

The invention relates to a vacuum hoisting device for transporting loads exhibiting an adhesive surface, based on features a) to h) of Claims 1 to 3.

5 The use of such vacuum hoisting devices enables rolls of wound strips, inter alia, the material of which consists, for example, of paper, metal, plastic or a laminate, to be raised and transported, to be precise, depending upon the shaping of the suction head, by end-side or peripheral-side attachment to or mounting onto the
10 horizontal or upright roll. Flat bodies also, such as discs, for example, are able to be transposed using vacuum hoisting devices of this kind. The vacuum hoisting device is suspended, such that it can be raised and lowered, from the hoisting gear of a crane. A multiple
15 arrangement can also here enter into consideration. Other hoisting gears can also however be provided, such as, for example, balancers, manipulators, roll-turners or the like.

A vacuum hoisting device of the generic type is
20 described, for example, in German Utility Model 84 35 161.6. This has, as a vacuum head, a flat suction plate, on the bottom side of which there are concentrically disposed, at a distance apart, a plurality of ring seals. These ring seals form vacuum spaces, which are
25 respectively enclosed by the said ring seals and are separated from one another and which, when the suction plate is placed on the adhesive surface, provided for this purpose, of the load intended for transport, form sealed annular chambers, insofar as cover is provided by
30 the load. The ring seals do not have to be circular in this case, but can have any other shape, e.g. an oval or angular shape, as long as they only form a closed ring. Nor is it necessary for them to be placed one inside the other. They can also enclose mutually adjacent vacuum
35 spaces or be distributed over a plurality of suction plates.

The vacuum spaces are connected by openings in the suction plate to a vacuum generator, for example a vacuum pump. Between vacuum generator and vacuum space or spaces there is provided a valve arrangement, for example a
5 three-way valve. As long as there is no load hanging from the vacuum hoisting device, the valve arrangement is set such that the connection to the vacuum generator is interrupted and the vacuum space or spaces are ventilated. The option additionally exists, for lifting
10 the vacuum hoisting device from a set-down load, of introducing compressed air into the vacuum space or spaces in order to facilitate the lift-off. For the raising of a load, the valve arrangement, after the vacuum hoisting device has been placed on the load, is
15 brought into the suction setting and the connection between vacuum generator and vacuum space or spaces thereby established. In this way, an adhesion is produced which is sufficient for the raising and transposal of the load.

20 The ventilation of the vacuum space or spaces should be carried out immediately after the load has been set down so as to prevent time being lost for further transposal operations. However, because of the spatial distance, the crane operator cannot always accurately observe whether
25 the load has already been set down and, consequently, whether the valve arrangement can be brought into a ventilation setting or not.

The object of the invention is to design a vacuum hoisting device of the type stated in the introduction,
30 such that the ventilation or, where appropriate, the supply of compressed air takes place immediately after the load has been set down.

This object is achieved according to the invention by virtue of the following features:

35 i) the crane hoisting gear is connected to the suction

- head by a connecting piece;
- j) the connecting piece is guided in a vertically movable manner between two end settings;
 - k) there is at least one limit switch or one sensor provided for detecting the lower end setting of the connecting piece;
 - l) there is a control device present;
 - m) the limit switch or the sensor interact with the control device in such a way that, once the connecting piece has been lowered into the lower end setting, the valve arrangement is switched into the ventilation setting if it was previously in the suction setting;
 - n) the control device interacts with the drive of the crane hoisting gear in such a way that, in the lower end setting of the connecting piece, the drive is switched off.

According to the invention, the hoisting gear automatically triggers the ventilation of the vacuum space or spaces immediately after the load has been set down, in that the connecting piece hanging from hoisting gear enters, in the vertical guide, into the lower end setting and this setting is detected by the sensor or limit switch. The crane operator therefore has no longer any need to intervene, but can rely upon the switchover, which is automatic and functions without time delay. Safety is also thereby increased.

The fact that the drive is automatically switched off once the connecting piece has been lowered means that a slack-rope securement is simultaneously obtained. An additional limit switch or sensor can herein be provided for this purpose.

