



(22) Date de dépôt/Filing Date: 1991/09/25

(41) Mise à la disp. pub./Open to Public Insp.: 1992/03/27

(45) Date de délivrance/Issue Date: 2003/09/16

(30) Priorité/Priority: 1990/09/26 (G 90 13 525.3) DE

(51) Cl.Int.⁵/Int.Cl.⁵ B66C 13/20, B66C 1/02

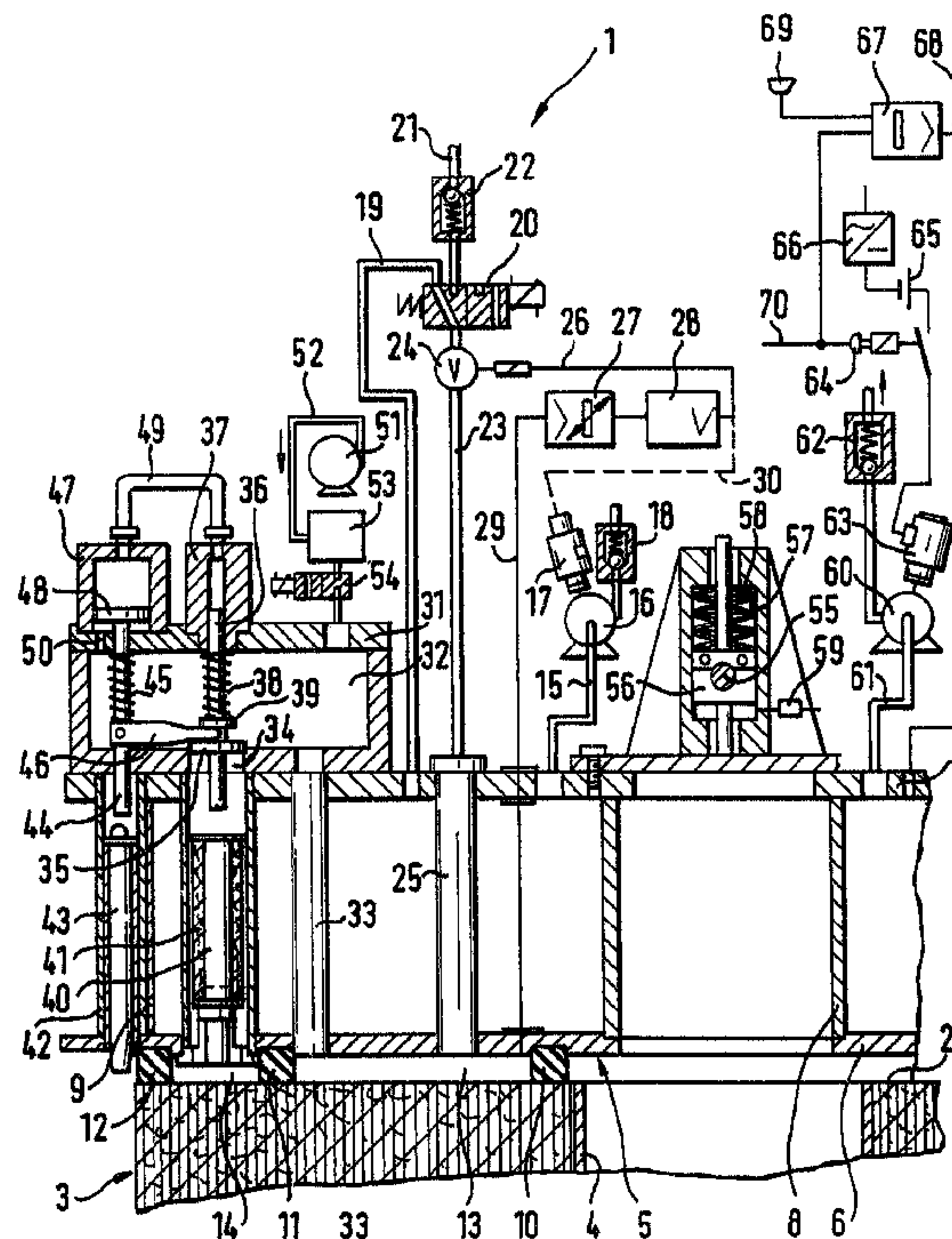
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(54) Titre : DISPOSITIF D'ELEVATION PAR LE VIDE

(54) Title: VACUUM LIFTER



(57) Abrégé/Abstract:

A vacuum lifter for moving loads with adhesion surfaces comprises at least one suction head with several annular seals projecting from its suction side and forming vacuum spaces enclosed by said seals, said vacuum spaces communicating with a vacuum source, the vacuum source communicating through valve(s) with the outer vacuum space(s), said valve(s) being controlled each by sensors detecting the magnitude of the adhesion surface of the load. In order to always prevent impulsive detachment and especially unwanted renewed lifting of the load after it was deposited, a compressed-air system 51, 52, 53 is associated to at least one of the vacuum spaces 13 and a control system is provided which turns ON for a specified time the compressed-air system following detection of interruption of the connection to the vacuum source 16 and following venting of this vacuum space 13, a blocking valve 22 being provided to interrupt venting.



ABSTRACT

A vacuum lifter for moving loads with adhesion surfaces comprises at least one suction head with several annular seals projecting from its suction side and forming vacuum spaces enclosed by said seals, said vacuum spaces communicating with a vacuum source, the vacuum source communicating through valve(s) with the outer vacuum space(s), said valve(s) being controlled each by sensors detecting the magnitude of the adhesion surface of the load. In order to always prevent impulsive detachment and especially unwanted renewed lifting of the load after it was deposited, a compressed-air system 51, 52, 53 is associated to at least one of the vacuum spaces 13 and a control system is provided which turns ON for a specified time the compressed-air system following detection of interruption of the connection to the vacuum source 16 and following venting of this vacuum space 13, a blocking valve 22 being provided to interrupt venting.

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VACUUM LIFTER

Description

The invention concerns a vacuum lifter for moving loads with adhesion surfaces and comprising at least one suction head with several annular seals projecting from its suction side while forming vacuum spaces enclosed by said seals, said vacuum spaces communicating with a vacuum source which communicates with the outer vacuum space(s) by valve(s) controlled by sensors measuring the magnitude of the load's adhesion surface.

As a rule such vacuum lifters are used as crane accessories, however they are also mounted on conveyance means such as fork lifts with lift masts, on balancing equipment, manipulators, roller reversers or the like. Multiple mountings also are possible. Such vacuum lifters for instance allow raising and conveying rolls of wound bands for instance made of paper, metal, plastic or laminates, and, depending on the shape of the suction head, by coming to rest against the end face or the periphery of the prone or upright roll. Flat bodies also, for instance panels, may be transferred by such vacuum lifters.

A vacuum lifter of this species illustratively is described in the German Gebrauchsmuster 84 35 161.6. Its suction head is a plane suction plate to the lower side of which are mounted several concentrically spaced annular seals. These annular seals enclose mutually separated vacuum spaces which, when the suction plate is deposited on the pertinent adhesion surface of a load to be transported, will form sealed annular chambers when and if the load is covered. The "annular" seals need not be circular but may be of any other shape, for instance being oval or polygonal provided they form a closed ring. Nor is it necessary that they be one inside another. They may also enclose adjacent vacuum spaces or be distributed over several suction plates.

The vacuum spaces are connected through apertures in the suction plate with a vacuum source, for instance a pump. A valve is associated with each of at least the vacuum chambers outside the inner one and is present in the connection to the vacuum source. Each valve is coupled to a sensor measuring the magnitude of the adhesion surface of the load when the vacuum lifter is lowered. The sensor is always mounted in such a way that it opens the valve when the load adhesion surface is so big that the associated vacuum chamber shall be completely sealed upon deposition on the adhesion surface. In this manner only those vacuum spaces that form closed annular chambers after deposition of the vacuum lifter on the load shall reliably communicate with the vacuum source and therefore shall not suck-in unwanted air.

In particular mechanical pickups are applicable as sensors to control the valves, and these sensors project downward over the plane of the annular seals and will be forced upward by the load adhesion surface when suction is applied. However other sensors, for instance optical ones, also are conceivable. The mechanical pickups always are mounted on the outside of the pertinent annular seal because thereby the associated valve shall reliably be opened only when the load adhesion surface is larger than the associated annular or vacuum chamber.

Now it may happen that the diameter of the load adhesion surface is precisely the same size as the outside diameter of one of the annular seals, so that the adhesion surface does not project outward beyond the annular seal. Consequently the associated sensor mounted on the outside of this annular seal will not measure, and in the event of being a measuring pin, will not be forced upward. In that event the associated valve shall not be opened, whereby, in turn, the vacuum space enclosed by this annular seal remains unconnected to the vacuum source and therefore is not evacuated. Provided the vacuum

spaces inward from this vacuum space generate enough holding force to move the load, no drawback regarding moving the load is incurred for the time being.

