



(11)

EP 3 276 277 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
31.01.2018 Bulletin 2018/05

(51) Int Cl.: **F24F 13/28** (2006.01) **F24F 3/16** (2006.01)

(21) Application number: **17155600.4**

(22) Date of filing: **10.02.2017**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
 GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
 PL PT RO RS SE SI SK SM TR**
 Designated Extension States:
BA ME
 Designated Validation States:
MA MD

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(30) Priority: 28.07.2016 EP 16181787

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(54) **FILTER CLEANING DEVICE FOR AN AIR CONDITIONER AND AIR CONDITIONER HAVING SUCH FILTER CLEANING DEVICE**

(57) The present disclosure concerns a filter cleaning device for an air conditioner (1), particularly a duct-type air conditioner, the filter cleaning device comprising a filter (12) to be passed through by an air flow and having a filter surface (13), a brush (17) contactable with the filter surface (13) for removing particulate matter from the filter surface, wherein the brush has a cylindrical shape, a motor (46) configured to rotate the brush in opposite directions; a first comb shaped member (48) engaged with the brush and a second comb shaped member (49) engaged with the brush, wherein the first and second comb shaped members each have a length direction parallel to the axis of rotation of the brush and a width direction, wherein first comb shaped member and the second comb shaped member are inclined away from each other in a cross-sectional view perpendicular to an axis of rotation (19) of the brush. Further the present disclosure contains an air conditioner having such filter cleaning device.

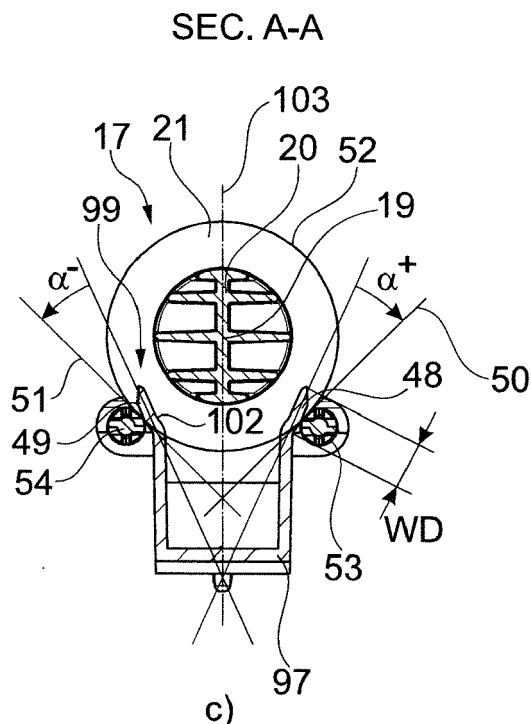


Fig. 16

Description

TECHNICAL FIELD

- 5 **[0001]** The present invention relates to filter cleaning devices for air conditioners, particularly so-called duct-type air conditioners and to air-conditioners having such filter cleaning devices.

BACKGROUND

- 10 **[0002]** Air conditioners are common in different buildings, particularly in commercial premises such as offices and hotels. In those premises often air conditioners of the so-called duct-type are employed.
- [0003]** Duct-type air conditioners are understood as air conditioners of which the indoor unit is connected to an air ducting hidden behind a false ceiling or a false wall. In many cases, also the indoor unit is completely or partly hidden behind the false ceiling or the false wall. An example of such an air conditioner is shown in figure 1.
- 15 **[0004]** Such duct-type air conditioners 1 generally comprise air ducting 6, 7 located behind a false ceiling U or a false wall. One air ducting 6 leads to an exit grating 8 or exit terminal in a space to be conditioned such as an office, a corridor, a meeting room or a hotel room. Another air ducting 7 leads to an inlet grating 9 or inlet terminal which may either be located within the space to be conditioned or outside that space. The air ducting 7 may alternatively be connected to a ducting network supplying air centrally to a plurality of indoor units.
- 20 **[0005]** The air conditioner 1 has an indoor unit comprising a casing having an inlet 2 to which the air ducting 7 is connected and an outlet 3 to which the air ducting 6 is connected. A heat exchanger 4 is located within the casing downstream of the inlet 2 and downstream of one or more fans 5. Yet, the heat exchanger 4 may also be located upstream of the fan/s 5. A filter 12 having opposite filter surfaces 13, 14 is disposed upstream of the heat exchanger 4 and in many cases located at or near the inlet 2.
- 25 **[0006]** An air flow is generated by the fan/s 5 during operation of the air conditioner 1. Air flows from the inlet grating 9 via the air ducting 7 to the inlet 2, passes the filter 12 and subsequently the heat exchanger 4 for heating or cooling the air before being introduced into the space to be conditioned via the outlet 3, the air ducting 6 and the exit grating 8.
- [0007]** The filter 12 has the purpose of removing particulate matter such as dust and fibers from the air flow to avoid the parts of the air conditioner, particularly the heat exchanger 4, from being soiled and clogged.
- 30 **[0008]** Yet, the filter 12 requires regular cleaning to avoid clogging of the filter. Such clogging of the filter may result in an increased resistance to the air flow which requires a higher load on the fan/s. Hence, clogging of the filter can reduce the efficiency of the air conditioner.
- [0009]** Yet, cleaning of the filter very often requires opening the false ceiling or the false wall and specialized maintenance engineers or cleaning personnel to remove and clean the filter. This is perceived negative. For this reason, systems have been suggested to simplify removal of the filter. Such systems are for example disclosed in KR 10 2003 0083185 A or KR 10 2004 0080810 A.
- 35 **[0010]** However, also these systems require cleaning personal to frequently access the spaces to be conditioned, which may disturb the people using the space. To address this problem, filter cleaning devices have been suggested which are able to automatically clean the filter. One system uses a suction force for cleaning the filter, wherein a suction device is communicated with a suction nozzle moving along the filter surface, whereby the particulate matter adhering to the filter surface is removed by the suction force applied via the suction nozzle. Two examples of those devices are disclosed in WO 2007/040276 A1 and WO 2016/009351 A1. However, these devices are, on the one hand, perceived to be relatively complicated and hence expensive and, on the other hand, perceived to either not sufficiently remove the particulate matter or to require a relatively high suction force which may lead to damaging of the filter.
- 40 **[0011]** To address these deficiencies, filter cleaning devices have been proposed using a mechanical cleaning member, such as a brush. The particulate matter removed from the filter by the brush is collected and retained in a dust box. One type of those filter cleaning devices moves the filter along a fixed mechanical cleaning member for removing the particulate matter. Those devices however require a specific configuration of the filter, such as having a continuous belt shape or a large space into which the filter is moved before being returned to its original position. EP 2 119 979 A1 discloses an example of such device. This device particularly employs a rotatable brush. In order to remove particulate matter adhering to the bristles of the brush after being removed from the filter, EP 211-9979 A1 suggests a comb shaped member engaged with the brush and particularly its bristles scrapping off the adhering particulate matter for transfer to a dust box.
- 50 **[0012]** Alternative types of such filter cleaning devices disclose to slide the mechanical cleaning member along the filter surface with the dust box however being fixed relative to the casing. One such filter cleaning device is disclosed in JP H06-32926 U. Yet, also in this device the brush, being pressed against and slid along the filter, may damage the filter and/or push particulate matter into and even through the filter rather than removing the particulate matter from the filter.
- 55 **[0013]** To address these problems, the inventors considered the use of a brush rotated by a motor in opposite directions.

Yet, it turned out that cleaning or removing of particulate matter adhering to the brush or its bristles by one comb shaped member is not sufficient when the brush rotates in opposite directions.

SUMMARY OF THE INVENTION

[0014] In view of the aforesaid, it is an object of the invention to provide a filter cleaning device and an air conditioner comprising such a filter cleaning device which can overcome or at least reduce the above drawback of the prior art.

[0015] In particular, it is an object to provide a filter cleaning device having a brush rotated by a motor in opposite directions and a corresponding air conditioner which are capable of improving the removal of particulate matter adhering to the brush.

[0016] According to one aspect, a filter cleaning device having the features of claim 1 and an air conditioner having such filter cleaning device as defined in claim 12 are suggested.

[0017] In accordance with an aspect, the filter cleaning device for an air conditioner, particularly a duct-type air conditioner, comprises a filter to be passed through by an air flow and having a filter surface. The filter surface defines a width and a length of the filter. In particular, the filter may have two filter surfaces on opposite sides of the filter in the direction of the air flow. The filter can be flat and/or longitudinal. The filter can in principle be of any kind as long as it is configured to remove particulate matter, particularly dust and fibers, from the air flow flowing through the filter, and to be used in combination with an air conditioner. As one example, the filter can comprise a frame holding a mesh made of for example plastic material or metallic material. Further, the filter cleaning device comprises a brush as a cleaning member contactable with the filter surface for removing particulate matter from the filter surface, wherein the brush has a cylindrical shape (is substantially cylindrical). The brush is preferably rotatably mounted so as to be continuously rotatable about a cylinder axis (the cylinder axis of the cylinder). In this context "continuously rotatable" is to be understood in that the brush can be rotated clockwise and/or counterclockwise without any abutment or limitation of the rotation angle. Moreover, the filter cleaning device comprises a motor configured to rotate the brush in opposite directions. The motor may be an electric motor, particularly a stepping motor. For removing the particulate matter from the brush, the filter cleaning device comprises a first comb shaped member engaged with the brush and a second comb shaped member engaged with the brush. The comb shaped members are to be understood as members having a plurality of teeth extending from a body. Adjacent teeth are separated by a recess. As such, the comb shaped members may be configured as disclosed in EP 2 119 979 A1 the content of which is incorporated herein by reference. The first and second comb shaped members may be formed integral and being connected by a common comb body. The first and second comb shaped members each have a length direction parallel to the axis of rotation of the brush and a width direction. The width direction is perpendicular to the length direction and parallel to the axis of rotation of the brush. According to an embodiment, the first comb shaped member and the second comb shaped member are inclined away from each other in a cross-sectional view perpendicular to the axis of rotation of the brush. In this context, the first and second comb shaped members are angled so that their width directions intersect outside the diameter of the brush. To put it differently, the projection of the width direction of the first comb shaped member and the projection of the width direction of the second comb shaped member intersect outside the diameter of the brush. Preferably, the first comb shaped member and the second comb shaped member may be disposed symmetrically in a cross-sectional view perpendicular to the axis of rotation of the brush with respect to a line perpendicularly intersecting with the axis of rotation of the brush. In this context, the projection of the width direction of the first comb shaped member and the projection of the width direction of the second comb shaped member intersect on said line.

[0018] According to this aspect, a filter cleaning device is provided which enables sufficient cleaning of the brush to remove particulate matter adhering to the brush even when the brush rotates in opposite directions. In particular, the first comb shaped member is configured to remove particulate matter from the brush when the brush is rotating in a first direction and the second comb shaped member is configured to remove particulate matter from the brush when the brush is rotating in a second direction opposite to the first direction. Thus, the cleaning efficiency of the filter cleaning device can be enhanced.

[0019] According to a further aspect, the first comb shaped member is angled with its width direction with respect to a first tangent on a circle having a common center axis with the axis of rotation of the brush at a positive angle and the second comb shaped member is angled with its width direction with respect to a second tangent on the circle and being perpendicular to the first tangent at a negative angle. According to this aspect, the first and second comb shaped members are angled with respect to the axis of rotation of the brush in order to provide for an appropriate removal of particulate matter therefrom independent of the rotational direction of the brush.

[0020] In this aspect, it is preferred that the absolute value of the positive angle and the negative angle is the same. Accordingly, the first comb shaped member and the second comb shaped member are disposed symmetrically in a cross-sectional view perpendicular to the axis of rotation of the brush with respect to a line perpendicularly intersecting with the axis of rotation of the brush.

[0021] Hence, it is possible to remove particulate matter from the brush with the same efficiency independent of the

rotational direction of the brush.

[0022] According to a further aspect, the first comb shaped member is inclined away from the axis of rotation in a direction towards the first rotating direction and the second comb shaped member is inclined away from the axis of rotation in a direction towards the second rotating direction.

[0023] Consequently, it can be realized that the brush and particularly the bristles reliably enter the recesses between the teeth of the comb shaped members and any particulate matter adhering to the brush or its bristles is scrapped away by the comb shaped members.

[0024] According to a further aspect, a first rotatable separation roller extending parallel to the axis of rotation of the brush is disposed upstream of the first comb shaped member in the first rotating direction and a second rotatable separation roller extending parallel to the axis of rotation of the brush is disposed upstream of the second comb shaped member in the second rotating direction.

[0025] It may happen that particulate matter removed from the brush by the comb shaped members again adheres to the brush and/or the surfaces of the comb shaped members after being loosened by the comb shaped members. This aspect suggests the separation rollers in order to transfer the loosened particulate matter from the brush and the comb shaped members. In particular, the separation rollers create an air flow moving the particulate matter away from the brush and the comb shaped members and/or centrifuge any particulate matter adhering to the separation rollers away from the separation rollers. Accordingly, the particulate matter can reliably be transferred to the dust box.

[0026] In this aspect, it is preferred that the first separation roller is configured to rotate in a direction opposite to the first rotating direction and the second separation roller is configured to rotate in a direction opposite to the second rotating direction.

[0027] Accordingly it can be reliably achieved that the particulate matter is moved away from the brush and the comb shaped members to be transferred to the dust box.

[0028] Further, it may be preferred that the first and second separation roller are driven by the motor also rotating the brush.

[0029] The use of a common motor has the advantage that less expensive parts are required and less wiring is necessary.

[0030] According to a further aspect, the brush is reciprocally and translationally movable along the filter surface. Particularly, the brush may span the filter surface in a direction of the width of the filter and/or is movable along the length of the filter. The brush may be disposed on one of the opposite sides of the filter so as to engage with one of the filter surfaces during cleaning operation.

[0031] In this aspect, the cleaning member, that is the brush, has a cylindrical shape and is rotatably mounted and movable along the filter. Hence, removing the particulate matter from the filter can be effected more efficiently because the brush can be moved along the filter more quickly and the particulate matter is brushed away from the filter surface due to the rotational movement of the brush. In addition, because of the rotational movement of the brush, the mechanical forces applied to the filter surface are reduced as compared to a brush slid along the filter surface. Therefore, the risk of damaging the filter can be reduced. During cleaning operation, the brush moves along the length of the filter in opposite directions, wherein the direction of rotation of the brush is changed when changing the direction along the length of the filter (direction of movement). Accordingly, removing particulate matter from the filter can be achieved most effectively.

