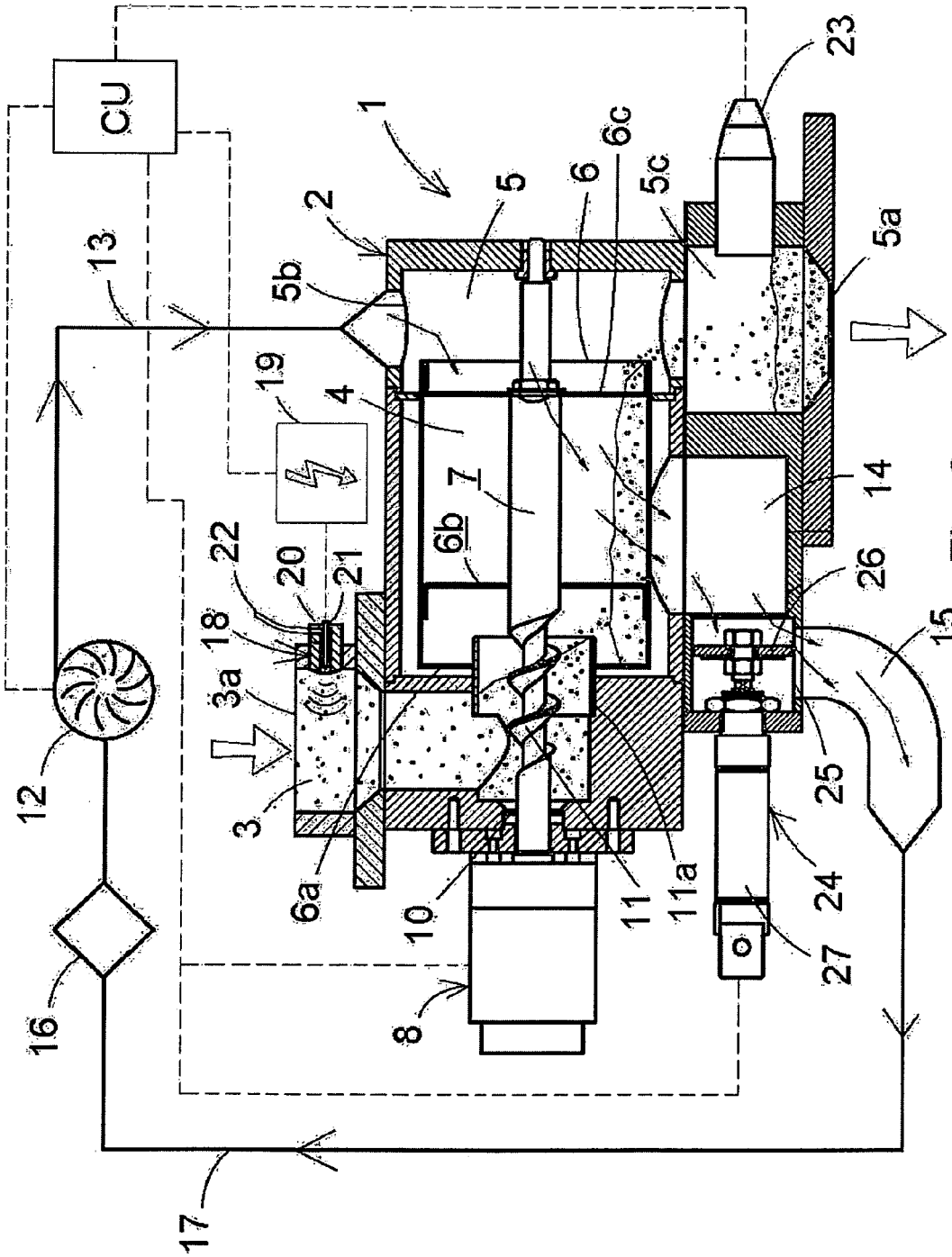
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Fig. 2

