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(54) **Electric filter**

(57) Electric filter (1) to be used for purification of combustion gases by means of separation based on an high voltage electric field, consisting of a conduit (5), where there are electrodes (6) to be positively charged while the walls of the conduit (5) are to be negatively charged, whereby the electric filter (1) is also provided with means for removal of accumulated scale from the walls of the conduit (5). The electric filter (1) consist of an outer jacket (3) and a central inner jacket (4) so that the conduit (5) is formed between the outer jacket (3) and the inner jacket (4), and the cleaning apparatus comprises a trough (11) that can be moved up and down in the conduit (5).

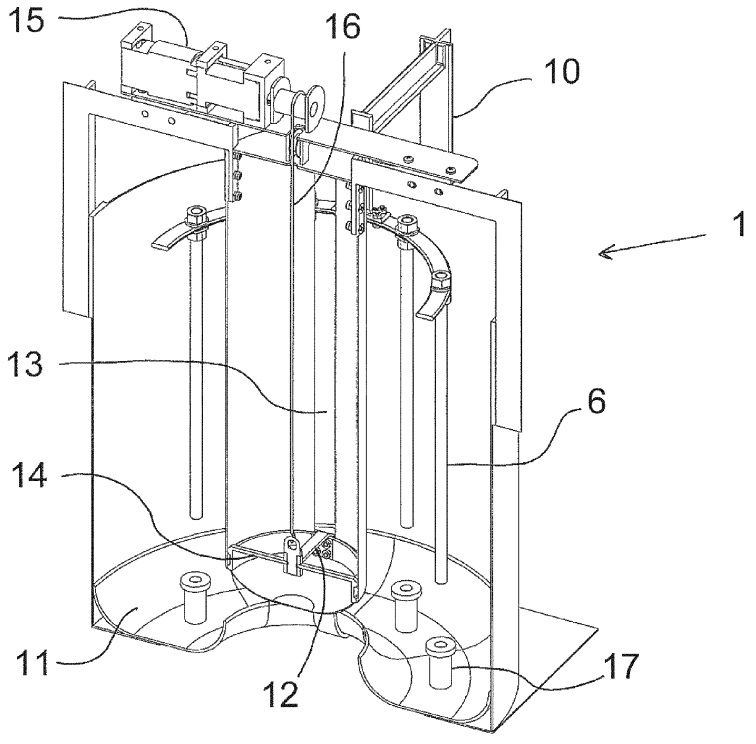

Fig. 4

EP 2 623 205 A2

Description

[0001] This invention concerns an electric filter, more precisely an electric filter by means of which it is possible to remove particles and harmful substances from combustion gases. The purpose is especially, but certainly not exclusively, to remove the mentioned harmful substances from combustion gases generated by small scale burning.

[0002] Electrostatic precipitation is a principle, well-known as such, based on the use of high voltage potential. The gases to be purified are conducted to a high voltage electric field, where the small particles in the gases are charged according to certain laws and adhere to the collecting surfaces. The accumulated material is removed from the surfaces in an appropriate manner.

[0003] Because electric filters are used for various kinds of purification tasks, their structures also vary considerably. A great number of filter structures is known, consisting of separate units to which the combustion gases are conducted for purification and from which the purified gas is conducted out, while the recovered harmful material is separately removed from the system.

[0004] There are numerous problems in electric filtration and inventions have consequently been made to solve them. One significant problem is related to the high voltage used, which is often of the order of several tens of kilovolts. The high voltage easily causes breakthroughs, especially when the plant is fouled, since soot and similar impurities are known to be conductive materials.

[0005] A second problem is the size of the plant, which has an influence on the price. If the intention is to make a separate electric filter device, which is not directly related to regular flues, its price and usually also its size rises to considerable dimensions.

[0006] A third problem is how to remove accumulated material from the device. For this purpose, various kinds of vibrators and shakers have been used. Their effect is however quite modest and their implementation is troublesome, requiring relatively complicated and also expensive devices. It is also problematic that the detached scale tends to be caught again by the flow in the chimney/equipment, so that in principle there is not much benefit from the purification.