[0032] It may be preferred in this aspect that the motor is configured to respectively rotate the brush in the direction of movement of the brush along the filter surface. "In the direction of movement" is to be understood in this context in that the brush is rotated against the rotation direction which would be imparted to the brush when moving the brush along the filter surface with the brush in contact with the filter surface by friction. To put it differently, the brush is rotated so that the upstream side of the brush is rotated against the filter surface whereas the downstream side rotates away from the filter surface. For example, the brush rotates clockwise if it is moved to the right and the brush rotates counterclockwise if it is moved to the left.

[0033] According to this aspect, particulate matter is scrapped or brushed away from the filter surface rather than being brushed and pressed into the filter surface. Thus, removing of particular matter from the filter surface is very efficient.

[0034] The filter cleaning device may further comprise a dust box for receiving particulate matter removed from the filter by the brush and removed from the brush by the first and second comb shaped members and optionally the third and fourth comb shaped members described below. The dust box may be movable together with the brush along the length of the filter. Further, the dust box may be arranged below the brush in a direction of gravity, whereby the particulate matter removed from the filter by the brush falls into the dust box by gravity. In a particular embodiment, the dust box may be arranged at an axial end of the brush.

[0035] According to this aspect, particulate matter removed from the filter by the brush and removed from the brush by the comb shaped members can easily be collected in the dust box. Preferably, the particulate matter falls into the dust box automatically by gravity when being removed and loosened from the brush.

[0036] To obtain a reliable cleaning of the filter and removing particulate matter therefrom, it is according to one aspect preferred that the brush has a body and a plurality of bristles radially extending from the body. In addition, because of

the use of bristles, optional reinforcing ribs of the filter may be accommodated by a larger bending of the bristles. Even further, the use of bristles in combination with the comb shaped members provides for a very effective loosening of any particulate matter adhering to the brush in that the separate bristles path through the recesses between teeth of the comb shaped members so that the particulate matter is scrapped away from the bristles.

[0037] Depending on the circumstances, it may happen that dust accumulates at the brush and the first and second comb shaped members whereby dust lumps are created. Those dust lumps that tend to be long and stick to the first and second comb shaped members or get caught in the dust box. Accordingly, it is difficult to remove the dust effectively from the filter cleaning device. A third comb shaped member and a fourth comb shaped member, each engaged with the brush, are suggested in order to cope with this problem. The third and fourth comb shaped members have a different function than the first and second comb shaped members. In particular, the first and second comb shaped members described above are configured to gather the dust from the brush, that is scratch the dust from the bristles of the brush. In contrast, the third and fourth comb shaped members form an obstacle to the bristles of the brush, wherein the bristles are bent upon rotation of the brush when engaging with the third and fourth comb shaped members. Once the bristles have passed by the third and fourth comb shaped members, the bristles spring back to their original position, whereby the dust adhering to the bristles is scattered (thrown away) into the dust box. Consequently, the accumulation of dust at the bristles is prevented and small particles are transferred into the dust box. Hence, only a relatively small amount of dust remains at the bristles and will be scratched off by the first and second comb shaped members, however without or at least with a reduced risk that dust lumps are formed. Also in this embodiment, only one of the third and fourth comb shaped members is active depending on the rotational direction of the brush. To put it differently, the third comb shaped member is only active in a first direction of rotation and the force of the comb shaped member is only active in a second direction of rotation of the brush. Further and as with the first and second comb shaped members, also the third and fourth comb shaped members may each have a length direction parallel to the axis of rotation of the brush and a width direction.

[0038] According to an aspect, the third comb shaped member is directed toward the first comb shaped member and the fourth comb shaped member is directed toward the second comb shaped member. As a result, the arrangement of the first and second comb shaped members and the third and fourth comb shaped members is the opposite, whereby effective scattering of the dust into the dust box may be achieved by the third and fourth comb shaped members and scratching of the remaining dust is still obtained by means of the first and second comb shaped members. Also in this configuration, it may be that the projections of the width directions of the third and fourth comb shaped members intersect. As in the above embodiment, the projections of the width directions of the third and fourth comb shaped members may intersect outside the diameter of the brush. According to one aspect, the projections of the width directions of the third and fourth comb shaped members intersect on the same side as the projections of the width directions of the first and second comb shaped members relative to the center axis (axis of rotation) of the brush. Preferably, the third comb shaped member and the fourth comb shaped member may be disposed symmetrically in a cross-sectional view perpendicular to the axis of rotation of the brush with respect to a line perpendicularly intersecting with the axis of rotation of the brush. In this context, the projection of the width direction of the third comb shaped member and the projection of the width direction of the fourth comb shaped member intersect on said line. According to one particular embodiment, the point of intersection of the projections of the width directions of the third and fourth comb shaped members is the same as that of the projections of the width directions of the first and second comb shaped members.

[0039] According to another aspect, the third comb shaped member is inclined toward the axis of rotation of the brush in a direction of the first rotating direction and the fourth comb shaped member is inclined toward the axis of rotation in a direction of the brush toward the second rotating direction.

[0040] Besides the above filter cleaning device, also an air conditioner, particularly a duct-type air conditioner, having such filter cleaning device is suggested. Even though the use with a duct-type air conditioner is preferred, the present filter cleaning device may also be applied to other air conditioners in which a filter requires regular cleaning.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] Further features and advantages are described in the following description of one embodiment, which makes reference to the accompanying drawings. The drawings show in:

Figure 1: a schematic view of a duct-type air conditioner;

Figure 2: a perspective view of a filter cleaning device according to an aspect of the present invention;

Figure 3: a front view of the filter cleaning device as shown in figure 2;

Figure 4: a side view of the filter cleaning device as shown in figure 2;

Figure 5: a partial side view of the filter cleaning device shown in figure 2 with the front plate and other parts being removed and with the brush in a parking position;

Figure 6: a cross-section along the line B-B in figure 5;

Figure 7: a partial side view of the filter cleaning device shown in figure 2 with a front plate and other parts being removed and during filter cleaning operation;

Figure 8: a cross-section along the line C-C in figure 7;

Figure 9: the detail D of figure 8;

Figure 10: a partial isometric front view of the filter cleaning device shown in figure 2 with the front plate being removed;

Figure 11: a partial front view of the filter cleaning device shown in figure 2 with the brush and its supports as well as the casing being removed;

Figure 12: a cross-section along the line D-D in figure 11

Figure 13: a partial isometric top view of the filter cleaning device shown in figure 2 with some parts removed;

Figure 14: a partial isometric view of the filter cleaning device shown in figure 2 with some parts removed;

Figure 15: a partial isometric top view of the filter cleaning device shown in figure 2 with some parts removed;

Figure 16: a) a side view of the brush, b) a front view of the brush to be engaged with the filter surface and c) a cross-section along the line A-A in figure 16a);

Figure 17: a schematic cross-sectional view of the cleaning member unit perpendicular to the axis of rotation of the brush showing an alternative configuration of the combs.

DESCRIPTION OF A PARTICULAR EMBODIMENT

[0042] Figures 2 to 4 generally show a filter cleaning device 10 according to one example. The filter cleaning device comprises a casing 11. The casing 11 has a casing inlet 60 and a casing outlet 61. In operation of the air conditioner, air flows through the casing 11 from the casing inlet 60 to the casing outlet 61 passing the filter 12.

[0043] The filter cleaning device 10 may be mounted to existing air conditioners such as the one depicted in figure 1, wherein the existing filter 12 is first removed from the existing indoor unit and a filter cleaning device 10 is attached to the inlet 2 of the existing casing at a flange 62. Alternatively, the filter cleaning device 10 as described herein may already be integrated into the casing of an indoor unit of an air conditioner at the time of production of the air conditioner.

[0044] A control box 66 is attached to one side of the casing 11 and configured to control the cleaning operation of the filter 12 described later.

[0045] The filter 12 contained in the filter cleaning device 10 is longitudinal and flat having a length L and a width W. In the example, the length L is larger than the width W, whereby the filter 12 is longitudinal. Further, the lengths L and the width W are both much larger than the thickness/height, whereby the filter 12 is flat.

[0046] Further, the filter 12 comprises a frame 63 of plastic material, which is molded about a mesh 64 made of plastic material, metal or other suitable material. One longitudinal reinforcing rib 15 and a plurality of transverse reinforcing ribs 65 are provided in order to stabilize the mesh 64 over the length and widths of the filter 12. The filter has a first filter surface 13 facing the inlet 60 and a second filter surface 14 facing the outlet 61. The first and second filter surfaces 13, 14 can be best seen in figure 6.

[0047] The filter cleaning device 10 further comprises a cleaning unit 67 configured to clean the filter 12 and particularly its mesh 64. The cleaning unit 67 comprises cleaning member unit 67a and a counter surface unit 67b.

[0048] The cleaning member unit 67a has a mechanical cleaning member 16 in the form of a brush 17. The brush 17 consists of a body 20 from which a plurality of separate bristles 21 extend in a radial direction. As can be best seen from the cross-sectional view in figure 9 and the perspective in figure 14, the brush 17 has a cylindrical shape and is rotatable about an axis of rotation 19, which corresponds to the center axis of the cylinder. The axis of rotation 19 is preferably parallel to the filter surface 13. Furthermore, the axis of rotation 19 of the brush 17 is disposed in a distance to the filter surface 13 which is smaller than the diameter of the brush to ensure contact of the brush 17 with the filter surface 13.

Yet, the distance is according to the example larger than the diameter of the body 20 to prevent any damaging of the filter by the brush 17.

[0049] Considering figure 14, the brush 17 is basically supported at both its axial ends 18 by supports 43a, 43b forming a support unit. The supports 43 rotatably support or retain the brush 17.

[0050] The lower support 43b is embodied as a dust box 28. In particular, the lower support 43b has a bottom 100 and sidewalls 101 surrounding the bottom, whereby the dust box 28 is formed (see figure 14).

[0051] The upper support 43a and the lower support 43b of the support unit are respectively provided with two wheels 45a, b. The wheels 45a of the upper support 43a are rotatably fixed to the upper support 43a or an upper portion of a wall 88 of a housing 30 connecting the supports 43a, 43b, respectively. The housing 30 connects to the side walls 100 of the dust box 28 and provides for a shielding effect as described in more detail below. The wheels 45a are rotatable about an axis of rotation 69.

[0052] The wheels 45b of the lower support 43b are rotatably and pivotably fixed to the lower support 43b or a lower portion of the wall 88 of the housing 30. In particular, the wheels 45b are rotatably fixed to a pivot arm 71 about an axis of rotation 69 and the pivot arm 71 is pivotably fixed to the lower support 43b or a lower portion of the wall 88 of the housing 30 about a pivot 70. Furthermore, a spring (as an example of the second elastic member) 47 is fixed at one of its opposite ends to the pivot arm 41 of one wheel 45b and the other one of its opposite ends to the pivot arm of the other wheel 45b. Accordingly, the wheels 45b are urged towards each other about the pivots 70.

[0053] The wheels 45a at the top are engaged with a longitudinal top guide rail 44a (guide) extending in a length direction of the filter 12 along the filter cleaning device 10. The same applies for the wheels 45b at the bottom, which are engaged with a longitudinal bottom guide rail 44b (guide) extending substantially in parallel to the top guide rail 44a.

[0054] Accordingly, the support unit is movably guided between the guide rails 44a, 44b and hence movable along the length of the filter 12 or its filter surface 13, respectively.

[0055] The filter 12 and consequently also the guide rails 44a, 44b can be relatively long. As a consequence, bending of the guide rails 44a, 44b may occur with the result that the distance D (see **figure 12** with respect to the counter surface unit 67b) parallel to the filter surface 13 and between opposite guide rails 44a, 44b at the top and bottom is not constant over the lengths of the guide rails 44a, 44b. As described earlier, the wheels 45b of the lower support 43b are urged towards each other by the spring 47 about the pivots 70. Accordingly, the wheels 45b are urged towards a position in which their distance D to the wheels 45a at the upper support 43a is the largest. Thus, if the distance D between the opposite guide rails 44a, 44b becomes larger, the wheels 45b pivot counterclockwise (left wheel 45b in **figure 10**) and clockwise (right wheel 45b in **figure 10**) about the pivot 70 by the force of the spring 47. Thereby, the wheels 45b at the lower support 43b remain securely engaged with the lower guide rail 44b as do the wheels 45a at the upper support 43a. Similar, if the distance D between opposite guide rails 44a, 44b becomes smaller, the wheels 45b pivot in the opposite direction, thereby automatically compensating for the change in distance D. Accordingly, support unit may reliably be moved along the guide rails 44a, 44b without becoming loose or stuck.

[0056] As previously mentioned, the brush 17 is rotatably supported in the support unit. As a result, the support unit serves to move the brush 17 along the filter surface 13. For movement of the support unit along the filter 12, the support unit is driven.

[0057] According to one example a rack 72 (see **figure 13**) is provided extending along the filter 12 in parallel to the guide rails 44a, 44b. Furthermore, the support unit comprises a motor 46 (see **figure 14**) which may be a stepping motor. The motor 46 is attached to the upper support 43a, thus avoiding any possible contact with condensate accumulating at the bottom of the filter cleaning device. Further, the motor 46 is with its axis connected to a first gear 73 rotatably attached to the upper support 43a. The first gear 73 meshes with a second gear 74 again meshing with a third gear 75. Also the second and third gear 74 and 75 are rotatably attached to the upper support 43a. The third gear 75 meshes with the rack 72.

[0058] Accordingly, the motor 46 rotates the first gear 73, whereby the second gear 74 and the third gear 75 are rotated. Thus, the rotational force is transmitted via the gears 73 to 75 to the rack 72. The rack 72 converts the rotational force into a translational force, whereby the support unit and, hence, the brush 17 rotatably supported therein, are moved along the rack 72 and thereby along the filter 12.