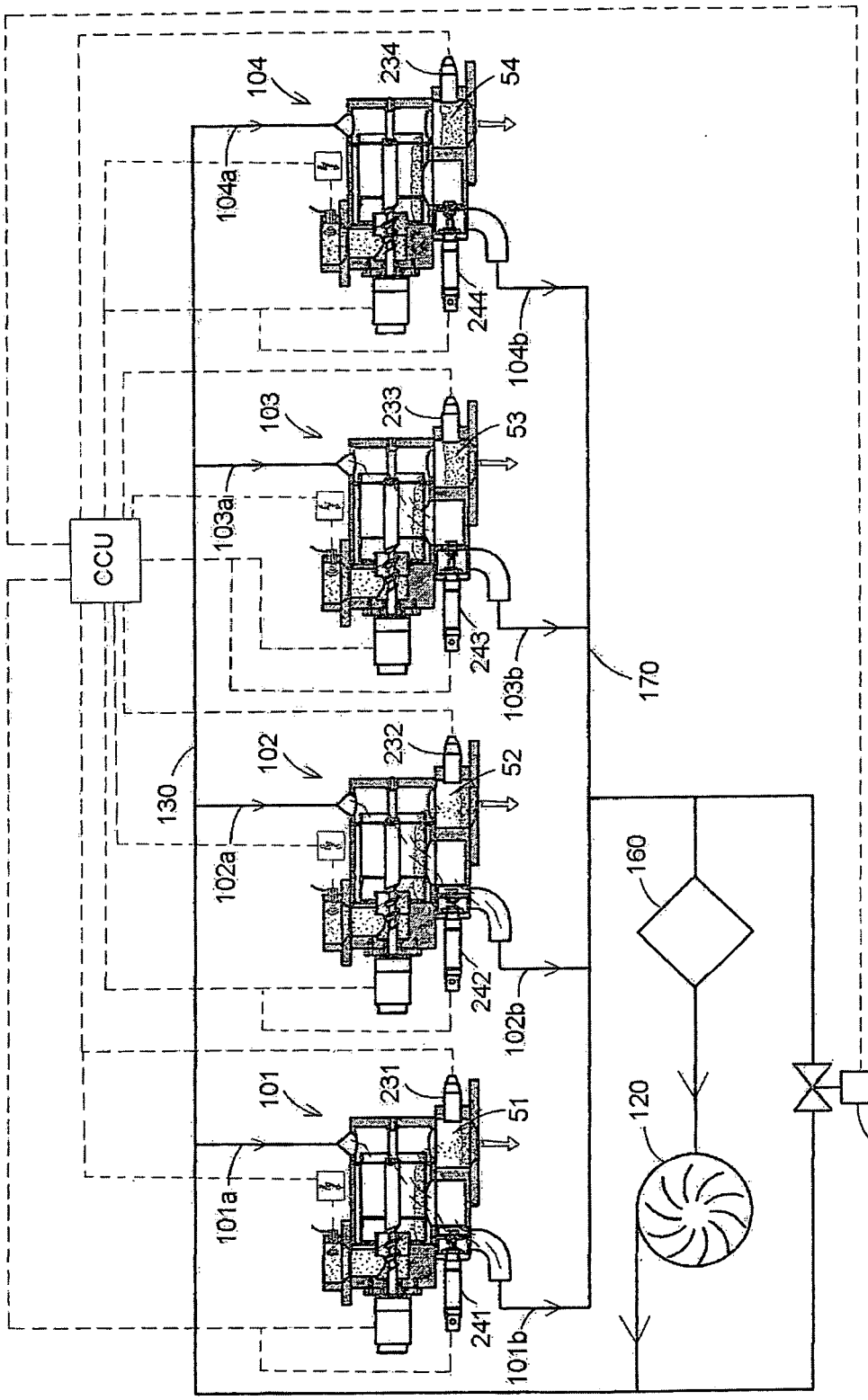
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Fig. 3