[0007] Also various scrapers and brushes for stripping the accumulated deposits from the walls of the duct are known. Their functionality and their placement so that this part of the apparatus does not disturb other operations are often defective.

[0008] The purpose of this invention is to provide a well-functioning electric filter that can be easily installed also as a retrofit into an existing chimney and provides easy collection and removal of scale. The aim is also a compact and affordable solution. Furthermore the invention aims at a reliable construction, which retains its good purification capacity and which, if the need arises, can easily be automatized.

[0009] The above-mentioned and other benefits and advantages of the present invention are achieved in the manner described as characteristic in the accompanying claims.

[0010] In the following, the invention is described in further detail with reference to the accompanying drawings, which depict beneficial and well-regarded embodiments of the invention.

FIG. 1 is as an axonometric drawing of one embodiment of the device according to the invention;

FIG. 2 shows the structure in Figure 1 as viewed straight from above;

FIG. 3 shows a vertical section of the device according to the invention in side view; and

FIG. 4 shows a section as in Figure 3, now, however, seen diagonally from above.

[0011] The embodiment of Figure 1 is described in the following. The chimney, from which the combustion gases to be purified are discharged, is not at all shown in the drawings. However, the basic arrangement of the device according to the invention is such, that the device is placed and fastened at the top of an existing chimney, so that the combustion gases discharging from the flue pass through the collecting duct in the device according to the invention. As regards the invention, the type of chimney is not relevant. The chimney can be a conventional construction made of bricks and equipped with a smoke flue or e.g. a prefabricated metal chimney.

[0012] Fig. 1 shows as an example a kind of bottom plate 2 to assist in the fastening. In fact, any manner or means that is suitable for the actual conditions can be used for fastening. If needed, sealing between the flue and the filter can be carried out using conventional methods.

[0013] From the figures 1 and 2 can be concluded that the cross section of the device 1 according to the invention is essentially circular so that an essentially annular flow conduit 5 is formed between the outer jacket 3 and the inner jacket 4, through which conduit the combustion gases from the flue flow. From the detailed description it can, however, easily be concluded that the circular cross section is in no way obligatory. It is fully possible to design the device for example in the shape of a rectangle.

[0014] As in electric filters in general, a high voltage electric field is also in this device used to collect impurities from combustion gases. So the essentially tubular inner jacket 4, which can be seen in the middle in the figures, is negatively charged, as well as the outer jacket 3 of the device, while several positively charged electrode rods 6 are situated in the ringshaped conduit 5, eight units in this embodiment. It is, however, clear that it is also possible to use other shapes instead of the rod- shaped electrode structure, such as plate-shaped electrodes, when

taken into account as required in the other details within the invention.

[0015] Because of the two negative surfaces, the electric filter according to the invention has a large collecting surface area, although the flow path is short. For this reason, the collecting is effective.

[0016] The negatively charged parts 3 and 4 are interconnected in a suitable manner, for example utilizing structures which also support other parts. In figure 1 these are marked with reference numerals 7 and 8. The positively charged electrodes 6 are fastened to the supporting structure 9, which in this embodiment is annular and, since it is used for current supply, it is supported to the outer structures in an insulated manner with the use of suitable connection means 10. Voltage is supplied to a suitable point in these connection parts from a high voltage source provided in connection with the device, not drawn in the figures. A control unit can also be provided in connection with the device for controlling the functions of the electric filter.

[0017] A notable thing regarding the invention is the fact that the current is supplied through structures that are insulated from the surroundings and from other structures in a location that is not in contact with combustion gases. Thus, breakthroughs caused by soot accumulation are avoided and in this respect the device remains in full working order throughout its service life. For the sake of example, insulation provided on the outer surface of the device is marked with reference numeral 18.

[0018] Thus, combustion gases from the flue travel to the conduit 5 of the device 1 where the impurities of the gases accumulate on the walls of the conduit 5, that is on the inner surface of the outer jacket 3 and on the outer surface of the inner jacket 4.