Alternatively to the above-described proposal, the object can also be achieved by virtue of the following features:

- i) the crane hoisting gear is connected to the suction

- head by a connecting piece;
- j) the connecting piece is guided in a vertically movable manner between two end settings;
 - k) the hoisting gear exhibits a force sensor;
 - 5 l) there is a control device present;
 - m) the force sensor interacts with the control device in such a way that the valve arrangement is switched into the ventilation setting if the load acting upon the crane hoisting gear falls below a specific
 - 10 threshold value and if the valve arrangement was previously in the suction setting;
 - n) the control device interacts with the drive of the crane hoisting gear in such a way that the drive is switched off if the load acting upon the hoisting
 - 15 gear falls below a specific threshold value.

As force sensors, wire strain gauges or piezoelectric force transducers enter particularly into consideration. Using this configuration, an even faster switchover of the valve arrangement is realized.

- 20 In the drawing, the invention is illustrated with reference to an illustrative embodiment represented diagrammatically in vertical section. The drawing shows the left and central part - the right part is omitted - of a vacuum hoisting device (1), which is seated on the
- 25 top side (2) of a vertically upright paper roll (3) exhibiting, on the inside, a winding sleeve (4). Wound onto this winding sleeve (4) is the paper web.

- The principal part of the vacuum hoisting device (1) is a vacuum tank (5), which is of circular configuration as
- 30 viewed from above. It is designed as a vacuum-tight welded construction and has as its lower extremity a suction plate (6) and on its top side a top plate (7). In the central region there is inserted a centre pipe (8), which forms the inner extremity of the vacuum tank (5).
- 35 On the outside, the vacuum tank (5) is closed off by a circumferential side wall (9).

On the bottom side of the suction plate (6) there are fitted, concentrically to the central vertical axis of the vacuum hoisting device (1), three circular ring seals (10, 11, 12) made from an elastomeric material. With these ring seals (10, 11, 12), the vacuum lifting device (1) is seated on the top side (2) of the paper roll (3). The innermost ring seal (10) has a diameter of such a size that it lies outside the winding sleeve (4), thereby preventing secondary air from being sucked in via the winding sleeve (4).

With the more outer, central ring seal (11), the innermost ring seal (10) forms an annular, inner vacuum space (13). The outermost ring seal (12) forms with the central ring seal (11) a further annular and outer vacuum space (14), which is separated from the inner vacuum space (13) by the central ring seal (11). Provided the vacuum hoisting device (1) has a larger diameter, further vacuum spaces can be correspondingly provided in the outward direction.

The vacuum tank (5) is connected by a vacuum line (15) to a vacuum generator (16). The vacuum generator (16) is connected to a rotation speed regulator (17) and has, moreover, a non-return valve (18). The vacuum generator (16) keeps the vacuum tank (5), which serves as a reservoir, constantly at a specific underpressure.

Emanating from the vacuum tank (5) is a vacuum pipe (19), which leads to a three-way valve (20) which is electromagnetically operated. To the three-way valve (20) there is connected an outlet (21) - provided with a non-return valve (22) - with which outlet a connection can be made to the free atmosphere. In addition, a pipeline (23) is connected, which contains a regulating valve (24) and opens out into a through-pipe (25). The through-pipe (25) passes through the vacuum tank (5) and is open in the direction of the inner vacuum space (13).

The regulating valve is connected to a regulating line (26) having a measured value converter (27), which interacts with a measured value pick-up (28) which is in turn connected, by a measuring line (29) passing through the vacuum tank (5), to the inner vacuum space (13). A further control line (30) - shown in dashed representation - is connected to the rotation speed regulator (17).

In the shown setting of the three-way valve (20), the vacuum tank (5) is connected via the vacuum pipe (19), the three-way valve (20), the pipeline (23), the regulating valve (24) and the through-pipe (25) to the inner vacuum space (13). It is therefore under full vacuum, the vacuum being set by the regulating valve (24) to a specific value, which is detected by means of the measuring line (29), the measured value pick-up (28) and the measured value converter (27) and passed on as a control variable to the regulating valve (24). Further influence upon the vacuum is exerted via the rotation speed regulator (17).

