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(54) **Suction cup and device provided with suction cups**

Saugschale und Vorrichtung ausgestattet mit Saugschalen

Coupelle de suction et dispositif équipé de coupelles de suction

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Description

Background of the invention

[0001] The invention relates to a suction cup.

[0002] The invention relates in particular to a suction cup for stones, more specifically paving stones.

[0003] The invention further relates to a device provided with a vacuum pump, common air duct and suction cups, in particular a device for lifting stones arranged in a pattern.

[0004] Such a device for producing a pack layer of elongate stones in a herringbone pattern is described in European patent application 08167055.6 which discloses a device for producing a pack layer of elongate stones in a herringbone pattern. After the pack layer has been produced, it is lifted with the aid of a lifting device which is provided with suction cups and laid in its definite position. Each stone of the pack layer has its own suction cup. The suction cups are connected to a vacuum pump via ducts. By creating a reduced pressure in the suction cup which is considerably lower than the atmospheric pressure, the stone is pressed against the suction cup, resulting in a force by means of which it can be lifted and moved.

[0005] Dutch patent NL2000599C2 also describes a device of this type. In this case, the lifting device is a mat made from flexible material. Ducts and suction cups are formed in the mat.

[0006] It is characteristic of the prior art that several suction cups are connected to the same duct in order to produce the reduced pressure in the suction cups.

[0007] It is a drawback of the prior art that when it is not possible to produce reduced pressure in one suction cup, for example due to the fact that a stone is missing or the reduced pressure drops away because a stone falls from the suction cup, this results in the reduced pressure in the suction cups connected to the same duct also dropping away and the stones which are held thereby falling from the suction cups. This may result in dangerous situations. The same problem exists for devices for lifting panel-shaped objects, for example sheets of glass, concrete slabs, stone slabs, plastic panels, or any other object which is lifted by a plurality of suction cups which are connected to the same common air duct.

[0008] GB1085376 discloses a suction cup. This known suction cup has a valve N which is operated by a lever M which pivots about a fixed hinge pin K. Such a lever which pivots about a fixed hinge pin is disadvantageous during use of the suction cup when, for example, sand and stone dust accumulate at the pivot pin and/or the lever and/or the spring P as a result of which the valve no longer closes properly in practice, resulting in loss, or the valve on the contrary does not open properly as a result of which a stone is not sufficiently or not at all secured to the suction cup. A further drawback is the fact that the valve N which pivots about a fixed pivot pin K is less free to turn towards the hole D in order to seal the latter, as a result of which the valve has to be readjusted in case of wear. A further drawback is the fact that the lever requires a considerable operating force since the suction cup has to be pressed against the stone directly in opposition to the line of action of the spring P.

[0009] A suction cup is also known from Fig. 8 in US 3,720, 433, as well as from Fig 5 in JPon158596. A drawback of these two known suction cups is that dirt accumulates very quickly between the valve and the valve seat, as a result of which the suction cup sucks insufficiently, if at all. In addition, the vacuum acts in opposition to the spring which may cause undesirable opening of the valve or an undesirably large operating force of the valve by means of the pin 34 as a result of the choice of spring.

[0010] EP0201469 discloses a vacuum holder for use in an industrial environment. The closure means (valve means 14) of the known vacuum holder tends to become soiled with debris and stone dust as a result of which the closure means does not under all circumstances result in a satisfactory closure. In addition, the vacuum holder comprises spaces V1, V2, V3 in which stone dust accumulates, thus preventing the vacuum holder from operating efficiently. When gripping stones, the adjustment of the spacer 1 is rendered more difficult by loose debris or stone dust as a result of which the closure means open insufficiently, if at all. The relatively large surface of the spacer 1 further increases the risk of interference in the adjustment of the spacer 1.

[0011] DE9016175U1 also discloses two suction cups. The suction cup from Figs. 2 and 3 has two sealing lips which quickly become soiled with sand and stone dust, thus having an adverse effect on the action of the suction cup. With the suction cup from Fig. 4, the vacuum acts in opposition to the spring, which may cause undesirable opening of the valve or an undesirably large operating force of the valve by means of the pin 16.

Summary of the invention

[0012] It is an object of the invention to provide an improved suction cup.

[0013] To this end, the invention provides a suction cup which is provided with a closing device comprising a closing element for closing the extraction opening which closing element is provided in the reduced-pressure space, in order to close off the extraction opening from the reduced-pressure space, and which closing device comprises a spring element, and wherein the suction cup is provided with a holding-open device in the reduced-pressure space in order to prevent the closing element from closing off the extraction opening while the open side of the suction cup is situated on an object, and wherein the spring element exerts a force on the closing element in order to close off the extraction opening from the inside by means of the closing element.

[0014] The invention is based on the following insight. Customary suction cups are connected to a vacuum

pump by means of an air duct. Reduced pressure can only be produced in a reduced-pressure space of a suction cup after the latter has been positioned on an object. For this reason, the vacuum pump is usually only activated after the suction cup has been positioned on the object. An object may be a single object or an assembly of smaller parts, for example a packet of stones in a pattern. Usually, a lifting device is provided with several suction cups connected to a common air duct. This means that a reduced pressure can only be produced in the suction cups which are connected to the common air duct when all the suction cups have been positioned on the object. It is an advantage of the invention that the suction cup is designed to close off the extraction opening and to keep the extraction opening open while the suction cup is positioned on an object. As a result, even when no reduced pressure can be produced in a suction cup as a result of a stone being missing or damaged, it is still possible to produce a reduced pressure in the other suction cups which are connected to the common duct. A further advantage is the fact that when the reduced pressure in a suction cup drops away due to for example a stone falling away from the packet of a suction cup, the closing element almost immediately closes off the extraction opening so that the reduced pressure in the duct and thus in the other suction cups is maintained. As a result thereof, the other suction cups stay at the peak of their performance and the other stones remain on the suction cups.

[0015] The closing element being provided in the reduced-pressure space offers the advantage that the closing element is pressed against the housing by the reduced pressure in the air duct, as a result of which the closing element closes off the extraction opening more efficiently and it becomes more difficult to open the extraction opening during lifting.

[0016] In one embodiment of the suction cup, the closing device comprises an arm which protrudes from the open side and which cooperates with the closing element in order to prevent the closing element from closing off the extraction opening while the suction cup is positioned on an object. Due to the fact that the arm protrudes outside the suction cup, the closing element will be displaced as soon as the suction cup is positioned on a surface, thus creating an opening so that air can be sucked out of the reduced-pressure space via the extraction opening and the suction cup is fixed to the surface.

[0017] In one embodiment, the arm has a curved surface in order to form a surface which makes sliding contact with the object. Thus, sharp projections or sharp edges are prevented, as a result of which the surface of the object to be clamped securely will not quickly become damaged. Also, the wear on the arm will be reduced as a result.

[0018] In one embodiment, the curved surface forms part of an attachment part of the arm which can be replaced on the arm. Thus, only a small part of the suction cup has to be replaced when the curved surface is worn out.