[0059] **Figure 13** additionally shows a fourth gear 76 again meshing with the rack 72. A centrally arranged fifth gear 77 meshes with the fourth gear 76 to transfer the rotation to a sixth gear 78. The axis of rotation 19 of the brush 17 is fixed to the axis of rotation of the sixth gear 78. Accordingly, upon operation of the motor 46 and movement of the support unit along the rack 72, the movement of the support unit along the rack 72 results in rotation of the fourth gear 76 meshing with the rack 72. As a consequence, the translational movement of the support unit along the rack 72 is converted into a rotational movement. This rotation is transferred via the centrally arranged fifth gear 77 to the sixth gear 78 thereby rotating the brush 17. In this context, if the support unit moves in **figure 13** to the right, the fourth gear 76 is rotated clockwise whereby the centrally arranged fifth gear 77 is rotated counterclockwise and the sixth gear 78 again rotates clockwise. If the support unit moves in **figure 13** to the left, the fourth gear 76 is rotated counterclockwise whereby the

centrally arranged fifth gear 77 is rotated clockwise and the sixth gear 78 again rotates counterclockwise. Thus, the brush 17 is rotated in opposite directions and depending on the direction of movement of the support unit. In particular, the brush 17 is always rotated in the direction of movement. In other words, the upstream side of the brush 17 is always rotated against the filter surface 13 whereas the downstream side of the brush 17 is always rotated away from the filter surface 13.

[0060] As will be apparent from the above description, only one motor 46 is used to move the support unit and hence the brush 17 along the filter 12 and hence its filter surface 13, and to rotate the brush 17.

[0061] Due to the movability of the cleaning member unit 67a and hence the brush 17 in a longitudinal direction of the filter 12 as explained above, the cleaning member unit 67a may be moved to a parking position shown in **figures 5** and **6** during non-cleaning operation of the cleaning unit. It is preferred that the cleaning unit does not overlap with the filter surfaces 13, 14 of the filter 12 in this parking position as seen in a plan view such as in the cross section of **figure 6** or in a front view as shown in **figure 5**. Thus it can be prevented that any portion of the filter 12 is blocked by the cleaning unit during non-cleaning operation, that is during air conditioning operation. Thus, the cleaning unit does not represent any obstruction to the air flow flowing through the filter 12 and the whole filter surface 13, 14 may be used.

[0062] When the brush 17 and particularly its bristles 21 brush along the filter surface 13 and remove the particulate matter therefrom, particulate matter may adhere to the bristles 21. In order to remove the particulate matter from the bristles 21 and, hence, the brush 17, the cleaning unit further comprises a first comb shaped member 48 and a second comb shaped member 49 which are respectively engaged with the brush 17 and particularly the bristles 21 (see **figure 16**). The comb shaped members 48 and 49 extend parallel to the axis of rotation 19 of the brush 17 along the whole or at least a substantial part of the axial lengths of the brush 17. Thus, the comb shaped members 48 and 49 have a length along the axial direction and a width perpendicular thereto (seen in the cross-sectional view in **figure 16c**). The comb shaped members 48 and 49 further have in their width direction a free edge 99 respectively engaged with the bristles 21 of the brush 17. The opposite edge of the comb shaped members 48 and 49 is respectively connected or integrally formed with a comb body 97. As shown in **figure 15**, the comb body 97 is fixed to the housing 30 or more particularly the back wall 88 of thereof.

[0063] The comb shaped members 48 and 49 are respectively formed along the length direction with a plurality of teeth 102 separated by recesses. In other words, the comb shaped members are configured of a plurality of merlons and crenels. The teeth 102 extend in the width direction from the comb body 97. The cross-sectional line A-A extends through one of the teeth 102. The two comb shaped members 48 and 49 are respectively angled or inclined with their width direction in opposite directions, that is away from each other. To put it differently, the comb shaped members 48 and 49 are inclined in different directions with respect to an axis of symmetry 103. In particular, the teeth 102 are angled or inclined as described above. As may be best seen from the cross-section in **figure 16c**, the comb shaped members 48 and 49 are respectively arranged symmetrically to the line of symmetry 103. As shown, the comb shaped members 48 and 49 are angled by a positive angle α^+ and a negative angle α^- , respectively. In particular, drawing a circle 52 being the outer diameter of the bristles 21 or at least co-axial with the outer diameter of the bristles 21 and drawing a first and second tangent 50, 51 to the circle which are perpendicular to each other, the first comb shaped member 48 is angled clockwise at a negative angle α^- and the second comb shaped member 48 is angled counterclockwise at a positive angle α^+ with their width direction. The absolute value of the angles α is however the same to provide for a symmetric arrangement. In this context, the width direction is preferably drawn as a centerline in the cross-section in **figure 16c** at that position of the comb shaped members having the largest thickness perpendicular to the width direction WD and the length direction LD. Accordingly, if the brush 17 is rotated clockwise in **figure 16c**, the comb shaped member 48 is inclined towards the direction of rotation of the brush 17. If the brush 17 is rotated counterclockwise, the comb shaped member 49 is inclined towards the direction of rotation of the brush 17. Accordingly, it can be effectively achieved that the bristles 21 of the brush 17 and to the recesses between the teeth 102 so that any particulate matter can be scrapped off of the bristles 21.

[0064] As previously mentioned, the dust may adhere to the comb shaped members 48 and 49 promoting the formation of dust lumps which stick to the comb shaped members 48 and 49 and/or are difficult to be removed from the dust box 28. According to another embodiment as shown in **figure 17**, two additional comb-shaped members 104, 105 (third and fourth the comb shaped members) are provided. In the particular embodiment, the comb shaped members 104 and 105 are provided in the proximity of the opening 31 from which the brush 17 projects. The comb shaped members 104 and 105 also engage with the bristles 21 of the brush 17. The comb shaped members 104 and 105 extend parallel to the axis of rotation 19 of the brush 17 along the whole or at least a substantial part of the axial lengths of the brush 17. Thus, the comb shaped members 104 and 105 have a length along the axial direction and a width perpendicular thereto (seen in the cross-sectional view in **figure 17**). The comb shaped members 104 and 105 further have in their width direction a free edge 106 respectively engaged with the bristles 21 of the brush 17. The opposite edge of the comb shaped members 48 and 49 is respectively connected or integrally formed with the housing 30 forming the dust box 28.

[0065] The comb shaped members 104 and 105 are respectively formed along the length direction with a plurality of teeth separated by recesses. In other words, the comb shaped members are configured of a plurality of merlons and

crenels. Alternatively, the comb shaped members 104 and 105 may have a plate-shaped with a straight edge engaging with the bristles 21. The comb shaped members 104 and 105 are respectively angled or inclined with their width direction in opposite directions towards each other. To put it differently, the comb shaped members 104 and 105 are inclined in different directions with respect to an axis of symmetry 103. As is the best shown in **figure 17**, the projections of the width directions of the comb shaped members 104 and 105 intersect at the point of intersection 108 on the line of symmetry 103. Also the projections 107 of the width directions of the comb shaped members 48 and 49 intersect in the same point of intersection 108 on the line of symmetry 103.

[0066] Moreover and as shown in **figure 17**, the free edges 99 of the comb shaped members 48 and 49 and the free edges 106 of the comb shaped members 104 and 105 face each other. To put it differently, the comb shaped members 48 and 49 and the comb shaped members 104 and 105 are directed towards each other, respectively.

[0067] As described above, the brush 17 may rotate in opposite directions and depending on the movement of the support unit. Thus, if the brush rotates clockwise, the first comb shaped member 48 serves for removing or loosening the particulate matter from the bristles 21, whereas if the brush rotates counterclockwise, the second comb shaped member 49 provides for this effect. Thus, a very effective cleaning of the bristles 21 may be affected no matter in which direction the brush 17 rotates.

[0068] Further and in the alternative embodiment of figure 17, when the brush 17 is rotated clockwise in figure 17, the bristles 21 engage with the third comb shaped member 104. As a result, the bristles 21 are temporarily retained by the third comb shaped member 104 and thereby bent because of the further rotation of the brush 17 and particularly its body 19. After the bristles 21, temporarily retained by the third comb shaped member 104, have passed by the third comb shaped member 104, the bristles 21 spring back to the original, e.g. radial position. Thereby, any dust adhering to the bristles 21 from the filter 12 is thrown from the bristles 21 and scattered into the dust box 28 as relatively small dust particles.

[0069] The remaining amount of dust still adhering to the bristles 21 downstream of the third comb shaped member 104 in the rotating direction is scratched of the bristles 21 by the first comb shaped members 48 as described above. Yet, because of the reduced amount of dust adhering to the bristles 21 at this stage, the formation of dust lumps is reduced, whereby the clogging of the comb shaped members 48 and long dust lumps which are difficult to be removed from the dust box 28 can be prevented.

[0070] If the brush 17 is rotated counterclockwise in figure 17, the fourth comb shaped member 105 is active and functions in the same manner as the third comb shaped member 104 as described above. Also and as described earlier, the second comb shaped member 49 is active and takes over the function of the first comb shaped member 48.

[0071] Furthermore, a first and second separation roller 53 and 54 are provided wherein the first separation 53 is associated to the first comb shaped member 48 and the second separation roller 54 is associated to the second comb shaped member 49. Both separation rollers 53, 54 extend parallel to the axis of rotation 19 of the brush 17. The separation rollers 53, 54 are respectively provided in order to remove the particulate matter loosened by the comb shaped members 48, 49 from the bristles 21 away from the brush 17 so that the particulate matter falls into or towards the bottom 100 of the dust box 28 by gravity. For this purpose, the separation rollers 53, 55 are rotated in the same direction as the brush 17. In particular, the separation rollers 53, 55 is there a centrifuge particulate matter coming into contact with the separation rollers away from the brush 17 and the comb shaped members 48, 49 or at least create an air flow blowing the loosened particulate matter away. In this context, it is preferred that the separation rollers 53 and 54 are located on an outer side of the comb shaped members 48, 49 with respect to the axis of rotation 19 of the brush 17, respectively.

[0072] According to one example, two seventh gears 79 (see **figure 13**) are provided meshing with the centrally arranged fifth gear 77. These seventh gears 79 are respectively attached to the axes of rotation of the first and second separation rollers 53 and 54 at their axial ends. As the sixth gear 78 also the seventh gears 79 will be rotated automatically by movement of the support unit along the rack 72 and rotation of the fourth gear 76. The axial ends of the separation rollers 53 and 54 opposite to the seventh gears 79 are rotatably accommodated in the collars 98 at the bottom of the support unit (lower support 43b) as shown in **figure 14**. In the above example, when the support unit moves to the right, both seventh gears 79 are rotated counterclockwise, whereas both seventh gears 79 are rotated clockwise when the support unit moves to the left. Accordingly also in this case, the motor 46 is used to rotate the first and second separation rollers 53, 54 in the same direction as the brush 17.

[0073] The support unit further comprises the housing 30 and a partition 68. The housing 30 together with the partition 68 forms a chamber accommodating the brush 17. That chamber is communicated with the dust box 28 in which particulate matter brushed off the filter 12 or its filter surface is retained before being removed by a vacuum source as explained later. The housing 30 together with the partition 68 further defines an opening 31 through which a portion of the brush 17 extends (see **figure 9**). Thereby it is ensured that the brush protrudes from the housing 30 and is capable of contacting and brushing the filter surface 13. Further, the housing 30 prevents particulate matter removed from the filter by the brush from being distributed throughout the filter cleaning device. Moreover, the housing 30 shields the dust box 28 and prevents particulate matter already collected in the dust box from being sucked from the dust box during the air conditioning operation. In addition, the relatively small opening 31 enables to reduce exchange of air at the dust box 28, when removing the particulate matter from the dust box using a vacuum source. Thus, building up a relatively high

under pressure is simplified.

[0074] Moreover, a suction section 32 as shown in **figures 6, 8 and 9** is provided for removing the dust accumulated in the dust box 28 from the dust box. The suction section 32 comprises an outlet 37. The outlet 37, which may be a circular opening, has a center axis 38. The outlet 37 is communicated with the dust box 28 via a cleaning path 80 having a cleaning opening 81 (see **figure 14**) opening into the dust box 28.

[0075] The suction section 32 further comprises a suction opening 33 fixed to the casing 11 of the filter cleaning device. In this example, a fitting extends from the casing 11 and forms the suction opening 33 at the inside of the casing 11. The fitting further has an exhaust opening 82 at the outside of the casing 11. The suction opening 33 and the exhaust opening 82 may be both circular. The center axis of at least the suction opening 33 is congruent with the center axis 38 of the outlet 37.

[0076] In one example, a suction socket 42 (see **figure 2**) may be communicated to the suction opening 33 via a hose 83 connected to the exhaust opening 82 at one end and to the suction socket 42 at the other end. The suction socket 42 may be configured to receive a fitting and/or a hose of a common vacuum cleaner and may be accessible in the false ceiling U or a false wall without the necessity to remove a part of the ceiling or a wall. Further, it may as well be conceivable to dispose the suction socket 42 outside the room to be conditioned via the air conditioner. Thus, cleaning personal is enabled to remove dust from the dust box 28 without having to enter the room to be conditioned such as the hotel room or a meeting room.

[0077] Once the cleaning operation is finished, the cleaning unit moves towards the left in **figure 8** until it reaches the parking position mentioned above. In this parking position the outlet 37 is communicated with the suction opening 33, whereby the dust box 28 is communicated via the cleaning opening 81, the cleaning path 80, the outlet 37 to the suction opening 33 and, hence, to the exhaust opening 82.

[0078] A sealing member 34 is provided at an area 35 surrounding the outlet 37 and/or an area 36 surrounding the suction opening 33. Upon movement of the cleaning unit to the parking position, the sealing 34 is sandwiched and pressed between the area 35 and the area 36 and the outlet 37 is communicated with the suction opening 33. In order to be sufficiently pressed, the stepping motor 46 is controlled by the control box 66. Upon a feedback of a positioning sensor (such as a limit switch) that the cleaning unit has reached the parking position the control is configured to move the cleaning unit towards the left (in the direction of the parking position) at least one additional distance (one or more steps of the stepping motor). Accordingly a relatively tight and reliable seal can be achieved.