If the vacuum in the inner vacuum space (13) is intended to be eliminated, the three-way valve (20) is switched over. The pipeline (23), the through-pipe (25) and hence the inner vacuum space (13) thereby gains [sic], via the non-return valve (22), connection to the atmosphere, i.e. the inner vacuum space (13) is ventilated. At the same time, the previously existing connection between the vacuum line (15) and pipeline (23) is interrupted, i.e. the vacuum in the vacuum tank (5) is maintained.

In the outer region, there is mounted onto the top plate (7) of the vacuum tank (5) a hollow vacuum block (31). Its interior (32) is connected, by a through-pipe (33) passing through the vacuum tank (5), to the inner vacuum space (13), i.e. the interior (32) always has the same pressure as that obtaining in the inner vacuum space (13).

The vacuum block (31) has on its bottom side a valve opening (34), which interacts with a valve disc (35). The valve disc (35) is seated on a valve rod (36), which is of hollow configuration and is open on its bottom and top
5 sides. The valve rod (36) is seated with its upper end in a valve rod guide (37). A further valve rod guide - which is not here represented in detail - is provided in the region of the lower end of the valve rod (36). The valve rod (36) is surrounded in the region of the interior (32)
10 by a pressure-exerting helical spring (38), which is supported on the top side against the valve rod guide (37) and on the bottom side against a collar (39) above the valve disc (35). The valve disc (35) is thus pressurized by a pressure spring in the direction of the
15 valve opening (34).

The valve opening (34) continues downwards in a filter pipe (40) passing through the vacuum tank (5), which filter pipe opens out into the outer vacuum space (14). In the filter pipe (40) there is disposed a filter insert
20 (41), through which suction air originating from the outer vacuum space (14) can flow whenever the valve disc (35) is lifted from the valve opening (34).

On the outer side of the side wall (9) of the vacuum tank (5) there is disposed a guide tube (42), in which there
25 is mounted in vertically movable arrangement - held relatively loosely - a feeler pin (43). This is situated directly next to the outer side of the outer ring seal (12).

Above and in axial extension of the feeler pin (43), an
30 actuating rod (44) is mounted in vacuum-tight arrangement in the lower and upper walls of the vacuum block (31). It is surrounded, in the region of the interior (32) of the vacuum block (31), by a pressure-exerting helical spring (45), which develops the same spring force as the helical
35 spring (38) of the valve rod (36). The helical spring (45) is supported against the upper wall of the vacuum

block (31) and, on the bottom side, against a forked lever (46) fastened rigidly to the actuating rod (44). The forked lever (46) extends horizontally up to the valve rod (36) and there positively takes hold between the collar (39) and the valve disc (35). The valve disc (35) thereby imitates the motions of the actuating rod (44).

The actuating rod (44) juts upwards out of the vacuum block (31) into a compensating cylinder (47) and exhibits there, on the end side, a compensating piston (48), which runs in seal-forming manner in the compensating cylinder (47) and the piston face of which corresponds to that of the valve disc (35). The space located above the compensating piston (48) is connected by a compensation line (49) to the valve rod guide (37). The space beneath the compensating piston (48) is connected by a compensation bore (50) to the interior (32) of the vacuum block (31).

In the case of larger vacuum hoisting devices having additional, outer vacuum spaces, there is provided for each vacuum space a previously described arrangement, in which the respective vacuum blocks are connected to the next respective inner vacuum space.

In the representation shown, the feeler pin (43) is in its lowest setting, since the diameter of the paper roll (3) conforms precisely to the external diameter of the outer ring seal (12). When the vacuum hoisting device (1) is placed on the paper roll (3), the valve disc (35) is therefore not lifted up. Those vacuum forces which, because of the vacuum in the interior (32), act upon the valve disc (35) in the direction of opening and those vacuum forces which act, via the compensation bore (50), upon the bottom side of the compensating piston (48), are herein equalized owing to the essentially conforming diameters of the valve disc (35) and compensating piston (48), i.e. the actuating rod (44), and hence the forked lever (46), is forced downwards with a force

corresponding to the force which acts upon the valve disc (35) in the direction of opening. Because of this equalization, the valve disc (35) is forced onto the valve opening (34) purely and simply by the helical springs (38, 45).