[0019] The closing device comprises a spring element under prestress which exerts a force in order to close off the extraction opening from the inside by means of the closing element. Thus, a self-closing suction cup is obtained which is highly self-closing when there is a reduced pressure in the duct to which the suction cup is connected.

[0020] In one embodiment, the spring element is situated on the outside of the housing. In a further embodiment, the spring element has a coiled spring with a cylindrical or conical shape. A conical shape improves the centring properties of the closing element with respect to the closing aperture.

[0021] In one embodiment, the spring element extends in line with the extraction opening for the air which has been sucked out via the extraction opening to act on the spring element. The fact that the spring element extends in line with the extraction opening for the air which has been sucked out via the extraction opening to act on the spring element assists the correct operation of the closing device as sand and stone dust are prevented from accumulating near the spring element.

[0022] In one embodiment, the closing device has a point of rotation in the reduced-pressure space. In one embodiment, the point of rotation is a part of the edge of the closing element. A point of rotation is advantageous because in this case the closing device can move freely with respect to the housing, as a result of which the accumulation of sand and stone dust is reduced or prevented completely and it is furthermore more simple to clear any sand or stone dust which has been accumulated. In this context, move freely means that the closing device is not fixedly connected to the housing by means of a fixed hinge.

[0023] In one embodiment, the closing device is provided with a centring element which extends through the extraction opening and is connected to the closing element. Thus, the closing element is always correctly positioned with respect to the closing aperture.

[0024] In one embodiment, the spring element extends around the centring element and is locked in between the housing and the closing device, with the spring element preferably being locked in between the housing and the centring element. As the spring element extends around the centring element, the reliability of the closing device is further improved by the fact that the spring element remains engaged with the housing and the closing device, even in difficult operating conditions.

[0025] In one embodiment, the edge of the open side is provided with resilient compressible material. On the one hand, the compressibility improves the sealing properties of the suction cup and, on the other hand, the closing element is removed further from the extraction opening, as a result of which the air can be sucked out of the reduced-pressure chamber more quickly.

[0026] Another aspect of the invention is to provide an improved lifting device or stone packet handling device.

According to the invention, a lifting device or stone packet handling device which is provided with a vacuum pump to which two or more suction cups are connected by means of a common air duct is furthermore provided with suction cups according to one of the embodiments according to the invention. The advantage of using suction cups according to the invention is that objects can be gripped having a surface area which is smaller than the surface area across which the suction cups extend. As a suction cup which is situated outside the surface area closes itself off, a reduced pressure or vacuum can be created in the suction cups which do make contact with the surface of the object.

[0027] In one embodiment of a lifting device for lifting stones arranged in a pattern, the suction cups are distributed in a manner which corresponds to the distribution of the stones in the pattern, with the reduced-pressure space of each suction cup coming into contact with a stone in the distribution. This offers the advantage that if one stone is missing from the pattern, the corresponding suction cup closes itself off and a reduced pressure can be produced in the other suction cups of the lifting device.

[0028] The invention furthermore relates to a device provided with one or more of the characterizing measures described in the attached description and/or illustrated in the attached drawings.

[0029] The invention furthermore relates to a method comprising one or more of the characterizing steps described in the associated description and/or illustrated in the associated drawings.

[0030] It will be clear that the various aspects mentioned in the present patent application can be combined and may each be considered individually for a divisional patent application.

Short description of the figures

[0031] In the attached schematic figures, various embodiments of a device according to the invention are illustrated, in which:

Fig. 1 shows a side view of an embodiment of the suction cup according to the invention;
Fig. 2 shows a top view of the suction cup from Fig. 1;
Fig. 3 shows a detail of the suction cup shown in Fig. 1
Fig. 4 shows a front view of the suction cup from Fig. 1;
Fig. 5 shows an opening device in perspective;
Fig. 6. shows a top view of the opening device illustrated in Fig. 5;
Fig. 7 shows a side view of the opening device illustrated in Fig. 5;
Fig. 8a shows a stone packet handling device in perspective;
Fig. 8b shows the stone packet handling device from Fig. 8a in top view.

Description of embodiments

[0032] An embodiment of the suction cup according to the invention will be described with reference to Figs.1 - 4. Fig. 1 shows a side view of an embodiment of the suction cup 1 according to the invention. The suction cup 1 comprises a housing 2 which forms a reduced-pressure space 9. The suction cup has an open side 11 and a suction side 12 situated opposite the open side 11. The reduced-pressure space 9 is situated between the open side 11 and the suction side 13. The suction side 13 of the housing 2 is provided with an extraction opening 4 for sucking air out of the reduced-pressure space 9. Preferably, the edge 3 of the housing is made from a compressible resilient material in order to produce a substantially airtight connection to the surface of the object on which the suction cup is positioned. Some examples of a compressible resilient material are foam rubber or a foam consisting of plastic cells which are joined together. Due to the reduced pressure which may result from the air out of the reduced-pressure space 9, the object is pulled against the suction cup 1, as a result of which the object on the suction cup 1 can be lifted.

[0033] The housing 2 furthermore comprises a connecting part 6 in the form of an edge 3 which stands to the suction side 13. An air duct may be connected to the connecting part 6 in order to suck air from the reduced-pressure space 9 via the extraction opening 4.

[0034] The suction cup is furthermore provided with a closing device 15 for closing the extraction opening 4. Fig. 2 shows an enlargement of a section A from Fig. 1. The closing device 15 comprises a closing element 12 for closing off the extraction opening 4. Preferably, the closing element 12 is provided with a compressible, resilient material on that side which is turned towards the extraction opening. Preferably, the closing element is saucer-shaped. Thus, an amount of sand, that is to say soiling, in the saucer does not lead to the closing element not being able to produce a good seal around the extraction opening, which would result in fresh air being sucked in continuously and insufficient reduced pressure in the air duct being produced for the other suction cups connected to the air duct.

[0035] The closing device 15 furthermore comprises a spring element 8 and a connecting element 10 in the form of a bolt. The connecting element 10 runs through the centre of the closing element 12 and the spring element 8. The closing element 12 is situated on one side of the extraction opening 4 and the spring element 8 is situated on the other side of the extraction opening 4. The spring element 8 is prestressed, as a result of which the closing element 12 is pressed against the housing 2 and closes the extraction opening 4. The closing element 12 is adjustably fastened to the connecting element 10 by means of nuts 16. As a result thereof, the prestress on the spring element 8 can be varied. Due to the fact that the connecting element 10 extends through the extraction opening and is connected to the closing element 12, the clos-

ing element 12 is held in place relative to the extraction opening 4. Thus, the closing element 12 will always close off the extraction opening 4 on all sides when it is pulled against the suction side 13 of the housing. Thus, the connecting element 10 also functions as a centring element. The spring element 8 is connected to the closing device 15 in such a manner that when the closing element 12 tilts, the spring element 8 is deformed mainly laterally, that is to say at right angles to the longitudinal axis of the spring element 8, which prevents the accumulation of sand and stone dust near the spring element 8 even more effectively.