[0019] In the following, reference is made mainly to the figures 3 and 4 which show the inner structures of the electric filter according to the invention. Essential as regards the invention is the removal of the impurities from the collecting surfaces, automatically if desired, in order to maintain the purifying capacity and to prevent the accumulated material from causing current leakage through it in an uncontrolled way. For this purpose, the device according to the invention includes a cleaning mechanism, which is described in the following.

[0020] In this context it is worth noting that when the collecting/cleaning trough 11, described below, is in its lower position, it leaves free a flow passage for combustion gases allowing these to enter the purifying area 5. Therefore the shapes of the flow passage are smooth and cause as little flow resistance as possible, and if necessary, it is possible to add various types of flow guiding structures to the device to secure an appropriate flow of the combustion gases.

[0021] Before the cleaning, the current to the device is naturally switched off. For cleaning, the embodiment shown comprises a trough 11, which essentially corresponds to the dimensions of the annular conduit 5. In the embodiment shown, the trough 11 is essentially annular. The dimensioning of the trough is such, that the upper edges of the trough 11 correspond quite accurately, or are suitably equipped to correspond to the dimensions of the conduit so that as the trough 11 moves upwards, the edges simultaneously remove the accumulated impurities from the inner surface of the outer periphery and from the outer surface of the inner periphery. The detached impurities fall into the trough 11 for recovery.

[0022] By a trough in the context of the present invention is meant an upwardly opening component that is suitable for collecting solid matter.

[0023] As mentioned, the accumulated impurities are removed by lifting and lowering the trough 11. One example of how to accomplish lifting and lowering of the trough is demonstrated in the figures 3 and 4. The trough 11 is connected with a central rod 12 or similar. For the movement of this rod is provided in the inner shell 4 a longitudinal, in the figure vertical, groove or slit 13 on two opposite sides, to make possible the up and down movement of the rod along the said slits 13.

[0024] The up and down movement of the trough 11 can be supported and controlled, if necessary, with means supported to the inner surface of the inner jacket 4, which means can be of any kind, shaped e.g. as bars or rings, as required. However, the trough 11 retains its own position automatically also during raising and lowering.

[0025] One solution, which appears reasonable, for raising and lowering of the trough and the structures connected to it, is demonstrated in the figures. Thus, the small electric motor 15 that winds the lift cable 16 or lift chain or similar connected to lifting structures 12, is fully adequate for this purpose. The lowering can also, if desired, be secured by arranging the same motor to wind also the wire that secures the lowering, naturally in the direction opposite to that of the lifting wire. Technically this is possible, for example, by placing a support wheel in the area below the trough 11, via which wheel the wire assisting the lowering operation runs to the trough structures. There are, however, numerous suitable mechanisms, of which the use of mechanic racks to effect up and down motion of the trough may be mentioned as particularly preferable.

[0026] According to the best embodiment of the invention, the apparatus is equipped with a control unit that can be programmed to perform the cleaning, in other words the raising and lowering of the trough 11, automatically in a desired cycle. The unit can perform various kinds of measurements, on the basis of which is determined when cleaning is required or possible. The automation can also take care of measures that are related to removal of deposits from the trough 11. In case the use of automatic operation is not wanted or feasible, the functions can also be controlled as required by remote control.

[0027] Various sensors can be connected to control the automation, in particular a sensor measuring temperature and providing information on the combustion proc-

ess and of its termination. With the same temperature sensor can also be determined when it is reasonable to switch on or off the current supply to the electric filter. The level of the voltage can also be controlled automatically, for instance by reducing the voltage if breakthroughs are anticipated.