Normally, the diameter of the paper roll (3) does not conform exactly - as is represented - to the external diameter of the outer ring seal (12). If the diameter is larger, the feeler pin (43) is not yet actuated when the vacuum hoisting device is positioned, since the said feeler pin (43) protrudes less far downwards than the ring seals (10, 11, 12), even if it is compressed somewhat by the natural weight of the vacuum hoisting device (1). It is only once the three-way valve (20) is brought into the shown setting and the vacuum space (13) is therefore subjected to the full vacuum that the ring seals (10, 11, 12) are heavily compressed such that the feeler pin (43) comes to bear against the top side of the paper roll and is even forced upwards. In so doing, it also bridges the distance between its upper end and the lower end of the actuating rod (42) and transports the latter along with it.

By means of the forked lever (46), the valve disc (35) is then lifted from the valve opening (34) counter to the action of the helical springs (38, 45). In this way, a vacuum is likewise created, via the filter pipe (40), the valve opening (34), the vacuum block (31) and the through-pipe (33), in the outer vacuum space (14). As the valve disc (35) is lifted off, the pressure at this is equalized on the top and bottom sides, the effect of which, without further measures, would be that the vacuum force acting upon the bottom side of the compensating piston (48) would be intent upon forcing the actuating rod, (44) and hence also the valve rod (36), back downwards. Since, however, the valve rod (36) is of hollow configuration and a connection exists, via the compensation line (49), to the compensating cylinder

(47), a vacuum is also created in the space above the compensating piston (48), so that the pressure differential which initially exists is eliminated.

5 Once the paper roll (3) has been set down - as already described above - the inner vacuum space (13) is ventilated by actuation of the three-way valve (20). This ventilation also has an effect upon the interior (32) of the vacuum block (31) and hence upon the outer vacuum space (14), since the valve disc (35) is still open. When
10 the vacuum hoisting device (1) is lifted off, the feeler pin (43) extends again out of its guide tube (42) and the valve disc (35) and actuating rod (44) are lowered again, owing to the respective actions of the helical springs (38) and (45), until the valve disc (35) has closed the
15 valve opening (34).

The above-described situation assumes that the paper roll (3) has a larger diameter than the one shown, so that the feeler pin (43) is raised during the positioning operation. In the present illustrative embodiment, this
20 is not the case, so that the feeler pin (43) remains in its downwardly projecting setting. The effect of this is that the valve opening (34) remains closed, even though the outer vacuum space (14) is closed by the top side (2) of the paper roll (3) and a vacuum could there be
25 created. The inner vacuum space (13) is calculated however, in terms of its surface area, such that in these cases the suction force which emanates from it is sufficient to raise the paper roll (3) and transport it in hanging suspension, so that there is no need in such
30 cases for a vacuum to be created in the outer vacuum space (14). When the vacuum hoisting device (1) is set down and then raised, the problem arises however that, as a result of the ring seals (11, 12) springing outwards in the outer vacuum space (14), a vacuum is generated, since
35 here - in contrast to the ventilated inner vacuum space (13) - there can be no after-current of air. This can result in the paper roll (3), when the vacuum hoisting

device (1) is raised, being transported along for a while until the vacuum formed in the outer vacuum space is eliminated by an after-current of air flowing slowly through the material of the paper roll (3), to the point
5 where the paper roll (3) is no longer supported. It then falls in an uncontrolled manner.

In order to prevent this, a compressed-air generator (51) is provided, which is connected by a compressed-air line (52) to a compressed air reservoir (53) and by a solenoid
10 valve (54) to the interior (32) of the vacuum block (31). Normally, the solenoid valve (54) is closed. Once the paper roll (3) has been set down and the three-way valve has been switched over into the ventilation setting, the solenoid valve (54) is opened by an automatic control
15 system (which is not here represented in detail) whenever the pressure in the vacuum space (13) has risen virtually to the free atmospheric pressure.