[0036] The closing device 15 furthermore comprises an arm 5 or holding-open device. The arm 5 is configured to prevent the closing device 15 from closing off the extraction opening 4 while the suction cup 1 is situated on an object. The holding-open device thus keeps the extraction opening open for as long as the open side of the suction cup is positioned on the surface of an object. If a spring element 8 is used, the arm 5 ensures that the closing device 15 opens the extraction opening 4 at least partially when the suction cup 1 is positioned on the surface of an object.

[0037] Fig. 5 shows an embodiment of the arm 5 in perspective. The arm has a first arm portion 51 and a second arm portion 53. The second arm portion 53 is flat and the first arm portion 51 is at least partly curved. The section 54 where the arm portions merge forms an angle in the arm 5. The second arm portion 53 has an opening 55 in order to fit the arm to the closing element 12. A part of the first arm portion 51 protrudes from the open side of the housing 2. When the suction cup 1 is placed on the surface of an object, the part of the first arm portion 51 which protrudes will be moved in the direction of the suction side 13. As a result thereof, the closing element 12, 14 will tilt about a point which is denoted by reference numeral 18 and an opening will be produced between the closing element 12, 14 and the housing, as a result of which air can flow past the closing device 15. In the illustrated embodiment, the closing device 15 rotates about point 18. In another embodiment, the arm 5 is formed in such a manner that a portion of the arm 5 bears against the suction side of the suction cup and thus forms the tilting point or point of rotation. It is also possible for a rotation shaft or hinge to be used as a point of rotation to convert the movement of the end of first arm portion 51 to the suction side 13 into a movement of the closing element 12, 14 away from the suction side 13. A shaft or hinge has the drawback that it is susceptible to wear and, in addition, causes sand and/or stone dust to accumulate, which impedes the movement of the arm 5 and the closing element 12.

[0038] When the resilient compressible edge 3 is used, it is not necessary for the first arm portion 51 to protrude from the open side 11 of the suction cup 1. When the part of the first arm portion 51 which is furthest from the suction side 13 extends further than the plane up to which the edge 3 is compressed under normal conditions of use, this will be sufficient to remove part of the closing edge of the closing element 12, 14 from the suction side 13 so that air can be sucked out of the reduced-pressure chamber 9 and a reduced pressure so that the object is sucked onto the suction cup 1.

[0039] If the arm 5 is rotatably fastened in the housing, for example by means of a rotation shaft, a spring element can be fitted between the first arm portion 51 and the suction side 13 of the housing 2 in a prestressed manner. The spring element then provides a force which is such that the end of the first arm portion 51 is pushed away from the suction side 13. As a result, the second arm portion 53 will push the closing element 12,14 against the housing 2 to ensure sealing of the extraction opening 4. It is also possible to dimension the weight of the first arm portion 51 and the second arm portion 53 with closing device 15 in such a manner that, under the force of gravity, the first arm portion moves away from the suction side and the second arm portion provided with closing element moves towards the suction side when the suction cup is used horizontally. In that case, the fact that the air is sucked out through the extraction opening 4 ensures that the closing element 12, 14 is pulled against the housing 2 and results in a substantially air-tight seal with the housing. The latter embodiment does not require a spring element.

[0040] The first arm portion 51 preferably has a curved surface 7 by means of which it contacts the surface of the object onto which the suction cup 1 is positioned. Due to the curved shape, the arm makes sliding contact with the object when the arm is moved in the direction of the suction side 13. This reduces the risk of friction between the surface 7 of the arm and the surface of the object which could cause damage to the surface of the object. Preferably, the surface 7 is part of an attachment part which can be placed on the arm 5 such that it can be replaced. When the surface 7 becomes worn out due to use, it can easily be replaced by a new attachment part and the suction cup does not have to be replaced completely. The arm 5 can, for example, be made from a metal, such as stainless steel. The attachment part can be made from plastic. However, the area of application of the suction cup will determine which materials are most suitable.

[0041] The arm 5 is furthermore provided with guide pieces 52. These ensure that the rotary movement of the arm in the housing is limited, so that the part of the arm which protrudes outside the housing cannot rotate beyond the contact edge of the housing. If this occurs nevertheless, the first arm portion 51 cannot be moved sufficiently in the direction of the suction side 13, as a result of which the closing part 12, 14 is not opened sufficiently and no reduced pressure can be produced in the reduced-pressure space. In addition, the arm which is then situated between the contact edge and the surface of the object that a leak is created as a result of which any reduced pressure in the suction cup 1 can quickly drop off and the object falls from the suction cup. In the illustrated

embodiment, the guide pieces 52 are planes which are at right angles to the second arm portion 53. These planes run parallel to the side walls of the housing 2. In another embodiment, the guide pieces 52 are a widened section of the second arm portion 53 which is closest to the point of rotation 18.

[0042] It should furthermore be noted that the second arm portion 53 can also be the closing element. If desired, a ring of resilient compressible material can be used to obtain a better seal.

[0043] The embodiment illustrated in Figs. 1 - 4 has two extraction openings 4, two closing devices 15 and two arms 5. The first arm portions 51 of both arms are situated next to, but unattached to, one another in the reduced-pressure space 9 and can move independently from one another. In order to make this possible in the limited reduced-pressure space, the first arm portion 51 is narrower than the second arm portion 53 in the longitudinal direction of the arms 5.

[0044] Fig. 4 shows two possible embodiments of spring element 8 in a side view. In one embodiment, the spring is a cylindrical wire spring 8. Also shown is a conical wire spring 8' which narrows as the distance between the winding of the spring and the surface of the housing 2 increases. This shape has the advantage that any dirt which is sucked in via the extraction opening 4 cannot accumulate so easily around the extraction opening, which would hamper the sucking of air out of the reduced-pressure space 9. Furthermore, the wide side of the conical spring ensures that the spring element 8' remains centred in the edge 6.

[0045] In the illustrated embodiment of the suction cup 1, the closing element 12, 14 is situated in the reduced-pressure space 9. As a result thereof, a valve is formed which is self-closing as a result of a vacuum/reduced pressure in an extraction duct. Preferably no air is sucked out when the suction cup 1 is being positioned on the object, since otherwise the force of the reduced pressure on the closing element has to be overcome in order to bring the contact edge of the suction cup in abutment with the surface of the object. In this embodiment, the prestress of the spring element 8 determines the minimum force which is required in order to bring the suction cup 1 in abutment with an object. Another advantage of this embodiment is the fact that dirt which is situated on the closing element can fall off as a result of the tilting upon opening of the extraction opening 4.