[0028] One thing related to raising and lowering is the location of the electrodes 6 in the conduit 5. As the raising of the trough is started, the electrodes would prevent the trough from rising when it has reached the ends of the electrodes 6. According to the invention, this is solved so that for each of the electrodes 6, in the bottom of the trough 11 there is a hole equipped with a collar into which the electrode is guided as the trough rises. The collar secures that the waste collecting on the bottom of the trough does not flow through the holes down into the chimney. The collar 17 can also be utilized for cleaning the electrodes by making the fitting tight enough or by equipping it with a suitable scraping ring whereby the electrode passing the collar is automatically cleaned.

[0029] The accumulated scale can be removed from the trough 11 as need arises. This can for example be done by a chimney sweeper during his regular duties. Yet, it is possible to arrange the removal in an easier way. One possible, easier alternative to remove the accumulated scale is to remove it by suction. It is possible to attach to the upper structures of the device a suction tube that extends to the trough 11 when it is in its upper position. The vacuum device itself can be situated anywhere. The vacuum device can start automatically when the trough reaches its upper position or it can be started manually. If required, it is possible to use a separate vacuum cleaner used for other purposes which is connected to the suction pipe only if need arises. For effective cleaning of the trough from every side, the suction pipe can be shaped so that it reaches the whole area of the trough perimeter, or a desired number of nozzles can be connected to the suction tube.

[0030] The lifting mechanism of the trough 11 can be located except inside the inner jacket 4 also in the flue 5. In that case the mechanism would optimally be of such a type that it would be made operational only for the time of the cleaning, and would otherwise be moved aside, so as not to disturb the electric filtration.

[0031] It is clear that the technical details and those relating to the external appearance of the electric filter according to the invention are dependent on authority regulations as well as on the practical circumstances of the place of installation, and thus can vary considerably relative to the above disclosure, but still stay within the basic idea of the invention and the scope of the enclosed patent claims.

[0032] If desired, it is possible to add cover structures to trough 11 to secure that the accumulated scale is not carried off by the flow of combustion gas. When the cleaning operation starts and the trough begins to move upwards, the above-mentioned cover structures open whereupon the deposits can fall into the trough. The structure can, for instance, be plate-shaped and hinged. The opening can be caused by the influence of motion or in some other way.

[0033] All in all, the solution above is simple, reliable and advantageous and can be connected to a combustion gas system at any stage. Apart from initial installation, retrofitting is also easy. Due to the small size of the device, it is also easy to disassemble from its place of installation and remove temporarily for sweeping or repair. Installation using hinges is possible, too. In appearance the device can be made almost inconspicuous, for instance by covering it with a housing which can be shaped like a chimney cap.

[0034] Several of the functions of the device according to the invention can be automated and it is also possible to equip it with a control/ monitoring unit, by means of which the operations can be optimized in many ways.

Claims

1. Electric filter (1) to be used for the purification of combustion gases generated by burning, by means of separation based on a high voltage electric field, said filter comprising a conduit (5), in which are provided electrodes (6) to be positively charged, while the walls of the conduit (5) are to be negatively charged, whereby the electric filter further includes means for detaching and collecting deposits from the walls of the conduit (5), **characterized in that** the electric filter has an outer jacket (3) and a central inner jacket (4), a conduit (5) for the combustion gases being formed between the outer jacket (3) and the inner jacket (4), and the means for detaching and recovering the accumulated deposits from the walls of the conduit (5) is formed as a trough (11) that can be moved up and down in the conduit (5).

2. Electric filter according to claim 1, **characterized by** that the electrodes (6) are attached to a support structure (9), to which current is to be supplied through an isolated (18) conductor (10) fixed to the outside of the conduit (5).

3. Electric filter according to claim 1, **characterized by** that there are holes provided with a collar (17) in the trough (11) for electrodes (6).

4. Electric filter according to claim 1, **characterized by** that the inner jacket (4) is provided with grooves or slits (13) to enable the motion of the trough (11) up and down.

5. Electric filter according to any preceding claim, **characterized by** that it comprises an electric motor (15) and a cable, chain, rod or the like (16) driven by the motor (15) for raising and lowering the trough.

6. Electric filter according to one of the preceding claims, **characterized by** being of a type rendering it fixable to the top of a chimney so as to be detachable and movable .