[0079] Additionally or alternatively to the sealing 34, a shroud 84 may be provided surrounding the outlet 37 or the suction opening 33. Upon reaching the parking position, the shroud 84 enters into the suction opening 33 and engages with an inner circumferential surface of the suction opening 33, thereby achieving a sealing effect. However, to achieve a reliable and sufficient sealing, relatively small tolerances regarding the inner diameter of the suction opening 33 and the outer diameter of the shroud 84 are required. For this reason, the above-described sealing 34 is preferred. In one embodiment, the shroud 84 may, hence, dispense the sealing function and merely provide for centering the outlet 37 relative to the suction opening 33. For this purpose, the shroud 84 may have a tapering 85 towards the suction opening 33, whereby upon engagement of the shroud 84 in the suction opening 33 a self-centering effect is obtained.

[0080] Moreover, a lid 39 is fixed to the casing 11 as best shown in **figures 7 and 8**. More particular, the lid 39 in this example is rotatably fixed to the casing 11 about the rotation axis 85. In this example the lid 39 is comprised of a covering 86 forming a cavity 41 and an actuating arm 40. The covering 86 and the cavity 41 are located on one side relative to the axis 85 and the actuating arm 40 is located on the other side relative to the axis 85. The lid 39 is urged about the axis 85 counterclockwise by a leg spring 87 (third elastic member). In particular and with reference to the following description of its function, the lid 39 is urged towards an opening position.

[0081] When the cleaning unit is moved towards the parking position (e.g. from the position in **figure 8** towards the left), the left end of the housing 30 or any other part of the cleaning unit comes in contact (engages) with the actuating arm 40. Accordingly, the cleaning unit pushes the actuating arm 40 in a clockwise direction about the axis 85. Thereby the covering 86 is rotated toward the housing 30 against the force of the leg spring 87. In the parking position, shown in **figures 5 and 6**, the covering 86 closes the opening 31 of the housing 30 and the cavity 41 accommodates that portion of the brush 17 protruding from the opening 31. Lid 39 is, thus, capable of preventing any particulate matter accumulated in the dust box 28 from leaving the dust box 28 and the housing 30 during air conditioning operation.

[0082] In this parking position also the outlet 37 and the suction opening 33 are communicated. Thus, upon plugging a fitting of a vacuum cleaner into the suction socket 42 and applying a suction force, particulate matter accommodated in the dust box 28 is sucked from the dust box 28. Further and due to the pressure reduction within the dust box 28, the covering 86 is sucked against the edge of the opening 31 of the housing. In another example, it may, hence, well be to dispense the actuating arm 40 and to merely close the lid 39 by the suction force applied by the vacuum cleaner in the parking position. In this example, however the opening 31 will only be closed during cleaning of the dust box 28 and the effect of preventing particulate matter from being drawn from the dust box 28 during the air conditioning operation is dispensed. Yet, closing of the opening 31 by the lid 39 also provides for a more effective cleaning of the dust box 28 as compared to a non-sealed opening. In particular, a higher under pressure may be built up within the dust box 28 leading

to a more effective or more complete cleaning of the dust box 28 by the vacuum cleaner.

[0083] The cleaning unit further comprises the counter surface unit 67b. The counter surface unit 67b comprises a counter surface 22 (see **figures 11 and 12**). In this example, the counter surface 22 is formed by the outer surface 25 of a cylinder 26. The cylinder 26 is rotatably supported in a supporting unit formed by an upper support 43c and a lower support 43d connected by a back wall 88. The support unit is configured very similar to that of the cleaning member unit 67a and comprises two upper wheels 45c and to lower wheels 45d wherein the wheels 45c, 45d and their connection are embodied in the same manner as described with respect to the cleaning member unit 67a and as shown in **figure 10**. Accordingly and in order to avoid repetition these elements are not described in more detail at this stage. Similar, motor 46 is also provided in the support unit (**figure 11**). The motor 46 is with its axis connected to eighth gear 94 meshing with a ninth gear 95 again meshing with a tenth gear 96 meshing with the rack 72. Thus, the support unit of the counter surface unit 67b is moved along the rack 72 upon operation of the motor 46 in the same manner as the support unit of the cleaning member unit 67a and further description is omitted.

[0084] The cylinder 26 comprises a cylinder axis 27 which is at the same time the axis of rotation of the cylinder 26. The cylinder 26 has at its center in the axial direction an annular groove 24. As can be best seen from **figures 11 and 12** the annular groove 24 accommodates the longitudinal reinforcing rib 15 of the filter 12. Thereby it can be ensured that the outer surface 25 of the cylinder reliably pushes the mesh 64 of the filter 12 against the bristles 21 of the brush 17 and closes the mesh 64 at the filter surface 14 in order to prevent particulate matter from being pressed through the mesh 64. Certainly, a plurality of such annular grooves 24 can be provided if a plurality of longitudinal reinforcing ribs 15 is provided.

[0085] In the shown example, the cylinder 26 is hollow. For ease of production, the cylinder 26 can be produced from half shells 89. The half shells 89 are each half circular in cross section and, thus, a half cylindrical. The half shells may be at one end be connected by a living or integral hinge. In addition, the axis of rotation 27 may be integrally formed with one of the half shells 89. For this purpose, two coaxial protrusions may extend from the axial end of the half shells in an axial direction. Thus, the cylinder 26 may be injection molded from plastic material. To form the cylinder 26, the half shells 89 are rotated about the living hinge and fixed together by latches 90 at one of the half shells 89 and corresponding hooks 91 at the other one of the half shells 89. Certainly also other methods for fixing the half shells may be used. Also the half shells may be formed separately and then be fixed together without the use of a living hinge.

[0086] Furthermore, the filter 12 may along its length not to be completely flat but bend in a direction towards the counter surface unit 67b and/or the cleaning member unit 67a or even wavy. Accordingly, it could happen that either the brush 17 comes out of contact with the filter surface 13 reducing cleaning efficiency or that the brush 17 is pushed into the filter surface 13 to heavily with the risk of damaging the filter. To cope with this problem, the cylinder 26 and hence the counter surface 21, formed by the outer surface 25 of the cylinder 26, is urged towards the filter surface 14.

[0087] As one example, the axis of rotation 27 of the cylinder 26 is guided in a long hole 92 (also see **figure 15**). The longitudinal direction of the long hole 92 extends in a direction perpendicular to the filter surface 14. Accordingly, the cylinder 26 may move in a direction perpendicular to the filter surface 14. A leg spring 23 (as an example of a first elastic member) is provided in order to urge the cylinder 26 in a direction towards the filter surface 14. More particularly, the axis of rotation 27 of the cylinder 26 is rotatably fixed to a carriage 93. The carriage 93 is translationally movable in the long hole. Accordingly and even though the counter surface 22 formed by the outer surface 25 of the cylinder 26 is rigid in a radial direction, the movability of the cylinder 26 in a direction perpendicular to the filter surface 14 accommodates changes in the distance of the filter surface 14 to the outer surface 25 due to unevenness of the filter 12 along its length. Accordingly the filter is always reliably pressed against the rotating brush 17 or more particularly its bristles 21 at a relatively constant force so that a high cleaning efficiency may be achieved without the risk of damaging the filter.

[0088] In the present example, the cleaning member unit 67a and the counter surface unit 67b are respectively formed independent and separate from each other. More particularly, the support units are formed separately. Accordingly, the filter cleaning device 10 may have a relatively low width (or height) being substantially dependent on the width of the filter 12. However in alternative embodiments, the support units may also be connected above and/or below the frame 63 of the filter 12. This would provide for the advantage that only one motor 46 would be required for both units 67a, 67b.

[0089] In the following, the function of the above-described filter cleaning device will be explained.

[0090] In the non-cleaning operation and during air conditioning operation, the cleaning unit including the brush 17 and the counter surface 22 is positioned in the parking position shown in **figures 2 to 6**.

[0091] First, the control considers whether cleaning operation is required. In this context, different parameters and can trigger that cleaning operation is required. As one example, the cleaning operation is performed in a predetermined time interval. Alternatively, a sensor may be provided capable of measuring a degree of particulate matter on the filter such as a sensor capable of measuring a flow resistance of air flowing through the filter. The output of this sensor may be used by the control to trigger the cleaning operation. Certainly, also other parameters may be used for this purpose.

[0092] Once cleaning operation is started, the control in the control box 66 cooperates with the control of the air conditioner to temporarily stop the air conditioning operation. Subsequently, the motors 46 are activated. Accordingly, the cleaning member unit 67a and the counter surface unit are moved from the left to the right along the filter surfaces

13, 14 respectively, wherein the rotational force of the motors 46 is transferred via the gears 73 to 75 to the rack 72 and the gears 94 to 96 to the rack 72. At the same time the brush 17 is rotated, wherein the translational movement of the support unit of the cleaning member unit 67a along the rack 72 is converted and transmitted via the gears 76, 77 and 78 to the axis of rotation 19 of the brush 17, thereby rotating the brush 17 clockwise. Accordingly the bristles 21 brush particular matter from the filter surface 14 away from the filter surface 14 whereby the particulate matter is transferred by the brush 17 through the opening 31 into the housing 30 and subsequently falls into the dust box 28 by gravity.

[0093] In the housing 30, the particulate matter is scrapped away from the bristles 21 by the first comb shaped member 48. The first separation roller 53 being rotated by the gear 79 in a counterclockwise direction ensures that the particulate matter scrapped away from the bristles 21 by the first comb shaped member 48 is moved away from the bristles 21. The thus separated particulate matter will then fall into the dust box 28 or particularly towards its bottom 100 by gravity and will be collected at the bottom 100 of the dust box 28 (lower support 43b).

[0094] The counter surface 22 formed by the outer surface 25 of the cylinder 26 is moved together with the brush 17 along the filter 12 being in contact with the opposite filter surface 14. In particular, a line connecting the axis of rotation 27 and the axis of rotation 19 is perpendicular to the filter surfaces 13, 14. Accordingly, the counter surface 22 supports the filter 12 at the side of the filter surface 14 so as to keep the mesh 64 in contact with the bristles 21 of the brush 17. During the movement of the brush 17 and the counter surface 21 along the filter 12, the counter surface 22 may compensate for any deviations of the filter 12 from an evenly flat shape in that it may move perpendicular to the filter surfaces 13, 14 within the long hole 92. Further, as the counter surface 22 is urged towards the filter surfaces 13, 14 by the leg spring 23, the bristles 21 are engaged with the filter surface 13 at a relatively constant pressure/force along the length of the filter. Accordingly, an efficient and reliable cleaning can be performed without the risk of damaging the filter.

[0095] Further, it is to mention that the counter surface 22 particularly the cylinder 26 is not actively driven or rotated, but rotates because of its frictional contact with the filter surface 14. When the cleaning unit moves to the right, the cylinder 26 hence rotates in the same direction as the brush 17, that is clockwise. Due to the rotation of the counter surface and its curved shape, the contact area and the friction between the contact area and the filter surface 14 is relatively low so that any damaging of the filter 12 by the counter surface 22 can reliably be prevented.

[0096] Once the cleaning unit has reached the end of the filter 12 opposite to the parking position, the rotation direction of the motors 46 is switched. This can for example be triggered by the cleaning unit moving against a limit switch, thereby switching the motors 46. Yet, also other control mechanisms are conceivable. Switching the rotational direction of the motors 46 changes the rotational direction of all gears 33 to 79 and 94 to 96. Accordingly, the brush 17 is rotated counterclockwise as are the separation rollers 53 and 54. During the movement to the left, the cylinder 26 is again rotated by frictional engagement with the filter surface 14, however, now counterclockwise. During movement in this direction, the second comb shaped member 49 and the second separation roller 54 are active for scrapping the particulate matter from the bristles 21 and move the scrapped of particulate matter away from the bristles 21 for being collected in the dust box 28.

[0097] The above process may be repeated as required until the cleaning operation is finished. If a command has been provided by the control in the control box 66 that the cleaning operation can be terminated, the cleaning unit is again moved to the parking position. During this movement and as previously indicated, the housing 30 of the cleaning unit engages with/comes into contact with the actuating arm 40 thereby pivoting the lid 39 around the axis 85 in a clockwise direction, whereby the covering 86 closes the opening 31 in the housing 30. If the cleaning unit has reached the parking position which may be indicated to the control by the use of a sensor or a limit switch, the motors 46 are activated to perform at least one more step towards the parking position in order to press the sealing 34 and securely communicate the outlet 37 and the suction opening 33. Subsequently, the cleaning operation is finished.

[0098] The cleaning personal in the premises in which the filter cleaning devices are mounted may in a regular interval then plug a fitting of the vacuum cleaner into the suction socket 42 and thereby apply a sucking force to the suction opening 33, whereby particulate matter accumulated at the bottom 100 of the dust box 28 is sucked from the dust box 28 via the cleaning opening 81, the cleaning path 80, the outlet 37, the suction opening 33, the exhaust opening 82, the hose 83 and the suction socket 42 into the vacuum cleaner. According to an alternative example, it may be conceivable to connect the control in the control box 66 to a network within the premises and to output a signal that the cleaning operation has been performed to the network so as to indicate to the cleaning personal that the dust box 28 is to be emptied. It is also possible to provide a visual indicator such as a light at the suction section 42, which could indicate to the cleaning personal that emptying the dust box 28 is required (for example a red light for cleaning and a green light for non-cleaning requirement). Instead of using a predetermined interval as requirement for removing the particulate matter from the dust box 28 or triggering the necessity to empty the dust box 28 by the termination of the cleaning operation, sensors outputting information on the amount of particulate matter accumulated in the dust box 28 can be used. This information can be outputted to the network or used to control the visual indicator. In a preferred embodiment, the suction section 42 is disposed outside the space to be conditioned, whereby the cleaning personal does not need to enter this space for emptying the dust box 28.

[0099] As will be apparent from the above description, the filter cleaning device described above provides for a very

efficient system overcoming the problems adhering to the prior art to at least to some extent.