[0046] However, it is also possible to install the closing device 15 in the suction cup 1 upside down, that is to say with closing element 12, 14 between the edge 6 and the spring element 8 in the reduced-pressure space 9. However, in this case the prestress on the spring element 8 has to be sufficient to keep the extraction opening 4 closed off at the reduced pressure required to retain the object on the suction cup under normal circumstances during lifting. By extending the connecting element 10 beyond the plane of the open side 11, it becomes possible to open the closure when the suction cup is pressed sufficiently hard onto the object to be lifted. The force required to bring the suction cup into abutment with an object is at most the prestress of the spring element 8. Any reduced pressure in the extraction duct will reduce the force required to open the closure. In this embodiment, no arm is necessary and the suction cup is still self-closing when an object is missing or falls from the suction cup during operation. As the direction of movement of the connecting element 10 is perpendicular to the plane of the open side, the movement of the surface which contacts the surface of the object is kept to a minimum. Thus, the risk of the surface becoming damaged is low.

[0047] Since the connecting element 10 runs through the extraction opening, it also functions as a centring element in order to maintain the position of the closing element 12, 14 at the extraction opening 4.

[0048] Figs. 8a and 8b show a stone packet handling device 29 in perspective and top view, respectively. The purpose of the stone packet handling device 29 is to handle a stone packet 39 composed of stones 38 in a herringbone pattern. Here, the stone packet handling device 29 consists of a frame 30 which extends across the stone packet 39. A handle 37 is provided at working height. The handle 37 is connected to the frame and provided at a distance therefrom. The stone packet handling device 29 comprises frame parts 32 which extend above a continuous row of stones 38 in a herringbone pattern. The suction cups 1 according to the invention which are connected to the frame parts 32 are arranged such that the open side thereof coincides with the upper side of a stone. In the present embodiment, each stone 38 has its own suction cup 1. It is also possible, for example with larger stones or slabs, for several suction cups to coincide with the upper side of one stone or slab. The frame parts are displaceably connected to the frame 30, so that the stone packet handling device 29 can be adjusted to the size of the stone 38 or can be adjusted to compensate for tolerances in the dimensional accuracy of stones. In practice, tolerances in the dimensional accuracy of a paving stone can easily be as much as 5 mm. Here, the frame parts 32 are arranged at a distance from one another, thus creating a viewing hole or gap offering a view of the stones, so that the stone packet handling device can be positioned accurately above the stone packet 39. In this case, the stone packet handling device 29 furthermore comprises a fluid line 31 to produce a reduced pressure or vacuum in the reduced-pressure space of the suction cups.

[0049] The frame parts 32, fluid line 31 and frame 30 together form an air duct which connects the suction cups to a reduced-pressure device, for example a vacuum pump (not shown). Further details of the assembly comprising frame 30, fluid line 31 and frame parts 32 are described in European patent application 08167055.6.

[0050] In the present embodiment of the stone packet handling device, the stones are arranged in a herringbone pattern. Another embodiment of a stone packet is a block pattern. In principle, it is possible for the stones

to be arranged in any random pattern. It is even possible for stones of a different size to be arranged in a predefined pattern in a stone packet. Several stone packets can be arranged on a pallet in the form of layers, provided that the open sides of the suction cups are arranged in such a manner that they coincide with the upper sides of the stones in the pattern. The open side of a suction cup cannot contact several stones, since the space between the stones prevents reduced pressure from building up in the reduced-pressure space, as a result of which the stones do not adhere to the suction cup and cannot be lifted in order to be placed on a sand bed.

[0051] The suction cups 1 may form part of a lifting device for lifting large objects, such as stone packets, slabs, panels, pipes, which requires several suction cups in order to lift the object. The lifting device is provided with a vacuum pump to which two or more suction cups are connected by means of a common air duct. The suction cups according to the invention have the advantage that no modifications have to be made to the lifting device when the objects are smaller in size than the device itself, for example a packet comprising fewer stones, a smaller panel, a shorter pipe. The suction cups which fall outside the dimensions of the object automatically close off their extraction opening. This makes it possible to produce a reduced pressure in the reduced-pressure space of those suction cups which do contact the surface of the object, making it possible to lift the object.

[0052] In order to lift a stone packet consisting of stones in a pattern using a lifting device, the suction cups are distributed in a way which corresponds to the distribution of the stones in the pattern, with the reduced-pressure space of each suction cup making contact with a stone in the arrangement during lifting.

[0053] The suction cup according to the invention can be used with both high-vacuum and low-vacuum systems.

[0054] It will be clear that the above description has been given in order to illustrate the functioning of preferred embodiments of the invention, and not in order to limit the scope of the invention. On the basis of the above explanation, many variations which fall under the scope of the claims will be obvious to a person skilled in the art.

Claims

1. Suction cup (1) for clamping an object, comprising a housing (2) for forming a reduced-pressure space (9) having an open side (11) and a suction side (13) situated opposite the open side (11), in which the suction side (13) of the housing (2) is provided with an extraction opening (4) for sucking air out of the reduced-pressure space (9), wherein the suction cup (1) is provided with a closing device (15) comprising a closing element (12) for closing the extraction opening (4) which closing element (12) is provided in the reduced-pressure space (9), in order to close off the extraction opening (4) from the reduced-pressure space (9), and which closing device (15) comprises a spring element (8), and wherein the suction cup (1) is provided with a holding-open device (5) in the reduced-pressure space (9) in order to prevent the closing element (12) from closing off the extraction opening (4) while the open side (11) of the suction cup (1) is situated on an object, **characterized in that** the spring element (8) exerts a force on the closing element (12) in order to close off the extraction opening (4) from the inside by means of the closing element (12).

2. Suction cup (1) according to Claim 1, **characterized in that** the holding-open device (5) comprises an arm (5) which protrudes from the open side (11) and which cooperates with the closing element (12) in order to prevent the closing element (12) from closing off the extraction opening (4) while the suction cup (1) is positioned on an object.

3. Suction cup (1) according to Claim 2, **characterized in that** the arm (5) has a curved surface (7) in order to form a surface which makes sliding contact with the object.

4. Suction cup (1) according to Claim 3, **characterized in that** the curved surface (7) forms part of an attachment part which can be replaced on the arm (5).

5. Suction cup (1) according to one of the preceding claims, **characterized in that** the spring element (8) is situated on the outside of the housing (2).

6. Suction cup (1) according to one of the preceding claims, **characterized in that** the spring element (8) is a coiled spring having a conical shape.

7. Suction cup (1) according to one of the preceding claims, in which the spring element (8) extends in line with the extraction opening (4) for the air which has been sucked out via the extraction opening (4) to act on the spring element (8).

8. Suction cup (1) according to Claim 2, **characterized in that** the closing device (15) has a point of rotation (18) about which the arm (5) and closing element (12) are rotatable.

9. Suction cup (1) according to Claim 1, **characterized in that** the closing device (15) is provided with a centring element (10) which extends through the extraction opening (4) and is connected to the closing element (12).

10. Suction cup according to Claim 9, in which the spring element (8) extends around the centring element (10) and is locked in between the housing (2) and

the closing device (15), the spring element (8) is preferably locked in between the housing (2) and the centring element (10).