In the interior (32) of the vacuum block (31) and, via the through-pipe (33), in the inner vacuum space (13), an
20 overpressure is therefore created. The air is prevented from flowing away, via the pipeline (23) and via the three-way valve (20) in the ventilation setting, by the non-return valve (22). The overpressure which develops in the inner vacuum space (13) is sufficient to lift the
25 vacuum hoisting device (1) from the paper roll (3) and to overcome the vacuum force which is thereupon formed in the outer vacuum space (14) as a result of the outward springing of the ring seals (11, 12). Unwanted transportation of the paper roll (3) then no longer comes
30 about. The compressed-air supply is immediately halted once the vacuum hoisting device (1) is lifted off, this being automatically controlled by corresponding pressure sensors.

The vacuum-hoisting device (1) - as is not here
35 represented in detail - is suspended centrically from a crane running gear. The bottom block of the crane running

gear is herein connected to a supporting bolt (55), which is mounted movably, by means of slide blocks (56), in a vertical guide (57). On the bottom side, the supporting bolt (55) is widened and is supported via this, in the upward direction, against a disc spring (58). In the lower part of the vertical guide (57) there is disposed a limit switch (59), which is actuated when the slide blocks (56) reach their end setting. The limit switch (59) is coupled via a control system (which is not here represented in greater detail) to the three-way valve (20).

When the paper roll (3) is set down, the crane running gear becomes slack, with the result that the slide blocks (56), with the supporting bolt (55), are lowered downwards. Upon actuation of the limit switch (59), the three-way valve (20) is switched out of the shown setting, in which the inner vacuum space (13) is under vacuum, into the ventilation setting, so that the inner vacuum space (13) automatically gains connection to the atmosphere. A further limit switch (which is not here represented in greater detail) is connected to the crane running gear as a slack-rope securement and automatically switches it off. In addition, the limit switch (59) can also further be connected to the solenoid valve (54) of the compressed-air generator (51), so that, at the same time, the inner vacuum space (13) is not only ventilated, but is also supplied with compressed air. The vacuum hoisting device (1) can then be lifted from the paper roll (3).

A control system ensures that, whenever the slide blocks (56) leave the limit switch (59), the three-way valve (20) is not switched over, but rather this switchover is effected only after renewed lowering of the vacuum hoisting device (1) onto another paper roll and hence lowering of the slide blocks (56) onto the limit switch (59). A different logic circuit can also however be provided or the three-way valve can be made such that it

is only resettable into the vacuum setting through the medium of the operator.

The vacuum hoisting device (1) additionally exhibits an emergency vacuum generator (60), which is connected by an emergency vacuum line (61) to the interior of the vacuum tank (5). The emergency vacuum generator (60) is likewise secured by a non-return valve (62). The emergency vacuum generator (60) is driven by a direct-current motor (63), which is connected by a pressure switch (64) to a battery (65). The battery (65) is connected to a battery charger (66) constantly connected to the power supply and is thereby kept continuously at the optimal charge state.

The pressure switch (64) is connected to a measured value pick-up [sic] (67), which is connected by a measuring line (68) to the interior of the vacuum tank (5). The measured value converter (67) is set such that it delivers a closing pulse to the pressure switch (64), configured as a solenoid switch, whenever it is established via the measuring line (68) that the vacuum in the vacuum tank (5) is falling below a specific minimum value. This starts up the direct-current motor (63) and hence the emergency vacuum generator (60), so that the fall in vacuum in the vacuum tank (5) is re-compensated and the normal vacuum level is regained. At the same time, a fault message is emitted by a signal transmitter (69) to ensure that the operator is definitely aware that the vacuum generated by the vacuum generator (16) is not sufficient for the transportation of the paper roll (3).

Additionally emanating from the pressure switch (64) is a remote-control line (70), which enables an operator also to actuate the pressure switch (64) independently or as an alternative to the above-described automatic system and hence to start up the emergency vacuum generator (60).

A fall in vacuum can result, for example, from a

breakdown of the vacuum generator (16) or also from a deterioration in the vacuum-gripping characteristics of a paper roll (3), as a consequence of its time-dependent, viscoelastic and hygroscopic properties, to the point
5 where the vacuum generator (16) is no longer adequate to generate the vacuum. In this case, the emergency vacuum generator (60) acts as a back-up. Provision can additionally be made for the emergency vacuum generator (60) also to be switched on by an operator, where this
10 appears necessary.