REFERENCE LIST

5	Air conditioner	1
	Inlet	2
	Outlet	3
	Heat exchanger	4
10	Fan	5
	Air ducting	6, 7
	Exit grating	8
15	Inlet grating	9
	Filter cleaning device	10
	Casing	11
	Filter	12
20	Filter surface	13, 14
	Width of the filter	W
	Length of the filter	L
25	Longitudinal reinforcing rib	15
	Cleaning member	16
	Brush	17
	Axial end of the brush	18
30	Axis of rotation (cylinder axis)	19
	Body	20
	Bristles	21
35	Counter surface	22
	First elastic member	23
	Annular groove	24
	Outer surface	25
40	Cylinder	26
	Axis	27
	Dust box	28
45	Direction of movement	29
	Housing	30
	Opening	31
	Suction section	32
50	Suction opening	33
	Sealing	34
	Area surrounding the outlet	35
55	Area surrounding the suction opening of the casing	36
	Outlet	37
	Center axis	38

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(continued)

	Lid	39
5	Actuating arm	40
	Cavity	41
	Suction socket	42
	Support	43 a-d
10	Guide	44 a-d
	Wheel	45 a-d
	Motor	46
15	Second elastic member	47
	First comb shaped member	48
	Second comb shaped member	49
	Length direction	LD
20	Width direction	WD
	First tangent	50
	Second tangent	51
25	Circle	52
	Positive angle	α^+
	Negative angle	α^-
	First separation roller	53
30	Second separation roller	54
	Casing inlet	60
	Casing outlet	61
35	Flange	62
	Frame	63
	Mesh	64
	Transverse reinforcing rib	65
40	Control box	66
	Cleaning unit	67a-b
	Partition	68
45	Axis of rotation	69
	Pivot	70
	Pivot arm	71
	Rack	72
50	first gear	73
	second gear	74
	third gear	75
55	fourth gear	76
	fifth gear	77
	sixth gear	78

(continued)

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45

seventh gear	79
Cleaning path	80
Cleaning opening	81
Exhaust opening	82
Hose	83
Shroud	84
Rotation axis	85
Covering	86
third elastic member	87
Back wall	88
Half shells	89
Latch	90
Hook	91
Long hole	92
Carriage	93
eighth gear	94
ninth gear	95
tenth gear	96
Comb body	97
Collar	98
Free edge	99
Bottom	100
Side walls	101
Teeth	102
Axis of symmetry	103
Third comb shaped member	104
Fourth comb shaped member	105
Free edge	106
Projection of width direction	107
Point of intersection	108

Claims

1. Filter cleaning device for an air conditioner (1), particularly a duct-type air conditioner, the filter cleaning device comprising:

- a filter (12) to be passed through by an air flow and having a filter surface (13);
- a brush (17) contactable with the filter surface (13) for removing particulate matter from the filter surface, wherein the brush has a cylindrical shape; and
- a motor (46) configured to rotate the brush in opposite directions;
- a first comb shaped member (48) engaged with the brush; and
- a second comb shaped member (49) engaged with the brush,

- wherein the first and second comb shaped members each have a length direction parallel to the axis of rotation of the brush and a width direction, wherein the first comb shaped member and the second comb shaped member are inclined away from each other in a cross-sectional view perpendicular to an axis of rotation (19) of the brush.

- 5 **2.** Filter cleaning device according to claim 1, wherein the first comb shaped member (48) is angled with its width direction (WD) with respect to a first tangent (50) on a circle (52) having a common center axis with the axis of rotation (19) of the brush (17) at a positive angle (α^+) and the second comb shaped member (49) is angled with its width direction (WD) with respect to a second tangent (52) on the circle and being perpendicular to the first tangent at a negative angle (α^-).
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- 3.** Filter cleaning device according to claim 2, wherein the absolute value of the positive angle (α^+) and the negative angle (α^-) is the same.
- 15 **4.** Filter cleaning device according to any one of the preceding claims, wherein the first comb shaped member (48) is inclined away from the axis of rotation (19) of the brush (17) in a direction toward the first rotating direction and the second comb shaped member (49) is inclined away from the axis of rotation in a direction of the brush (17) toward the second rotating direction.
- 20 **5.** Filter cleaning device according to any one of the preceding claims, wherein a first rotatable separation roller (53) extending parallel to the axis of rotation (19) of the brush (17) is disposed upstream of the first comb shaped member (48) in the first rotating direction and a second rotatable separation roller (54) extending parallel to the axis of rotation of the brush is disposed upstream of the second comb shaped member (49) in the second rotating direction.
- 25 **6.** Filter cleaning device according to claim 5, wherein the first separation roller (53) is configured to rotate in a direction opposite to the first rotating direction and the second separation roller (54) is configured to rotate in a direction opposite to the second rotating direction.
- 7.** Filter cleaning device according to claim 5 or 6, wherein the first and second separation roller (53, 54) are driven by the motor (46).
30
- 8.** Filter cleaning device according to any one of the preceding claims, wherein the brush (17) is reciprocally and translationally movable along the filter surface (13).
- 35 **9.** Filter cleaning device according to claim 8, wherein the motor (46) is configured to respectively rotate the brush in the direction of movement (29) of the brush (17) along the filter surface (13).
- 10.** Filter cleaning device according to anyone of the preceding claims, further comprising a dust box (20) for receiving particulate matter removed from the filter (12) by the brush (17).
- 40 **11.** Filter cleaning device according to any one of the preceding claims, wherein the brush (17) has a body (20) and a plurality of bristles (21) radially extending from the body.
- 12.** Filter cleaning device according to any one of the preceding claims, further comprising a third comb shaped member (104) engaged with the brush (17) and a fourth comb shaped member (105) engaged with the brush (17), wherein the third and fourth comb shaped members each have a length direction parallel to the axis of rotation (19) of the brush and a width direction.
45
- 13.** Filter cleaning device according to claim 12, wherein the third comb shaped member (104) is directed toward the first comb shaped member (48) and the fourth comb shaped member (105) is directed toward the second comb shaped member (49).
50
- 14.** Filter cleaning device according to claim 12 or 13, wherein the third comb shaped member (104) is inclined toward the axis of rotation (19) of the brush (17) in a direction of the first rotating direction and the fourth comb shaped member (105) is inclined toward the axis of rotation in a direction of the brush (17) toward the second rotating direction.
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- 15.** Air conditioner, particularly a duct-type air conditioner, the air conditioner having a filter cleaning device (10) according to any one of the preceding claims.

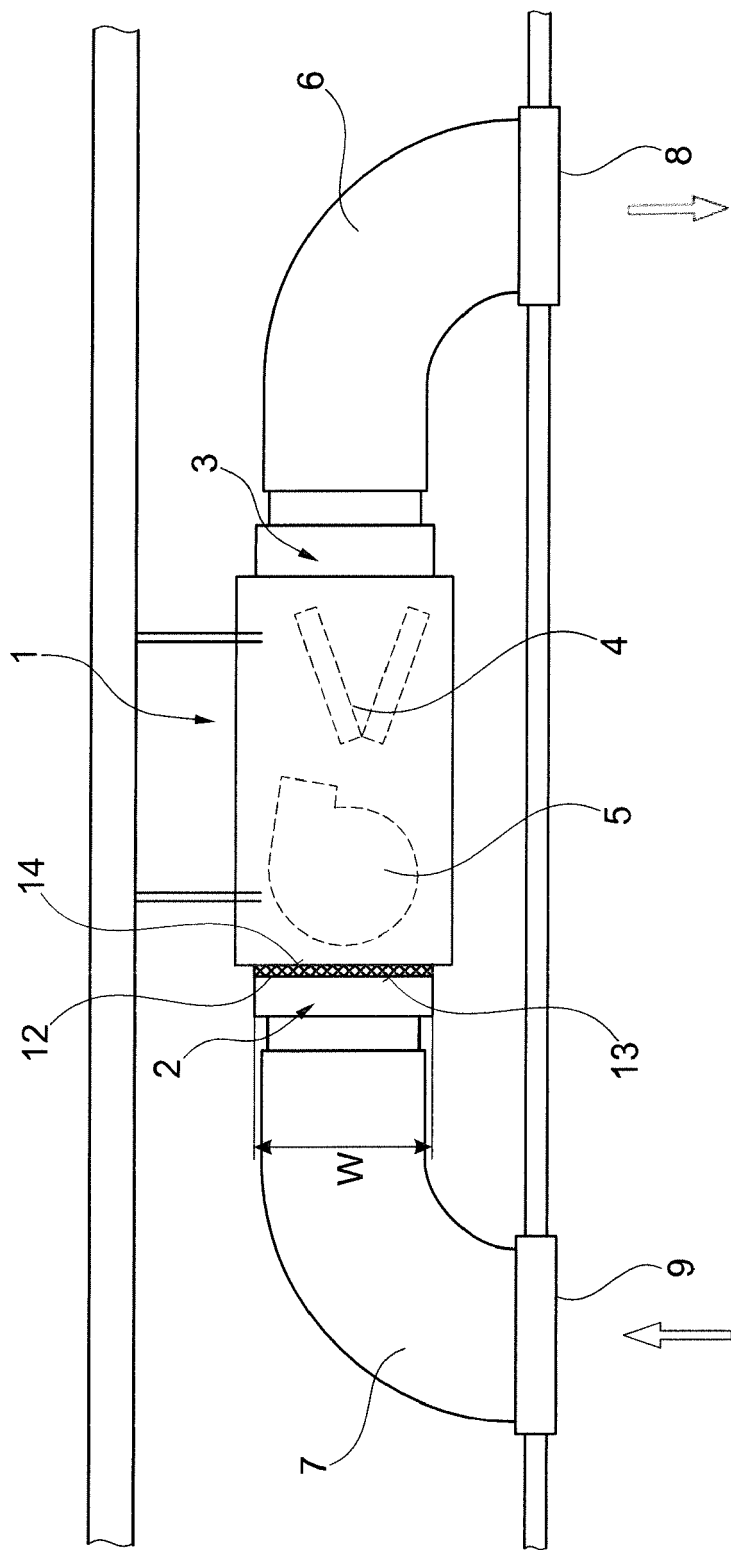
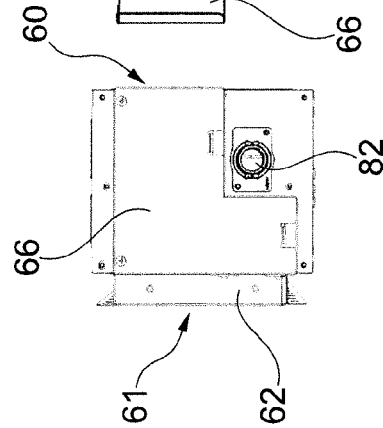
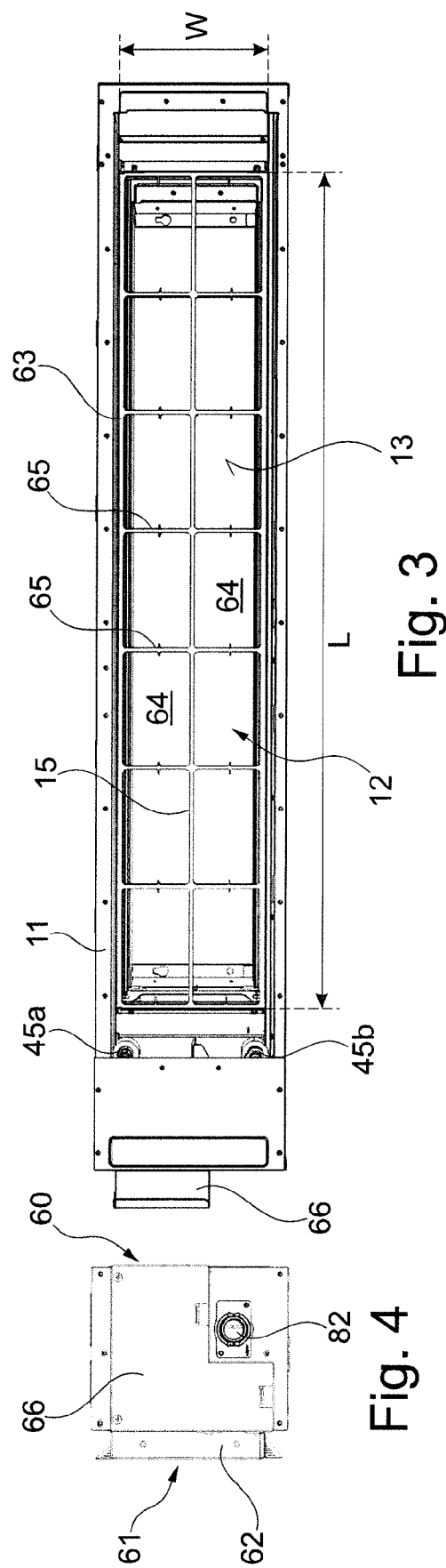
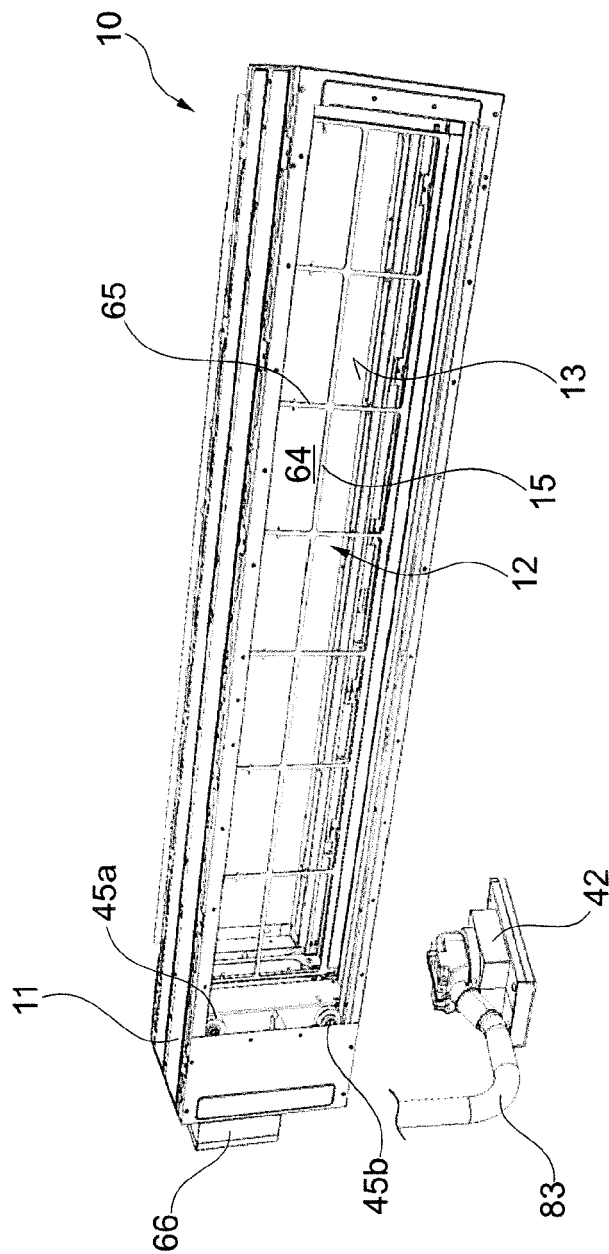