However problems do arise when thereafter raising the vacuum lifter off the deposited load. In this procedure the annular seals that were elastically compressed by means of the vacuum during the transport elastically move apart, so that during a short segment of the raising motion they remain in contact with the load adhesion surface. The inner, vented vacuum spaces can then draw in air, but not the outer vacuum space that was not subjected to vacuum during said transport. Because of the elastic outward motion of the annular seals, an undesired vacuum suction force has been created. If it is less than the weight of the load that was just deposited, then as the vacuum lifter is raised off, detachment takes place impulsively with possible errors in control sequence. If the vacuum force were to be larger than the weight of the deposited load, then initially this load is carried along. The air which no longer is evacuated and now follows the load is the predominant cause of the collapse of the vacuum suction in this vacuum chamber, whereby the load crashes in uncontrollable manner and is damaged. Moreover there is significant danger of an accident.

US patent 3,999,795 describes a vacuum lifter of which the vacuum head comprises three suction plates each with one annular seal. These three suction plates are not associated each with one valve, instead only with one central valve by means of which communication with the vacuum source may be set up. Moreover compressed air equipment is provided, which includes an injector feeding a de-icing liquid. By switching the central valve, de-icing liquid can be periodically supplied to the vacuum chambers, the compressed air ensuring atomization.

Moreover a vacuum lifter is disclosed in US patent 3,865,420 which comprises a vacuum head with a plurality of suction cups whereby for instance eggs can be moved. The

vacuum head communicates with a vacuum pump acting as the vacuum source, and the vacuum head alternately can be connected to the suction or the pressure side of the vacuum pump. However such a design is unsuitable for vacuum lifters of the above species.

The object of the invention is to so design a vacuum lifter of the initially cited kind that impulsive detachment and especially unwanted, renewed lifting of the load following its deposition shall be avoided under all conditions.

This problem is solved by the invention in that a compressed-air system is associated with at least one of the vacuum chambers and in that a control system is provided which, following detection that the communication with the vacuum source was interrupted and following venting of this (these) vacuum chamber(s), shall turn ON the compressed-air system for a given time, a blocking valve to interrupt venting also being present. The blocking valve preferably is in the form of a check-valve.

The compressed air system being controlled in this manner, it is possible to produce excess pressure whereby the vacuum lifter is reliably separated from the deposited load and thus overcomes the suction formed in the vacuum chamber which, for the reasons described above, is out of communication during transport with the vacuum source. Preferably the compressed air system is connected only to the inner vacuum chamber because therein sufficient excess pressure can be produced in any event.

In a further development of the invention, a pressure sensor measuring the pressure in the associated vacuum chamber is part of the automated control system and so affects said automated control system that the compressed air system shall be turned ON only after the pressure has risen in the associated vacuum chamber above a given value, preferably near atmospheric pressure. Instead of the pressure sensor, a timing link also may be provided that appropriately affects the automated control system.

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In accordance with the present invention, there is provided a vacuum lifter (1) for the transport of loads (3) having an adherent surface, with at least one suction head (5) having suction face which has a plurality of protruding ring seals (10, 11, 12) thereon forming vacuum spaces (13, 14) enclosed by the said ring seals and which are connected to a vacuum generator (16, 60), wherein the vacuum generator is connected to at least one of said outer vacuum spaces via valves (34) which are controlled via sensors (43) each of which scans the size of the adherent surface, characterised in that a compressed air device (51, 52, 53) is associated with at least one of the vacuum spaces (13) and a controller is provided which connects the compressed air device (51, 52, 53) for a certain time after detecting an interruption of a connection to the vacuum generator (16) and after aeration of the said vacuum space (13), wherein a stop valve (22) is provided for interrupting said aeration.

Appropriately the compressed air system includes a compressed-air reservoir to ensure adequate available compressed air at all times.

The invention is illustrated in the drawing by means of a schematic, vertical section of an embodiment. The right-hand part of the invention has been omitted from the drawing which shows the left and center parts of a vacuum lifter 1 seated on the top side 2 of an upended paper roll 3 comprising an inside winding tube 4. The paper web is wound on this winding tube 4.