11. Suction cup (1) according to Claim 1, **characterized in that** the suction cup (1) is provided with an edge (3) of resilient compressible material on the open side (11).

12. Lifting device provided with a vacuum pump to which two or more suction cups (1) are connected by means of a common air duct (31), **characterized in that** at least one suction cup (1) has the characteristic features of the suction cup (1) according to Claims 1 - 11.

13. Lifting device according to Claim 12 for lifting stones arranged in a pattern, **characterized in that** the suction cups (1) are distributed in a manner which corresponds to the distribution of the stones in the pattern, with the reduced-pressure space (9) of each suction cup (1) coming into contact with a stone in the distribution during lifting.

Patentansprüche

1. Saugglocke (1) zum Befestigen eines Objekts, welche ein Gehäuse (2) zum Bilden eines Unterdruckraums (9) umfasst, welches eine offene Seite (11) und eine Saugseite (13) aufweist, welche gegenüber der offenen Seite (11) gelegen ist, in welcher die Saugseite (13) des Gehäuses (2) mit einer Absaugöffnung (4) zum Absaugen von Luft aus dem Unterdruckraum (9) versehen ist, wobei die Saugglocke (1) mit einem Schließgerät (15) versehen ist, welches ein Schließelement (12) zum Schließen der Absaugöffnung (4) umfasst, wobei das Schließelement (12) in dem Unterdruckraum (9) bereitstellt ist, um die Absaugöffnung (4) von dem Unterdruckraum (9) abzusperren, und wobei das Schließgerät (15) ein Federelement (8) umfasst, und wobei die Saugglokke (1) mit einem Aufhaltegerät (5) in dem Unterdruckraum (9) versehen ist, um zu verhindern, dass das Schließelement (12) die Absaugöffnung (4) absperrt, während die offene Seite (11) der Saugglocke (1) auf einem Objekt gelegen ist, **dadurch gekennzeichnet, dass** das Federelement (8) eine Kraft auf das Schließelement (12) ausübt, um die Absaugöffnung (4) von der Innenseite durch das Schließelement (12) abzusperren.

2. Saugglocke (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** das Aufhaltegerät (5) einen Arm (5) umfasst, welcher aus der offenen Seite (11) hervorsteht und welcher mit dem Schließelement (12) zusammenwirkt, um zu verhindern, dass das Schließelement (12) die Absaugöffnung (4) absperrt, während die Saugglocke (1) auf einem Objekt angeordnet ist.

3. Saugglocke (1) nach Anspruch 2, **dadurch gekennzeichnet, dass** der Arm (5) eine gebogene Oberfläche (7) aufweist, um eine Oberfläche zu bilden, welche mit dem Objekt gleitend in Kontakt tritt.

4. Saugglocke (1) nach Anspruch 3, **dadurch gekennzeichnet, dass** die gebogene Oberfläche (7) einen Teil eines Befestigungsteils bildet, welcher auf den Arm (5) versetzt werden kann.

5. Saugglocke (1) nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** das Federelement (8) auf der Außenseite des Gehäuses (2) gelegen ist.

6. Saugglocke (1) nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** das Federelement (8) eine gewendelte Feder mit einer konischen Form ist.

7. Saugglocke (1) nach einem der vorstehenden Ansprüche, in welcher sich das Federelement (8) in einer Linie mit der Absaugöffnung (4) für die Luft erstreckt, welche über die Absaugöffnung (4) abgesaugt worden ist, um auf das Federelement (8) zu wirken.

8. Saugglocke (1) nach Anspruch 2, **dadurch gekennzeichnet, dass** das Schließgerät (15) einen Drehpunkt (18) aufweist, um welchen der Ausleger (5) und Schließelement (12) drehbar sind.

9. Saugglocke (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** das Schließgerät (15) mit einem Zentrierelement (10) versehen ist, welches sich durch die Absaugöffnung (4) erstreckt und mit dem Schließelement (12) verbunden ist.

10. Saugglocke nach Anspruch 9, in welcher sich das Federelement (8) um das Zentrierelement (10) erstreckt und zwischen dem Gehäuse (2) und dem Schließgerät (15) verriegelt ist, wobei das Federelement (8) bevorzugt zwischen dem Gehäuse (2) und dem Zentrierelement (10) verriegelt ist.

11. Saugglocke (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Saugglocke (1) mit einer Kante (3) aus elastischem komprimierbarem Material an der offenen Seite (11) versehen ist.

12. Hebegerät, welches mit einer Vakuumpumpe versehen ist, mit welcher zwei oder mehrere Saugglocken (1) durch eine gemeinsame Luftleitung (31) verbunden sind, **dadurch gekennzeichnet, dass** zumindest eine Saugglocke (1) die charakteristischen Ei-

genschaften der Saugglocke (1) nach Ansprüchen 1 bis 11 aufweist.

13. Hebegerät nach Anspruch 12 zum Heben von Steinen, welche in einem Muster angeordnet sind, **dadurch gekennzeichnet, dass** die Saugglocken (1) in einer Weise verteilt sind, welche der Verteilung der Steine in dem Muster entspricht, wobei der Unterdruckraum (9) jeder Saugglocke (1) mit einem Stein in der Verteilung beim Heben in Kontakt kommt.

Revendications

1. Coupelle d'aspiration (1) pour serrer un objet, comprenant un boîtier (2) pour former un espace à pression réduite (9) comportant un côté ouvert (11) et un côté d'aspiration (13) situé à l'opposé du côté ouvert (11), dans laquelle le côté d'aspiration (13) du boîtier (2) est muni d'une ouverture d'extraction (4) pour aspirer de l'air hors de l'espace à pression réduite (9), la coupelle d'aspiration (1) étant munie d'un dispositif de fermeture (15) comprenant un élément de fermeture (12) pour fermer l'ouverture d'extraction (4), cet élément de fermeture (12) étant disposé dans l'espace à pression réduite (9), afin de fermer l'ouverture d'extraction (4) vis-à-vis de l'espace à pression réduite (9), et ce dispositif de fermeture (15) comprenant un élément de ressort (8), et la coupelle d'aspiration (1) étant munie d'un dispositif de maintien en ouverture (5) dans l'espace à pression réduite (9) afin d'empêcher l'élément de fermeture (12) de fermer l'ouverture d'extraction (4) pendant que le côté ouvert (11) de la coupelle d'aspiration (1) est situé sur un objet, **caractérisée en ce que** l'élément de ressort (8) exerce une force sur l'élément de fermeture (12) afin de fermer l'ouverture d'extraction (4) à partir de l'intérieur à l'aide de l'élément de fermeture (12).

2. Coupelle d'aspiration (1) selon la revendication 1, **caractérisée en ce que** le dispositif de maintien en ouverture (5) comprend un bras (5) qui fait saillie à partir du côté ouvert (11) et qui coopère avec l'élément de fermeture (12) de façon à empêcher l'élément de fermeture (12) de fermer l'ouverture d'extraction (4) tandis que la coupelle d'aspiration (1) est positionnée sur un objet.