Fig. 1



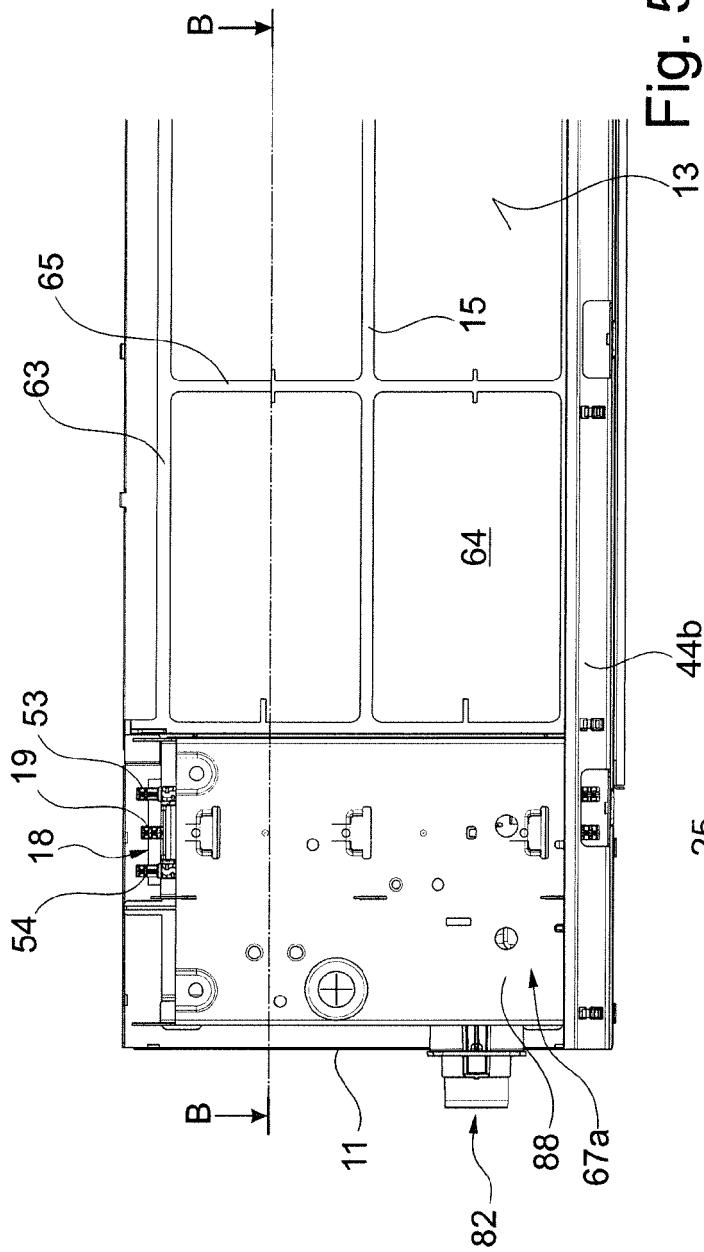


Fig. 5

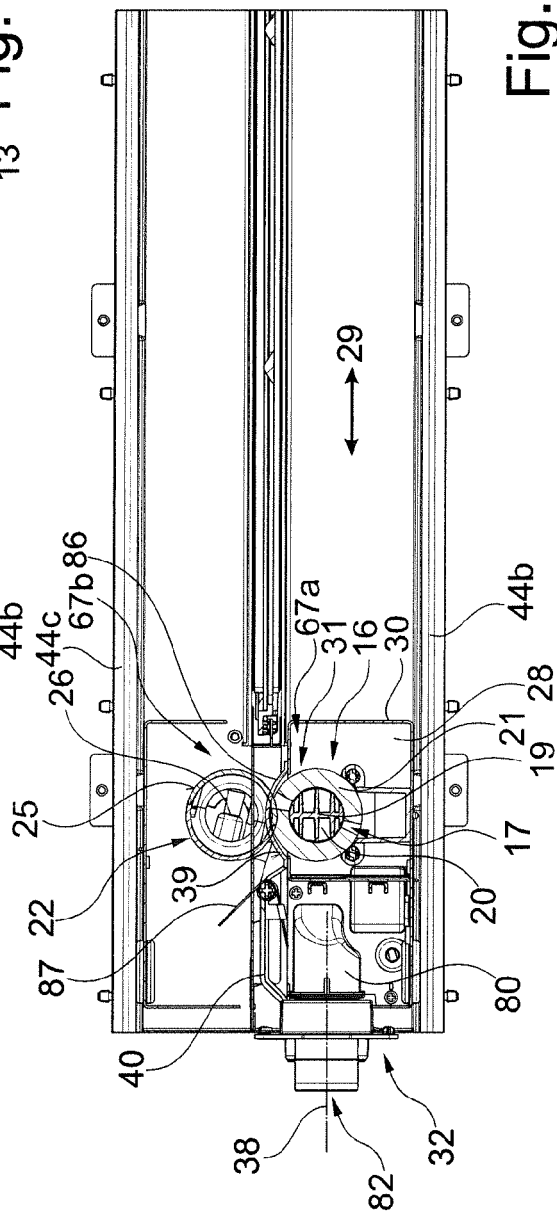
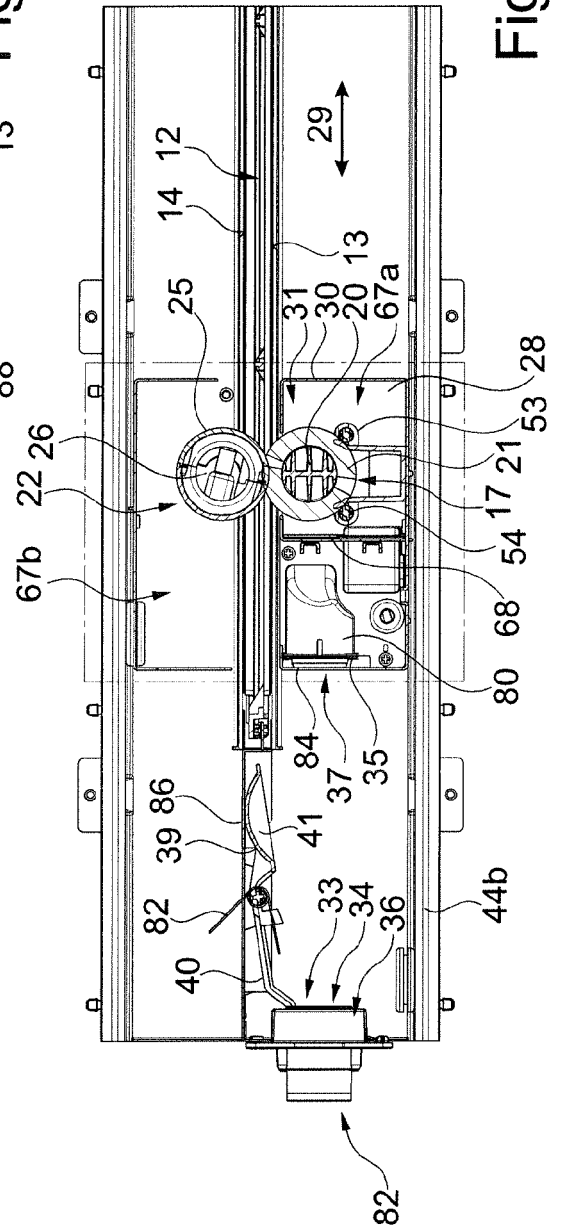
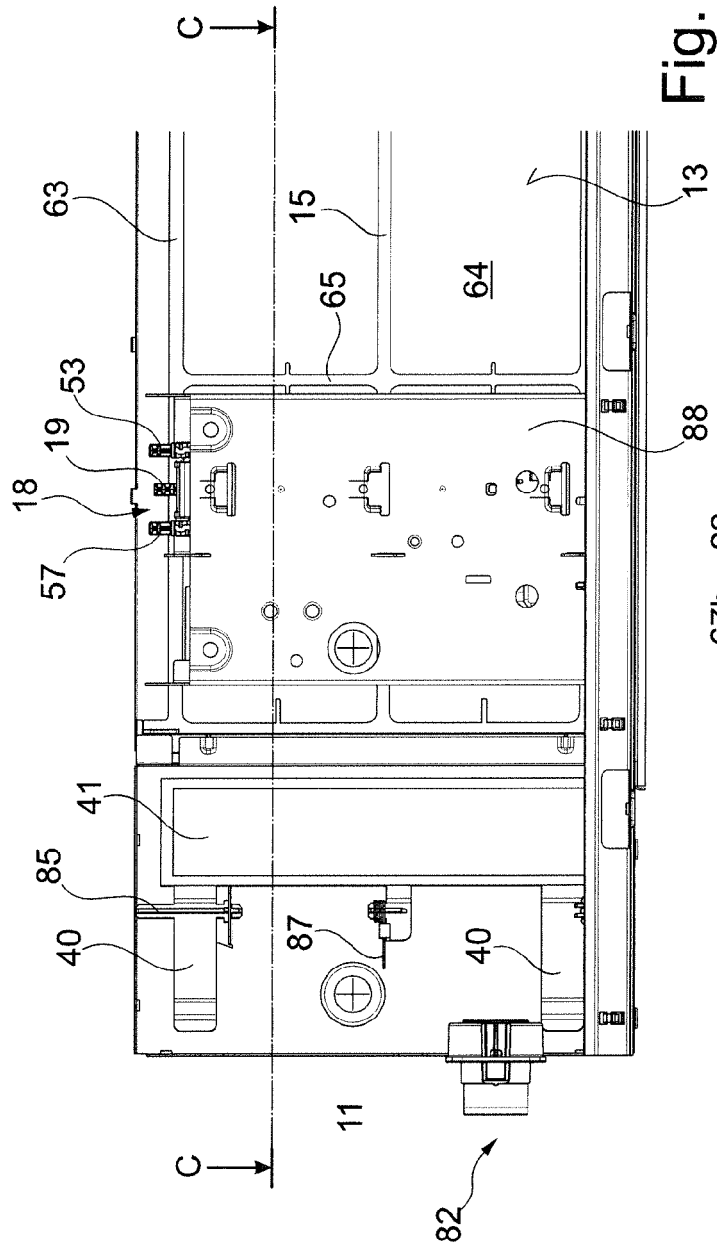