The main part of the vacuum lifter 1 is a vacuum vessel 5 which is circular in topview. It is made in welded, vacuum-tight manner and its lower seal is a suction plate 6 while at the top it has a top plate 7. A center pipe 8 is present at the center zone and forms the internal seal of the vacuum vessel 5. On the outside the vacuum vessel 5 is sealed by a peripheral side wall 9.

Three elastomeric annular seals 10, 11, 12 are mounted concentrically with the center vertical axis of the vacuum lifter 1 at the lower side of the suction plate 6. By means of these annular seals 10, 11, 12 the vacuum lifter 1 rests on the top side 2 of the paper roll 3. The inner annular seal 10 is of such a large diameter that it falls outside the winding tube 4, as a result of which no unwanted air can be aspirated through the winding tube 4. Together with the farther out center annular seal 11, the inner annular seal 10 forms an inner, annular vacuum space 13. The outer annular seal 12 together with the center annular seal 11 forms another, annular and outer vacuum space 14 separated by the center annular seal 11 from the inner vacuum space 13. If the vacuum lifter 1 has a larger diameter, further vacuum spaces toward the exterior may be provided in corresponding manner.

The vacuum vessel 5 communicates through a vacuum line 15 with a vacuum source 16. The vacuum source 16 is connected to an angular-speed control 17 and moreover

comprises a check valve 18. The vacuum source 16 keeps the vacuum vessel 5 acting as a reservoir to a constant, specific reduced pressure.

A vacuum pipe 19 issues from the vacuum vessel 5 and leads to a three-way valve 20 which is driven electromagnetically. The three-way valve 20 comprises an outlet 21 equipped with a check valve 22 to set up communication to atmospheric air. Moreover a pipe 23 is connected which comprises a control valve 24 and which receives a through-pipe 25. The through-pipe 25 passes through the vacuum vessel 5 and is open toward the inner vacuum space 13.

The control valve is connected through a control line 26 to a test-value transducer 27 cooperating with a test-value pickup 28 which in turn is connected through a test line 29 passing through the vacuum vessel 5 to the inner vacuum space 13. Another control line 30 shown in dashed lines is connected to the angular-speed control 17.

In the shown position of the three-way valve 20, the vacuum vessel 5 communicates through the vacuum pipe 19, the three-way valve 20, the pipe 23, the control valve 24 and the through-pipe 25 with the inner vacuum space 13. Said space therefore is subjected to full vacuum, which is set by means of the control valve 24 at a specific value detected by means of the test line 29, the test-value pickup 28 and the test-value transducer 27 and fed as a control value to the control valve 24. Further control of the vacuum takes place by means of the angular-speed control 17.

If the vacuum of the inner vacuum space 13 shall be eliminated, then the three-way valve 20 is switched. In this manner the pipe 23, the through-pipe 25 and hence the inner vacuum chamber 13 communicate through the check valve 22 with the atmosphere, that is, the inner vacuum space 13 is vented. Simultaneously the previously extant communication

between the vacuum line 15 and the pipe 23 is interrupted, that is, the vacuum in the vacuum vessel 5 is maintained.

A vacuum box 31 is seated on the external part of the top plate 7 of the vacuum vessel 5. The inner space 32 of this box 31 communicates by means of a through-pipe 33 passing through the vacuum vessel 5 with the inner vacuum space 13, that is, the inner space 32 is at the same pressure as is present in the inner vacuum space 13.

At its bottom side the vacuum box 31 comprises a valve port 34 cooperating with a valve head 35. The valve head 35 is mounted on a hollow valve rod 36 open at its top and bottom sides. By its upper end the valve rod 36 rests inside a valve-rod guide 37. A further valve-rod guide not shown herein in further detail is present near the lower end of the valve rod 36. A compressing helical spring 38 encloses the valve rod 36 in the zone of the inside space 32 and rests at its top against the valve-rod guide 37 and at its bottom against a collar 39 above the valve head 35. Accordingly the valve head 35 is spring-loaded toward the valve port 34.

The valve port 34 continues downward into a filter pipe 40 passing through the vacuum vessel 5 and issuing into the external vacuum space 14. A filter insert 41 is mounted inside the filter pipe 40 and allows the suction air from the external vacuum space 14 to flow through it when the valve head 35 is raised off the valve port 34.

A guide pipe 42 is mounted externally on the side wall 9 of the vacuum vessel 5 and inside of it a mechanical detecting pin 43 is held relatively loosely so as to be vertically displaceable. It is located immediately next to the outside of the external annular seal 12.