3. Coupelle d'aspiration (1) selon la revendication 2, **caractérisée en ce que** le bras (5) comporte une surface incurvée (7) de façon à former une surface qui vient en contact de glissement avec l'objet.

4. Coupelle d'aspiration (1) selon la revendication 3, **caractérisée en ce que** la surface incurvée (7) fait partie d'une partie de fixation qui peut être remplacée sur le bras (5).

5. Coupelle d'aspiration (1) selon l'une des revendications précédentes, **caractérisée en ce que** l'élément de ressort (8) est situé sur l'extérieur du boîtier (2).

6. Coupelle d'aspiration (1) selon l'une des revendications précédentes, **caractérisée en ce que** l'élément de ressort (8) est un ressort hélicoïdal ayant une forme conique.

7. Coupelle d'aspiration (1) selon l'une des revendications précédentes, dans laquelle l'élément de ressort (8) s'étend en ligne avec l'ouverture d'extraction (4) pour l'air qui a été aspiré vers l'extérieur par l'intermédiaire de l'ouverture d'extraction (4) de façon à agir sur l'élément de ressort (8).

8. Coupelle d'aspiration (1) selon la revendication 2, **caractérisée en ce que** le dispositif de fermeture (15) comporte un point de rotation (18) autour duquel le bras (5) et l'élément de fermeture (12) peuvent tourner.

9. Coupelle d'aspiration (1) selon la revendication 1, **caractérisée en ce que** le dispositif de fermeture (15) est muni d'un élément de centrage (10) qui s'étend à travers l'ouverture d'extraction (4) et qui est relié à l'élément de fermeture (12).

10. Coupelle d'aspiration selon la revendication 9, dans laquelle l'élément de ressort (8) s'étend autour de l'élément de centrage (10) et est verrouillé entre le boîtier (2) et le dispositif de fermeture (15), l'élément de ressort (8) étant de préférence verrouillé entre le boîtier (2) et l'élément de centrage (10).

11. Coupelle d'aspiration (1) selon la revendication 1, **caractérisée en ce que** la coupelle d'aspiration (1) est munie d'un bord (3) de matériau compressible élastique sur le côté ouvert (11).

12. Dispositif de levage muni d'une pompe à vide à laquelle deux ou plusieurs coupelles d'aspiration (1) sont reliées à l'aide d'un conduit d'air commun (31), **caractérisée en ce qu'**au moins une coupelle d'aspiration (1) possède les éléments caractéristiques de la coupelle d'aspiration (1) selon les revendications 1 à 11.

13. Dispositif de levage selon la revendication 12 pour lever des pierres disposées selon un motif, **caractérisé en ce que** les coupelles d'aspiration (1) sont réparties d'une manière qui correspond à la répartition des pierres dans le motif, l'espace à pression réduite (9) de chaque coupelle d'aspiration (1) venant en contact avec une pierre dans la répartition durant le levage.