Fig. 6



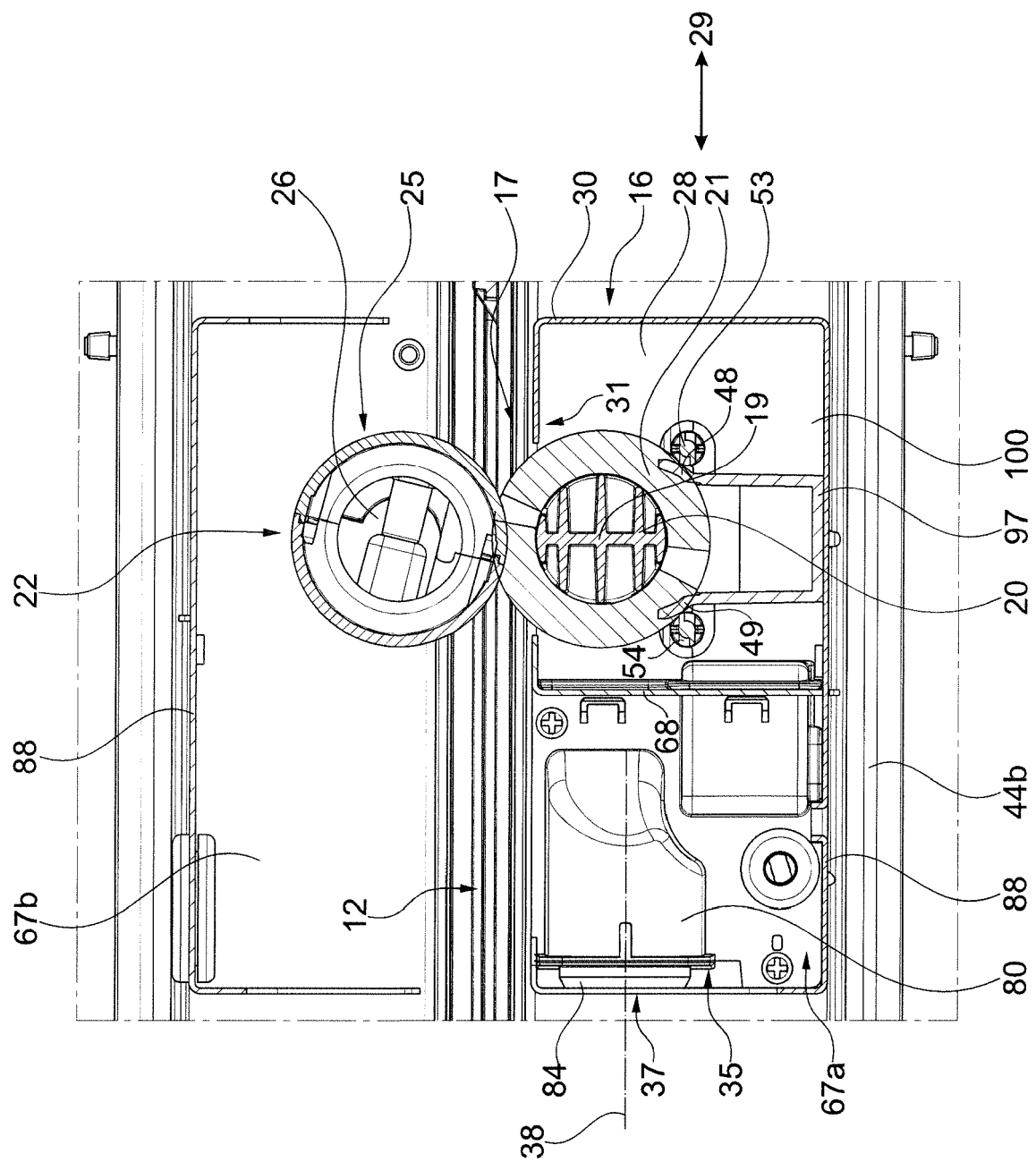


Fig. 9

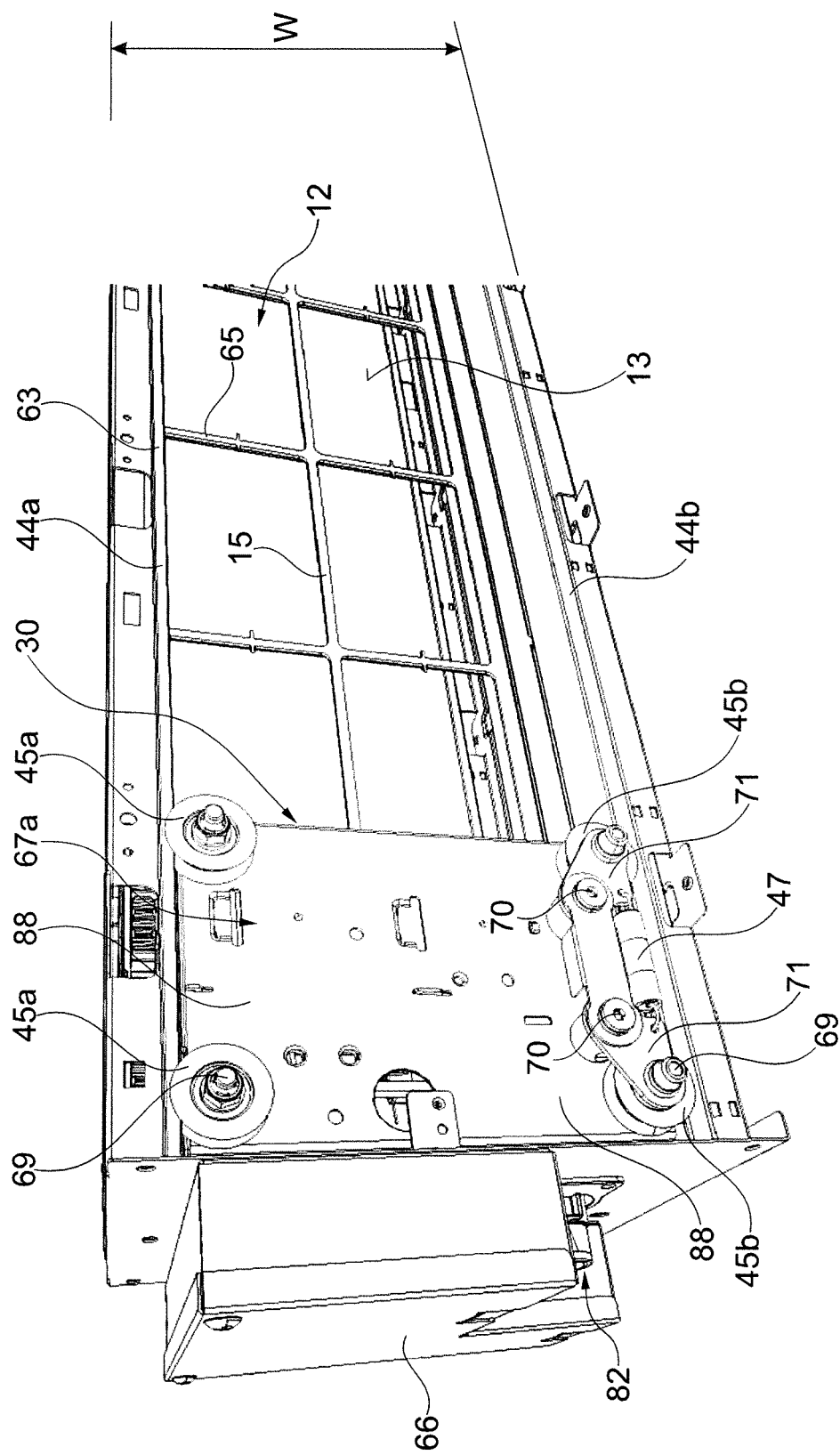
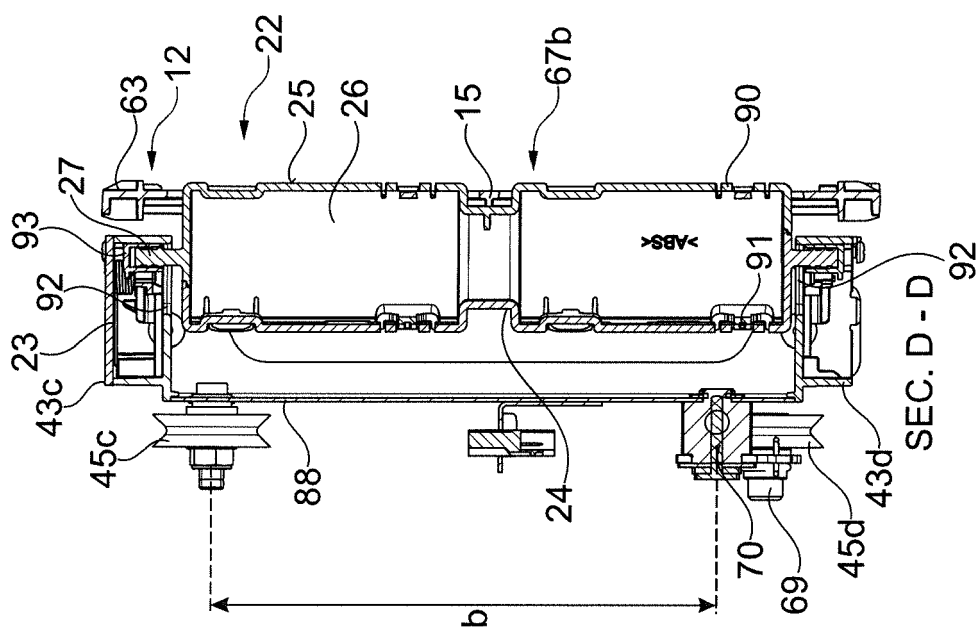
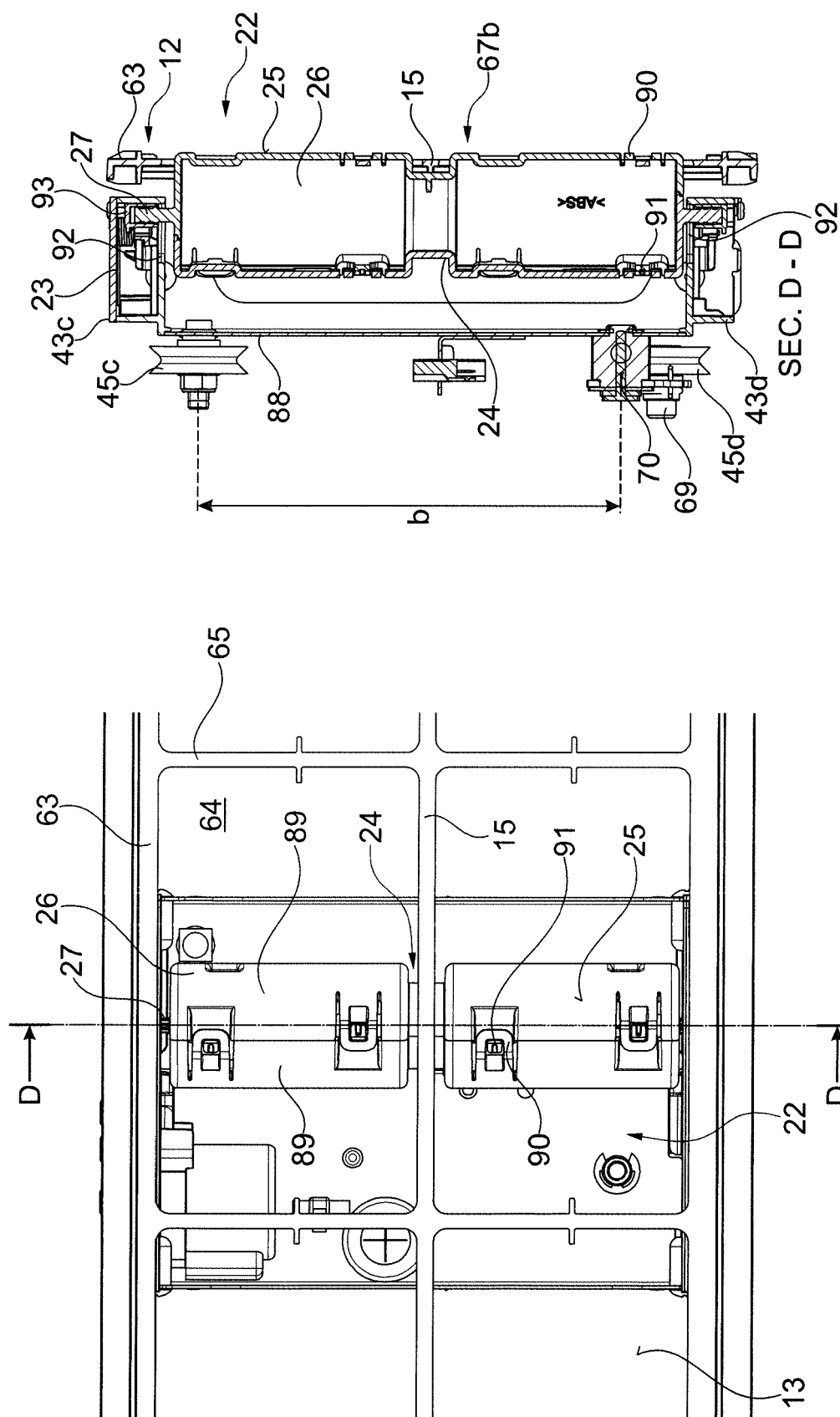