7. Electric filter according to one of the preceding claims, **characterized by** being provided with a suction pipe for removal from the trough (11) by suction of the deposits detached during cleaning, in particular when the trough is in a lifted position.

8. Electric filter according to one of the preceding claims, **characterized by** that the upper edges of the trough are shaped or equipped for scraping off the deposits and other impurities accumulated on the inner surface of the outer jacket (3) and on the outer surface of the inner jacket (4).

9. Electric filter according to one of the preceding claims, **characterized by** that its outer jacket (3) and inner jacket (4) are essentially circular in cross section, and that the flue conduit (5) between them is annular.

10. Electric filter according to one of the preceding claims, **characterized by** that it is provided with a control unit for automatic cleaning of the device and, when required, for monitoring of various parameters such as temperature, and for automatically carrying out desired operations on the basis of measured/observed parameters.

11. Electric filter according to one of the preceding claims, **characterized by** that the trough (11) can be closed with a hinged cover structure that can be opened as required, preferably automatically.

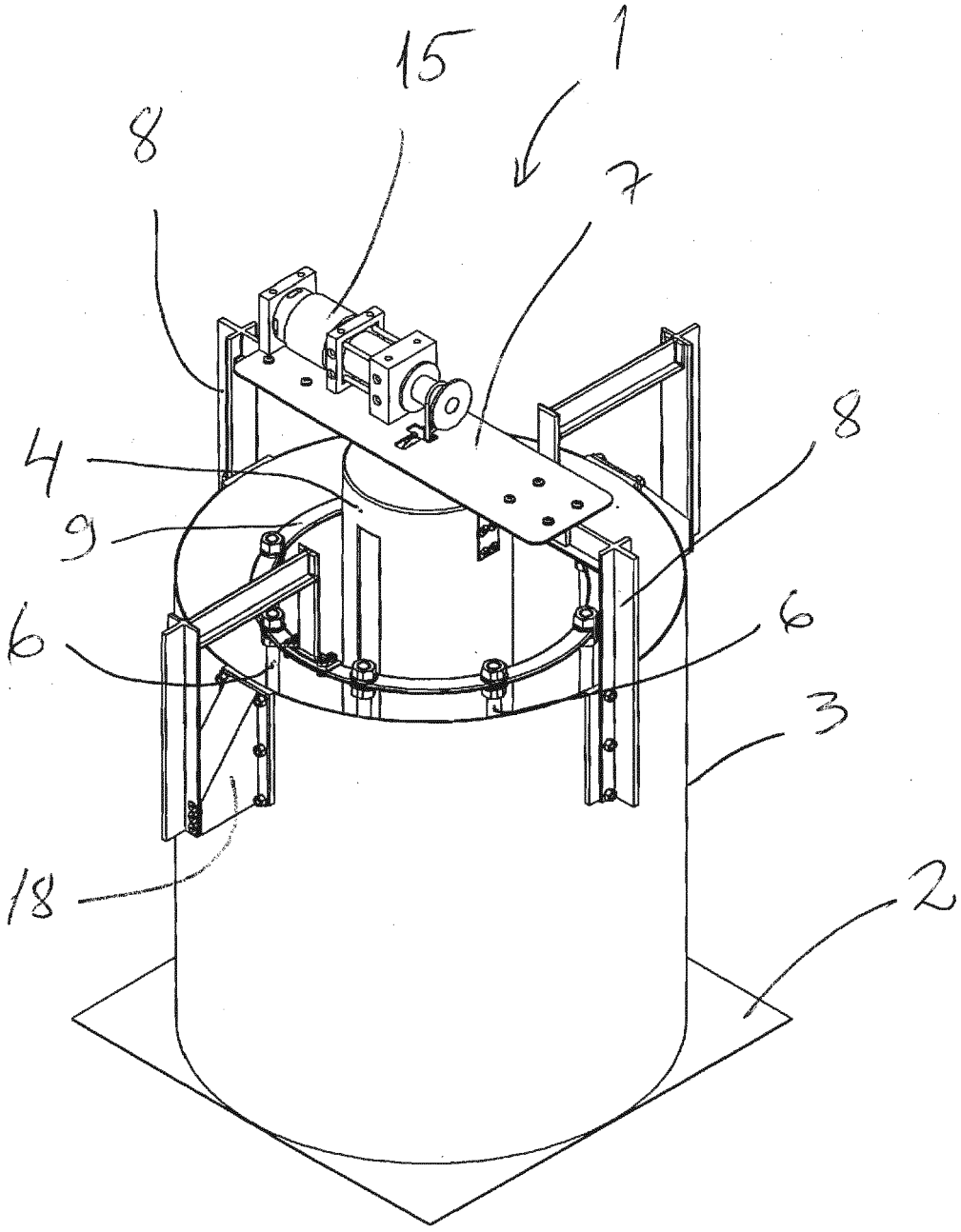

Fig. 1

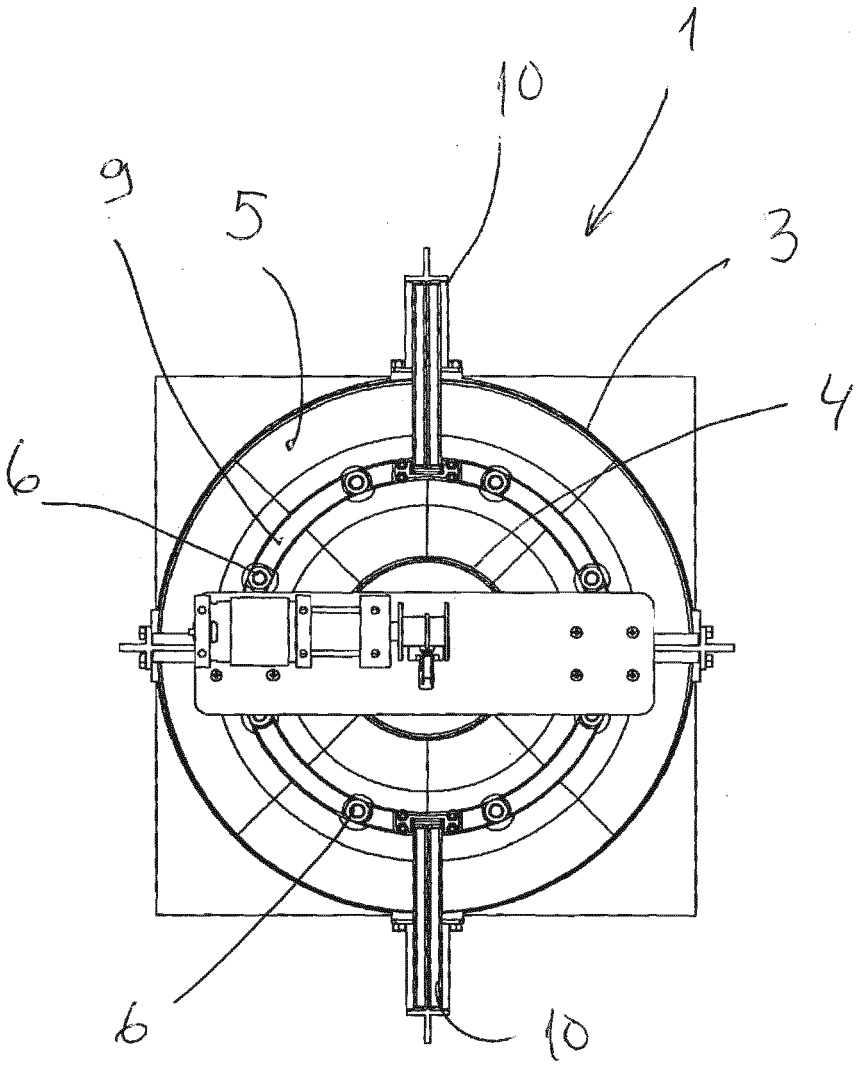

Fig. 2

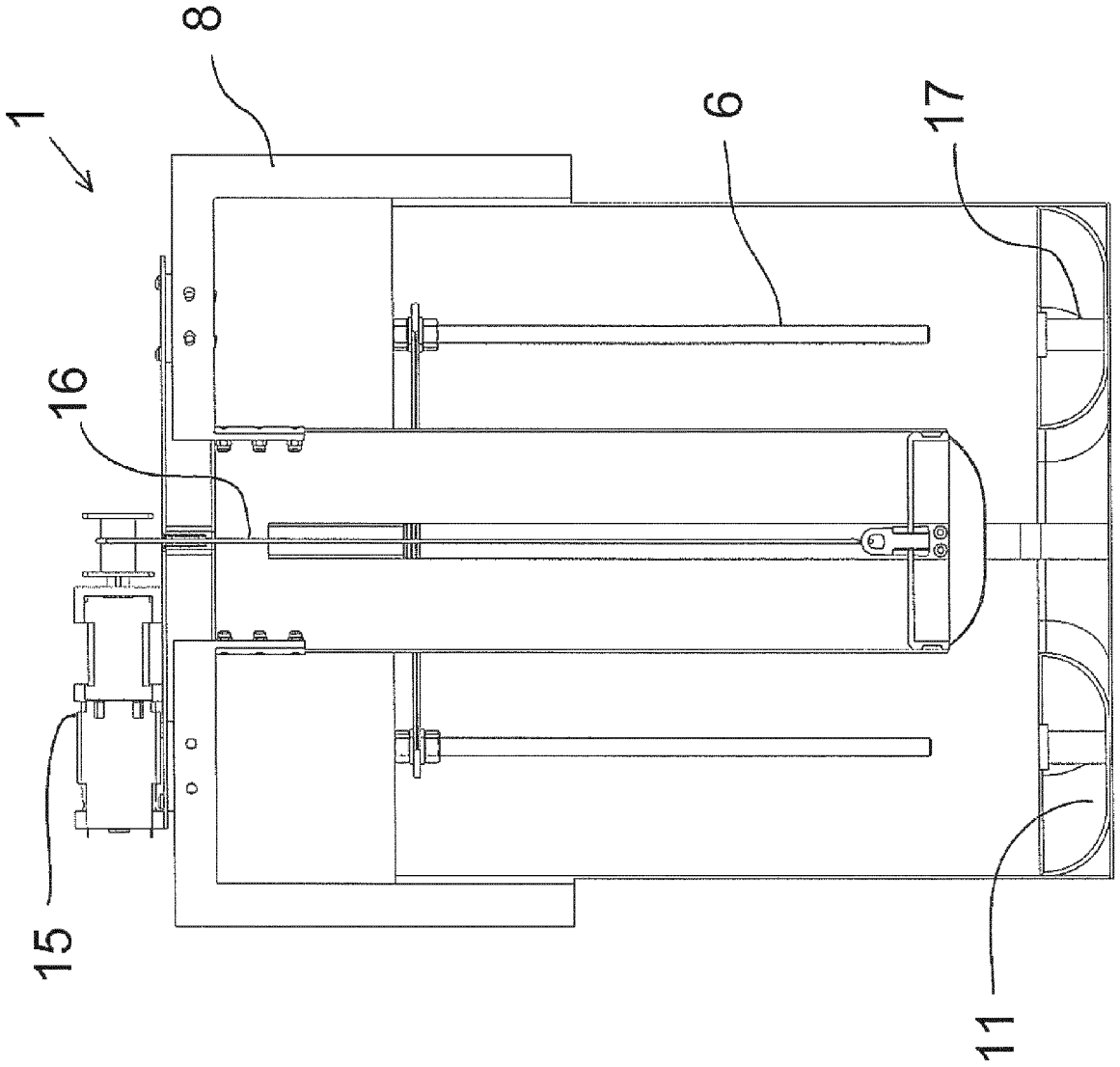

Fig. 3

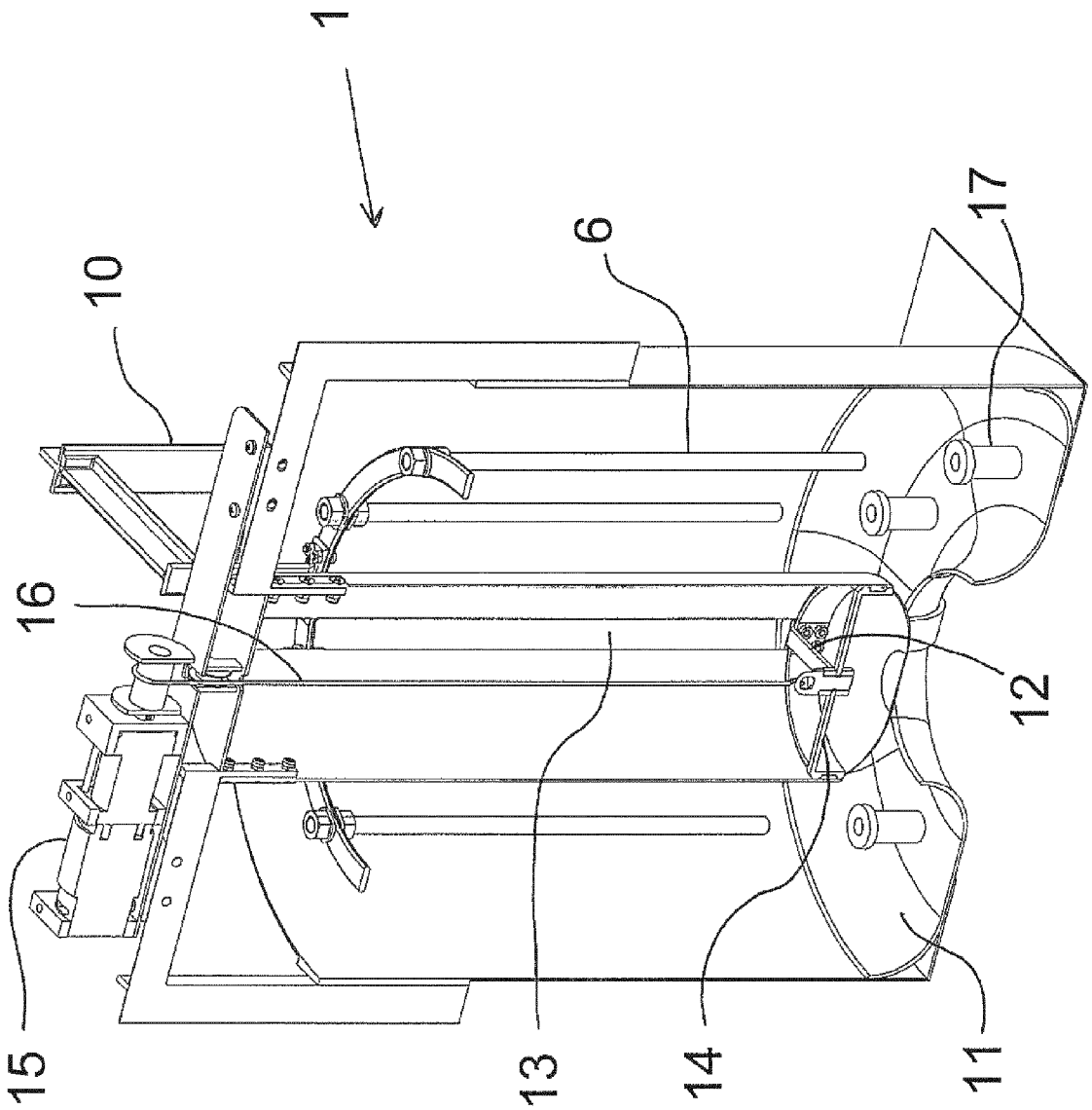

Fig. 4