Fig 1

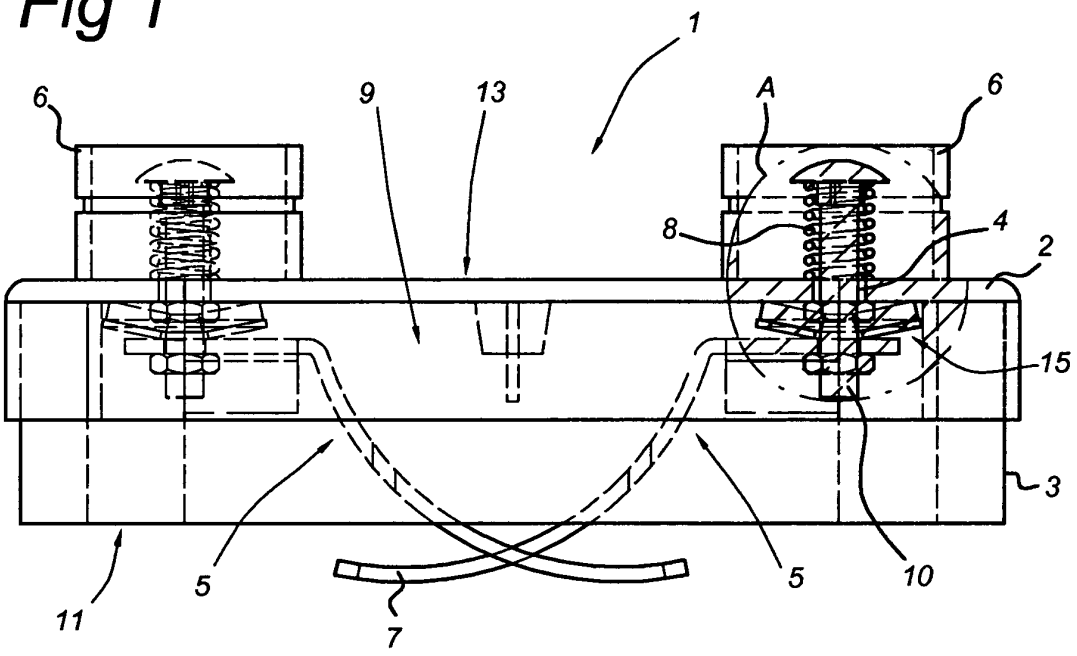


Fig 2

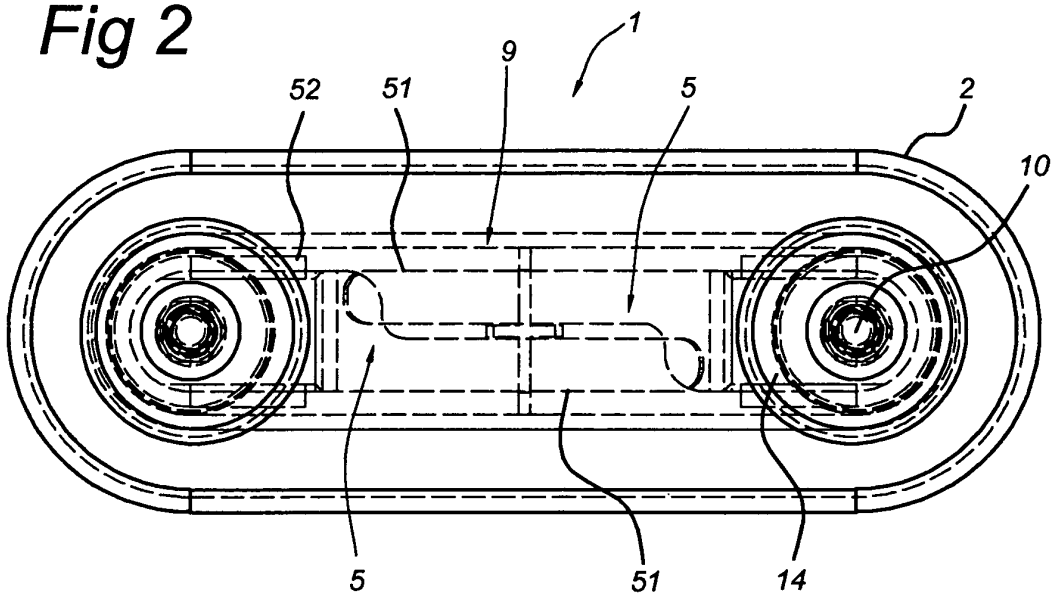


Fig 3

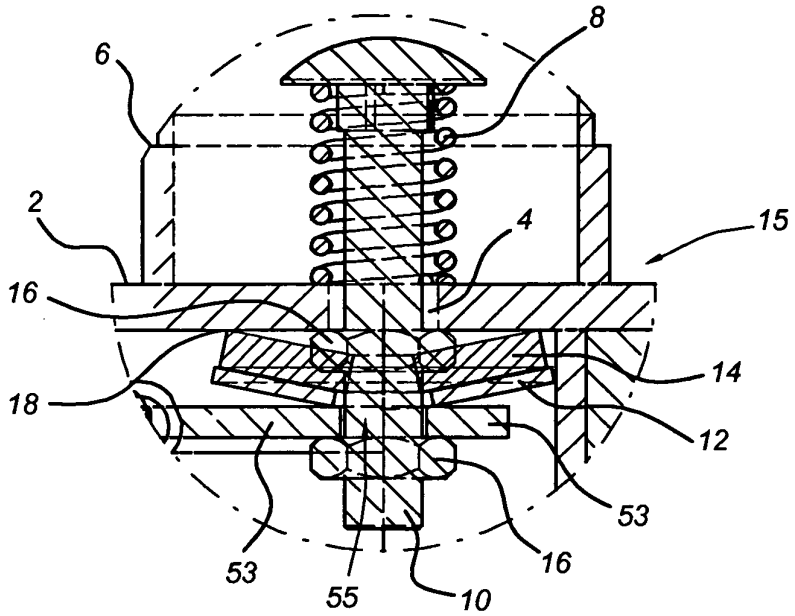


Fig 4

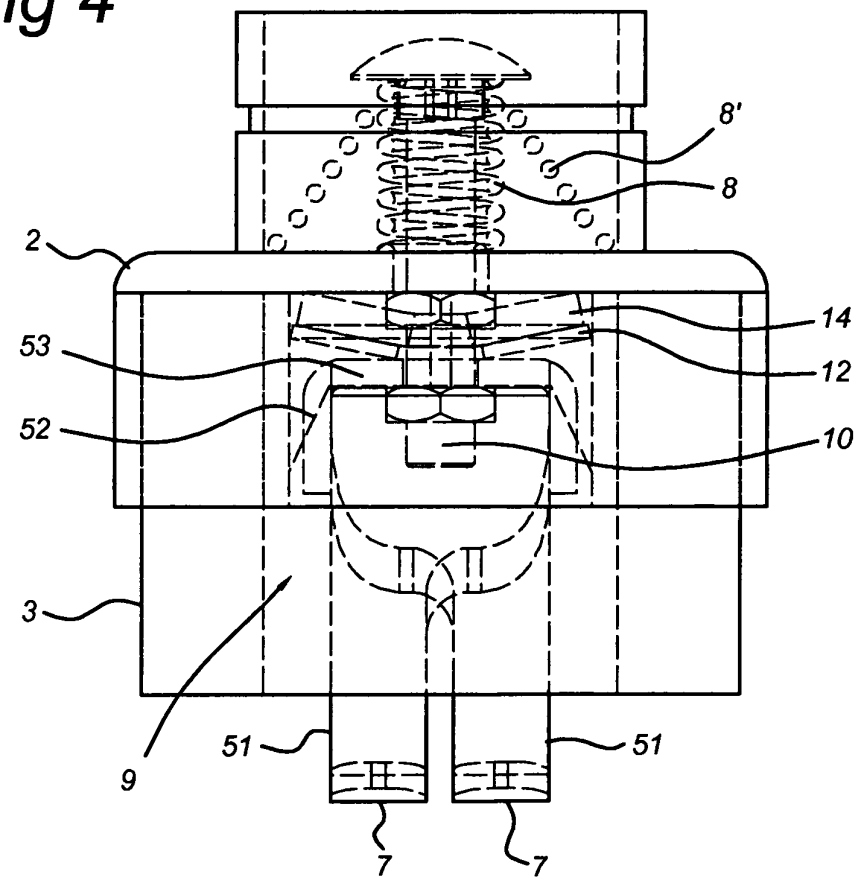


Fig 5

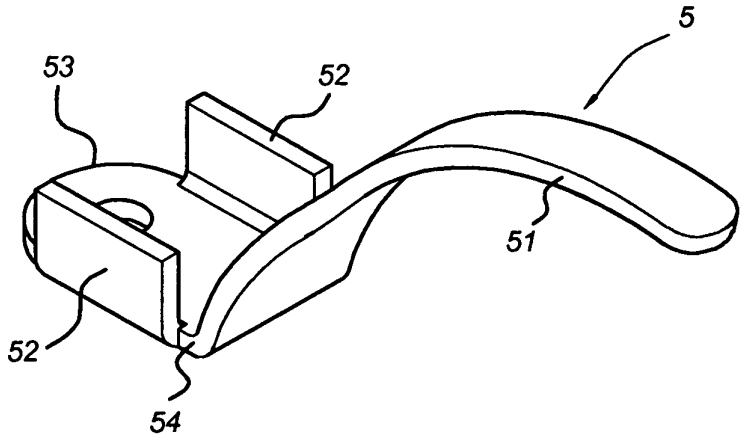