Fig. 10



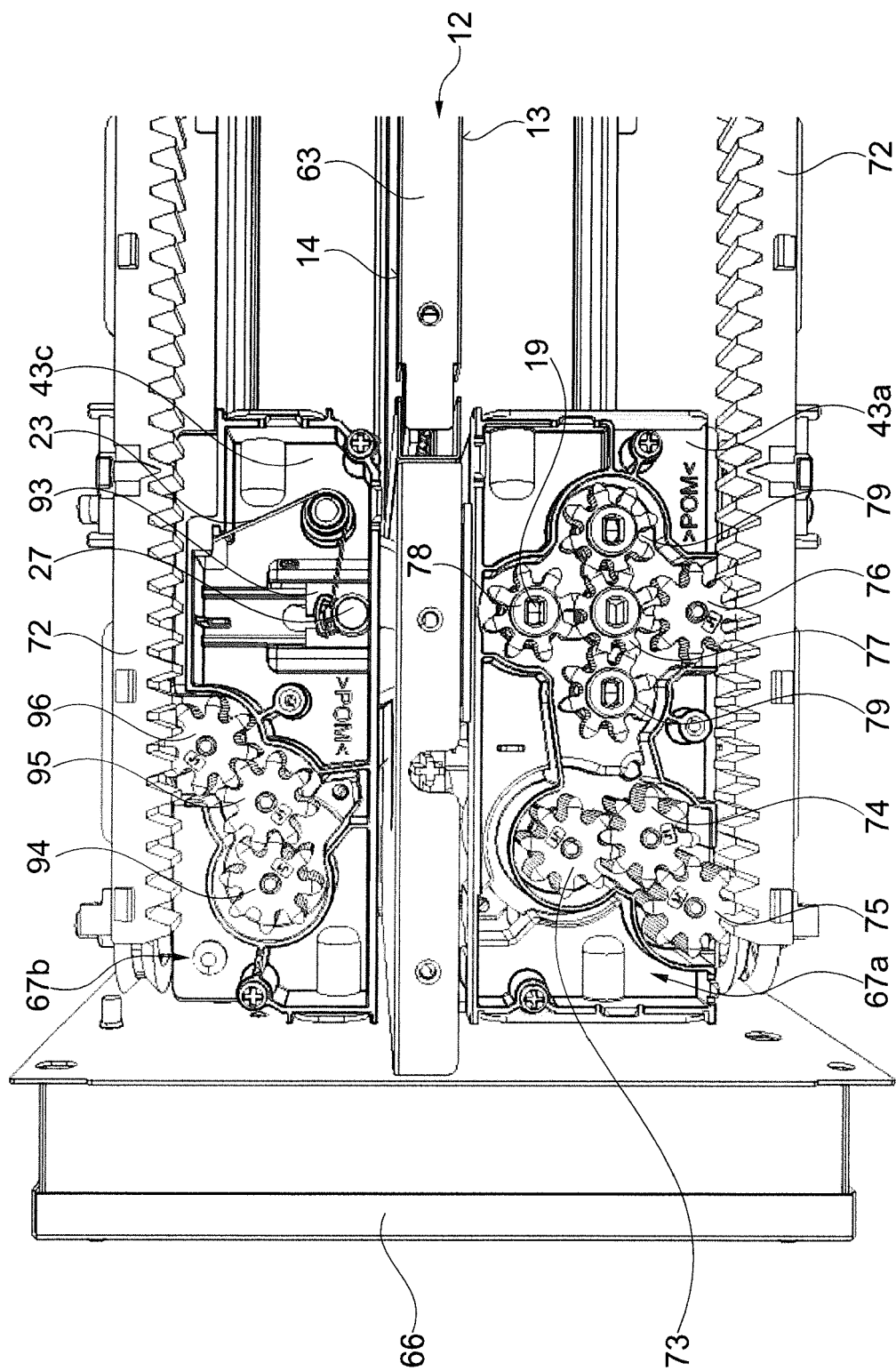


Fig. 13

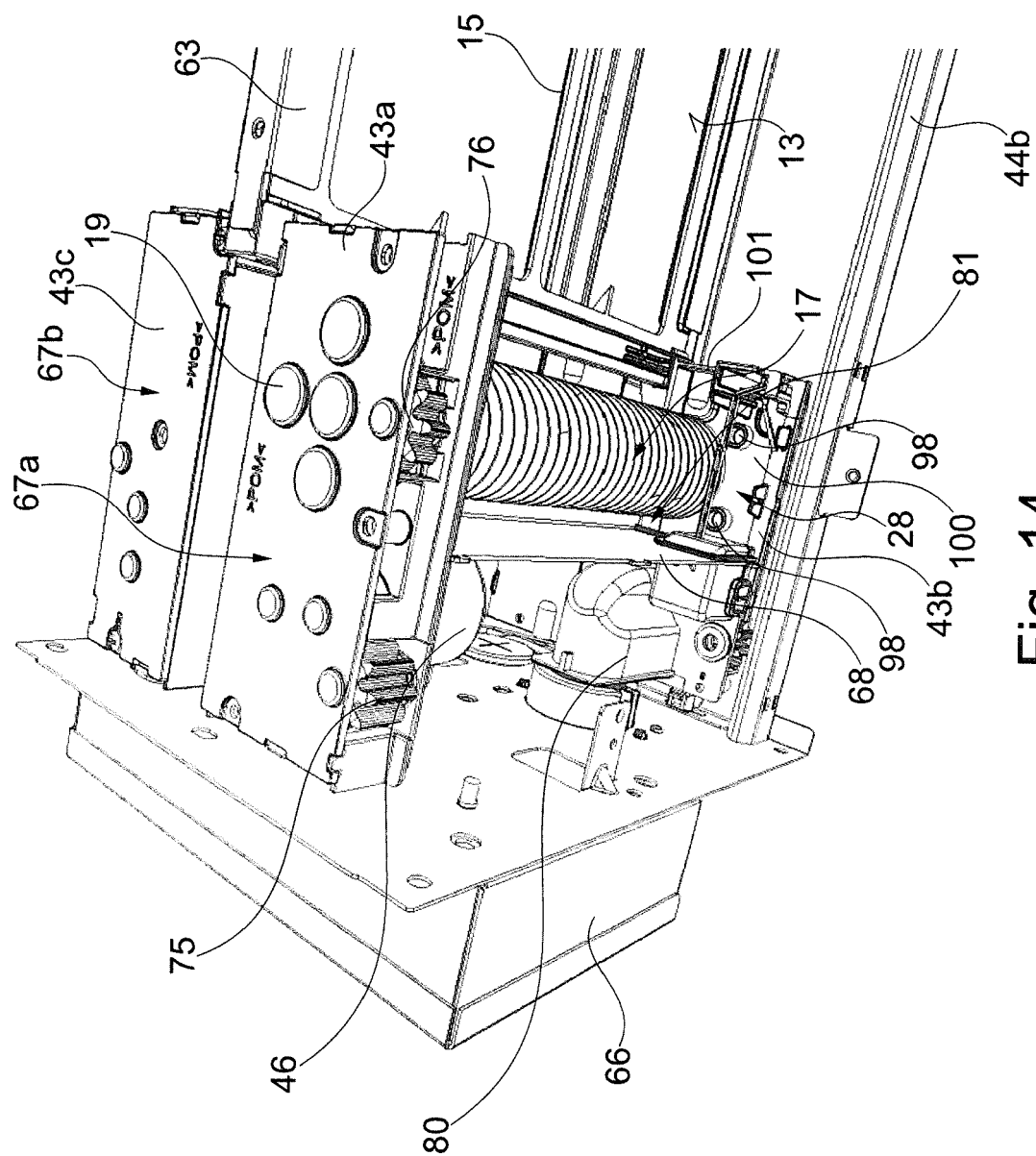


Fig. 14

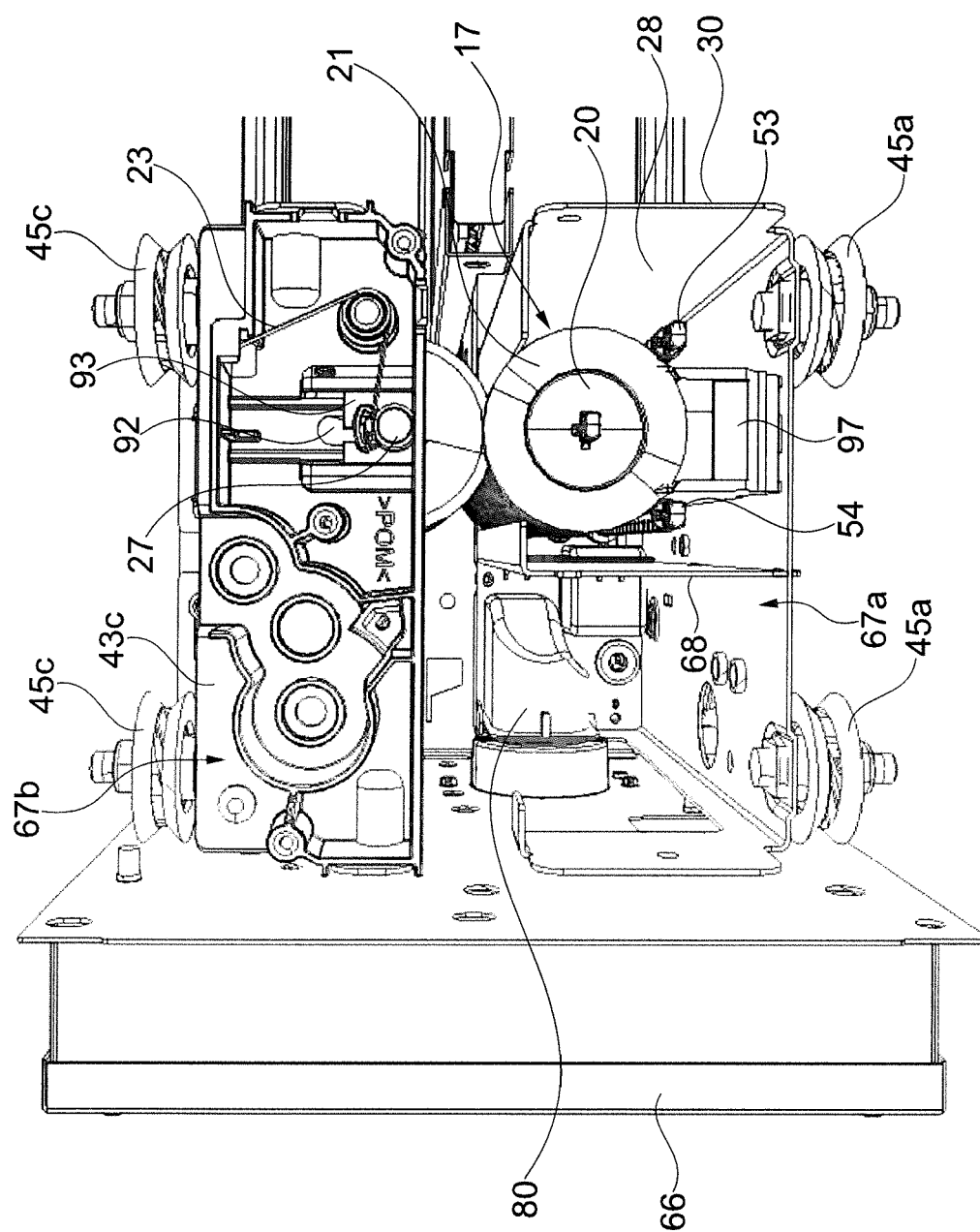


Fig. 15

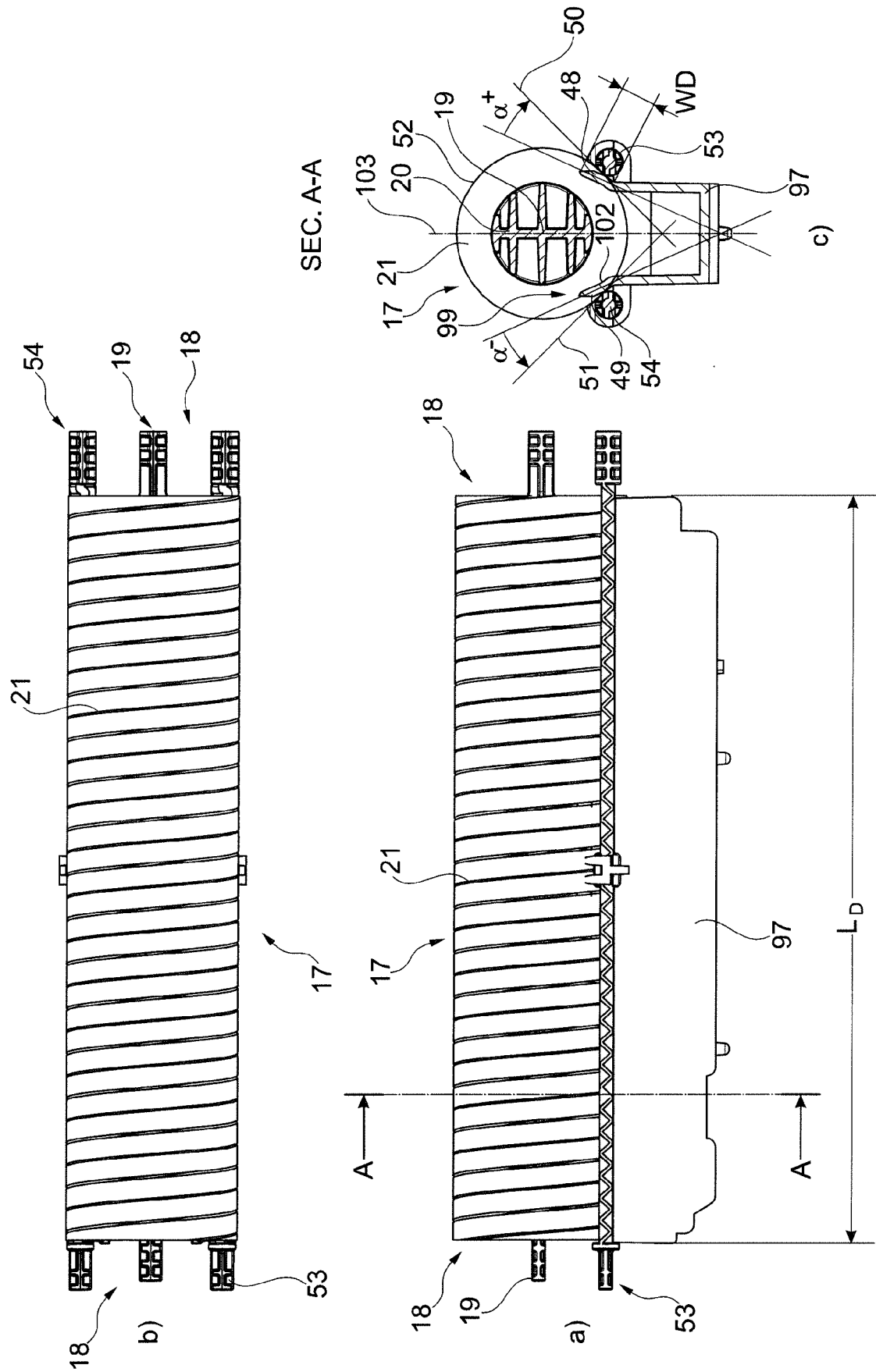


Fig. 16

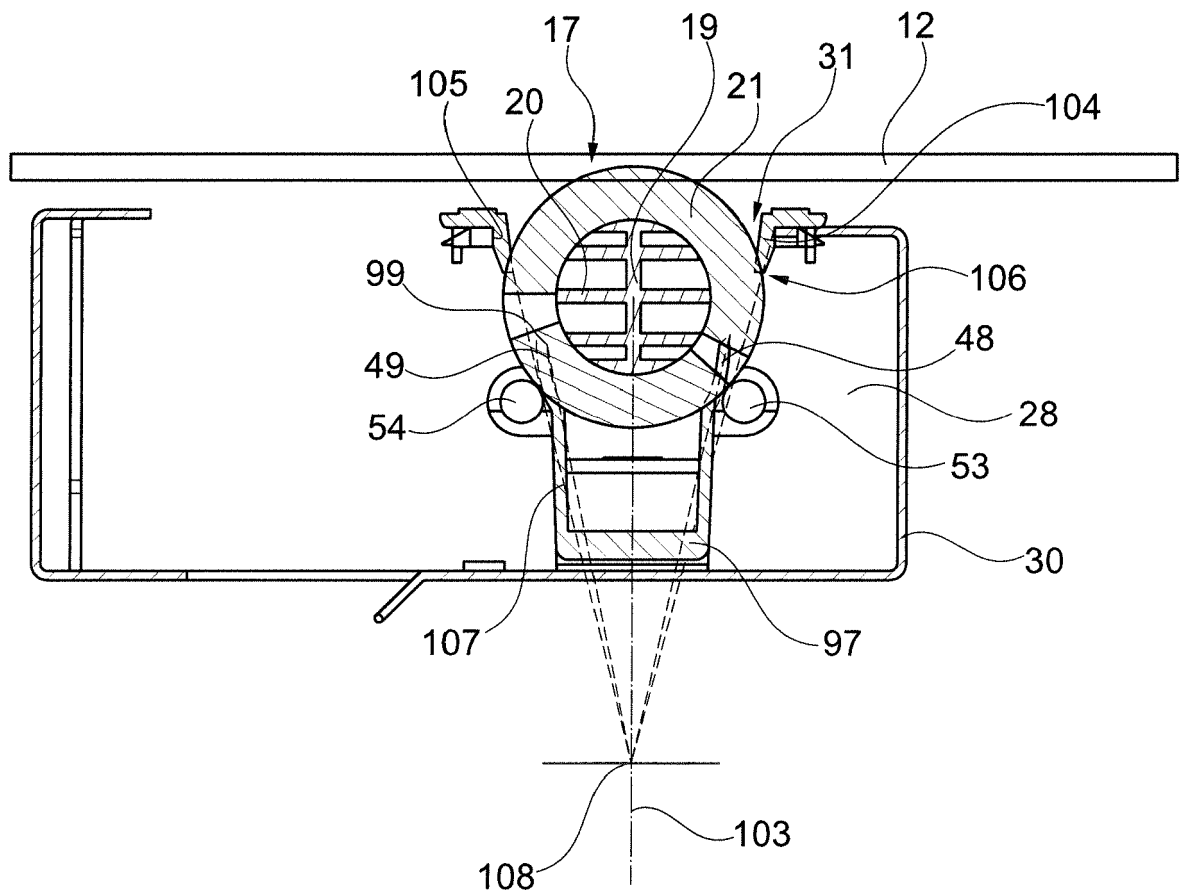


Fig. 17



EUROPEAN SEARCH REPORT

Application Number
EP 17 15 5600

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			F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 4 August 2017	Examiner Blot, Pierre-Edouard
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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