Vacuum, incidentally, is defined in this description to mean any pressure which is less than free atmospheric pressure.



Patent Claims:

1. Vacuum hoisting device (1) for transporting loads (3) exhibiting an adhesive surface (2), having the following features:
 - 5 a) the vacuum hoisting device (1) has a suction head (5, 6);
 - b) the suction head (5, 6) is suspended from a crane hoisting gear;
 - c) the crane hoisting gear has a drive;
 - 10 d) the suction head (5, 6) has at least one ring seal (10, 11, 12) projecting on its suction side;
 - e) there is at least one vacuum chamber (13, 14) enclosed by a ring seal (10, 11, 12);
 - f) the vacuum chamber or vacuum chambers (13, 14)
 - 15 are connected to a vacuum generator (16);
 - g) there is a valve arrangement (20) provided;
 - h) the valve arrangement (20) is switchable between a suction setting, in which the vacuum generator (16) is connected to the vacuum chamber or vacuum
 - 20 chambers (13, 14), and a ventilation setting, in which the connection to the vacuum generator (16) is interrupted and the vacuum chamber or vacuum chambers (13, 14) is or are ventilated or pressurized with compressed air;
 - 25 characterized by the following features:
 - i) the crane hoisting gear is connected to the suction head (5, 6) by a connecting piece (55);
 - j) the connecting piece (55) is guided in a vertically movable manner between two end
 - 30 settings;
 - k) there is at least one limit switch (59) or one sensor provided for detecting the lower end setting of the connecting piece (55);
 - l) there is a control device present;
 - 35 m) the limit switch (59) or the sensor interact with the control device in such a way that, once the connecting piece (55) has been lowered into the lower end setting, the valve arrangement (20) is



switched into the ventilation setting if it was previously in the suction setting;

- n) the control device interacts with the drive of the crane hoisting gear in such a way that, in the lower end setting of the connecting piece, the drive is switched off.

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2. Vacuum hoisting device according to Claim 1, characterized in that an additional limit switch or sensor is provided for controlling the drive of the crane hoisting gear.

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3. Vacuum hoisting device (1) for transporting loads (3) exhibiting an adhesive surface (2), having the following features:

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- a) the vacuum hoisting device (1) has a suction head (5, 6);

- b) the suction head (5, 6) is suspended from a crane hoisting gear;

- c) the crane hoisting gear has a drive;

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- d) the suction head (5, 6) has at least one ring seal (10, 11, 12) projecting on its suction side;

- e) there is at least one vacuum chamber (13, 14) enclosed by a ring seal (10, 11, 12);

- f) the vacuum chamber or vacuum chambers (13, 14) are connected to a vacuum generator (16);

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- g) there is a valve arrangement (20) provided;

- h) the valve arrangement (20) is switchable between a suction setting, in which the vacuum generator (16) is connected to the vacuum chamber or vacuum chambers (13, 14), and a ventilation setting, in which the connection to the vacuum generator (16) is interrupted and the vacuum chamber or vacuum chambers (13, 14) is or are ventilated or pressurized with compressed air;

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characterized by the following features:

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- i) the crane hoisting gear is connected to the suction head (5, 6) by a connecting piece (55);

- j) the connecting piece (55) is guided in a



vertically movable manner between two end settings;

k) the hoisting gear exhibits a force sensor;

l) there is a control device present;

5 m) the force sensor interacts with the control device in such a way that the valve arrangement (20) is switched into the ventilation setting if the load (3) acting upon the crane hoisting gear falls below a specific threshold value and if the
10 valve arrangement (20) was previously in the suction setting;

n) the control device interacts with the drive of the crane hoisting gear in such a way that the drive is switched off if the load (3) acting upon
15 the hoisting gear falls below a specific threshold value.

4. Vacuum hoisting device according to Claim 3, characterized in that an additional force sensor is provided for controlling the drive of the crane
20 hoisting gear.