Fig 6

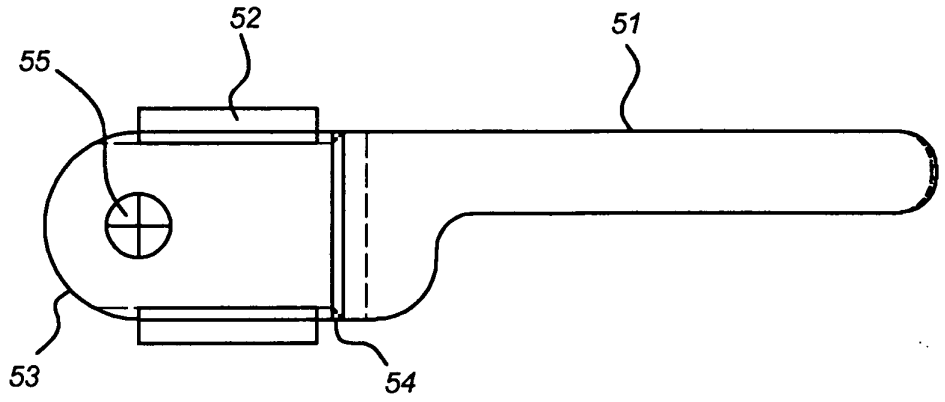


Fig 7

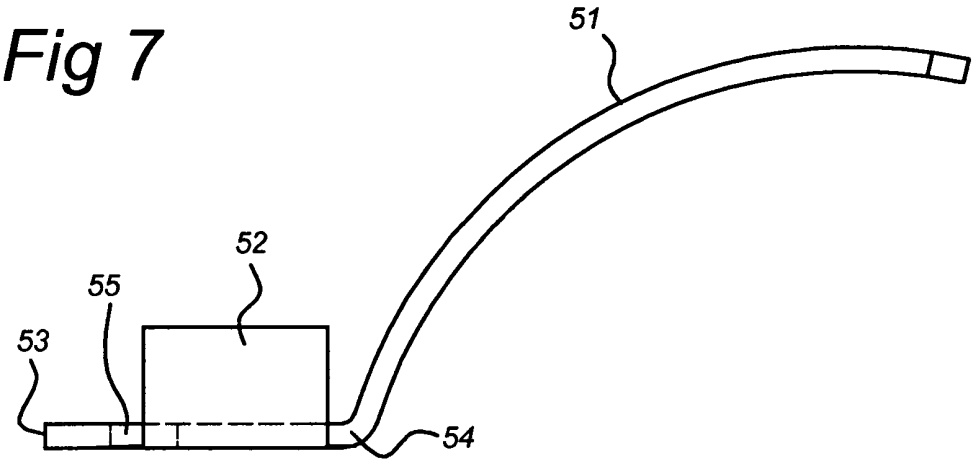


Fig 8a

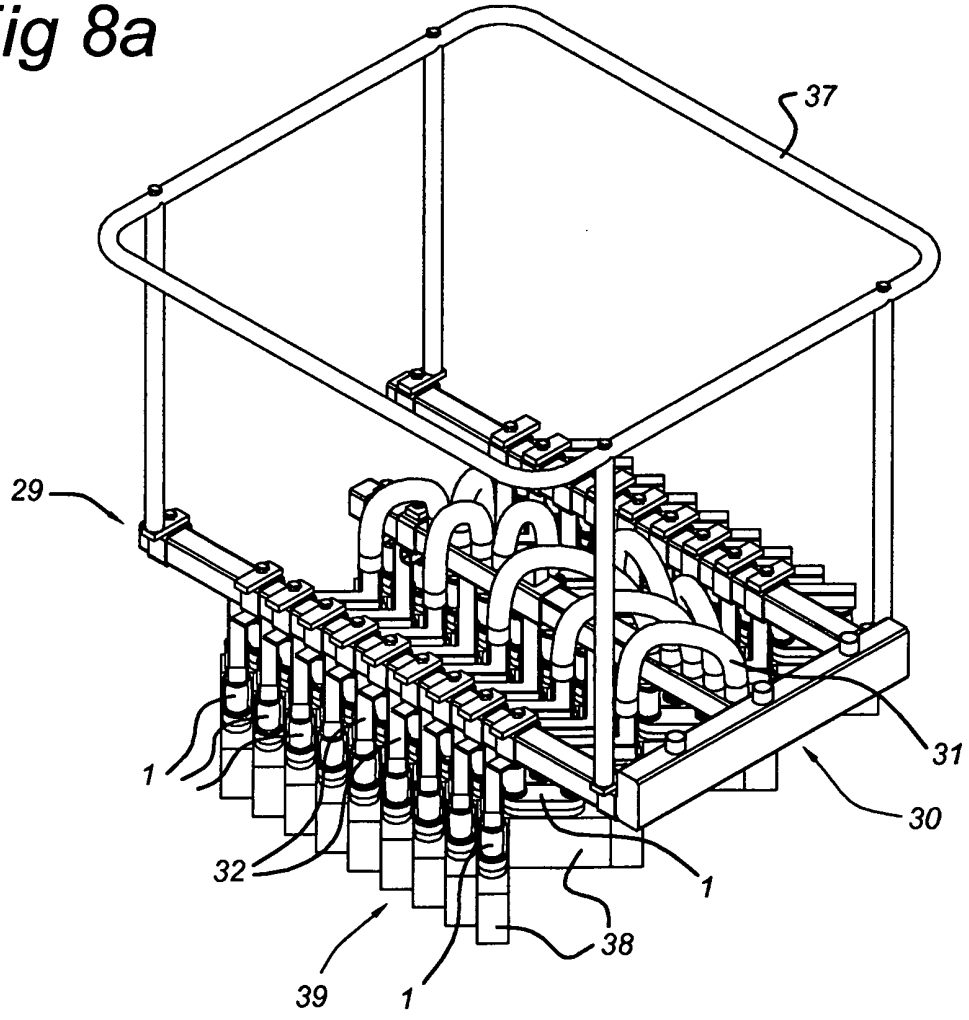
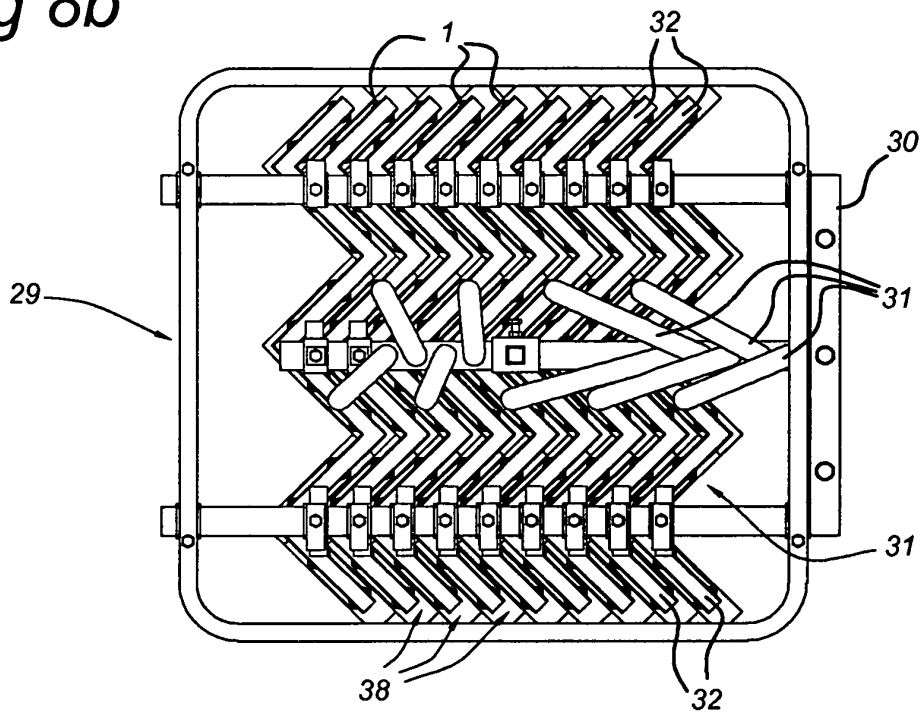


Fig 8b



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