An actuation rod 44 is supported in vacuum tight manner above and in the axial extension of the mechanical detecting pin 43 in the lower and upper walls of the vacuum box 31. Said pin is enclosed in the zone of the inside space 32 of the vacuum box

31 by a compressing helical spring 45 generating the same spring force as the helical spring 38 of the valve rod 36. The helical spring 45 rests against the top wall of the vacuum box 31 and at the bottom against a forked lever 46 rigidly affixed to the actuation rod 44. The forked lever 46 extends horizontally as far as the valve rod 36 where it enters in geometrical-ly locking manner between the collar 39 and the valve head 35. In this manner the valve head 35 follows the motions of the actuation rod 44.

The actuation rod 44 projects upward out of the vacuum box 31 into a compensating cylinder 47 where it comprises at its end a compensating piston 48 moving in sealed manner inside the compensating cylinder 47, the piston surface corresponding to that of the valve head 35. The space above the compensating piston 48 is connected through a compensation line 49 to the valve-rod guide 37. The space underneath the compensating piston 48 communicates through a compensating borehole 50 with the inside 32 of the vacuum box 31.

As regards large vacuum lifters with additional external vacuum spaces, each vacuum space is arranged in a prescribed manner, the particular vacuum boxes communicating with the particular nearest inner vacuum spaces.

In the embodiment shown, the detection pin 43 is in its lowest position because the diameter of the paper roll 3 just coincides with the outside diameter of the outer annular seal 12. When the vacuum lifter 1 is deposited on the paper roll 3, the valve head 35 therefore will not be raised. Thereby the vacuum forces acting on the valve head 35 in the direction of opening because of the vacuum in the inside space 32 and those acting through the compensation borehole 50 on the lower side of the compensation piston 48 will balance on account of the essentially coinciding diameters of the valve head 35 and compensation head 48, that is, the actuation rod 44 and thereby the forked lever 46 is forced down by a force corresponding to that acting on the valve head 35 in the direction of opening. Because

of this balance the valve head 35 is pressed merely by the helical springs 38, 45 against the valve port 34.

In the typical case the diameter of the paper roll 3 does not precisely match -- and this is shown in the Figure -- the outside diameter of the external annular seal 12.

5 If the diameter is larger, then the detecting pin 43 is not yet actuated when the vacuum lifter 1 has been deposited because projecting less than the annular seals 10, 11, 12 even when these are somewhat compressed by the weight proper of the vacuum lifter 1. It is only when the three-way valve 20 has been moved into the shown position, whereby the vacuum space 13 is subjected to full vacuum, that the annular seals 10, 11, 12 will be compressed
10 so strongly that the detection pin 43 comes to rest against the top side of the paper roll and even is forced upward. Thereby it also bridges the distance between its upper end and the lower end of the actuation rod 42 which it carries along.

Thereupon, by means of the forked lever 46, the valve head 35 is raised off the valve port 34 against the action of the helical springs 38, 45. In this manner the outer
15 vacuum chamber 14 is also evacuated through the filter pipe 40, the valve port 34, the vacuum box 31 and the through-pipe 33. By raising the valve head 35, pressure balancing takes place at its top and bottom sides, whereby, in the absence of further steps, the force generated by the vacuum at the lower side of the compensation piston 48 would move the actuation rod 44 and hence the valve rod 36 down again. However, the valve rod 36 being
20 hollow and there being communication through the compensation line 49 to the compensation cylinder 47, the space above the compensation piston 48 also is evacuated, whereby the initially extant pressure differential is eliminated.

After the paper roll 3 has been deposited, and as already described above, the inner vacuum space 13 is vented by actuating the three-way valve 20. This venting also

affects the inside space 32 of the vacuum box 31 and thereby the outer vacuum space 14 because the valve head 35 is still open. When the vacuum lifter 1 is being raised, the detection pin 43 again moves out of its guide tube 42 and as a result the valve head 35 and the actuation rod 44 descend again on account of the action of the helical springs 38 or 45 until the valve head 35 has sealed the valve port 34.

The above-described situation assumes that the paper roll 3 is of a diameter larger than shown, whereby the detection pin 43 shall be raised when the lifter comes down. However that is not the case in the present embodiment mode, and therefore the detection pin 43 remains in its downwardly projection position. As a result, the valve port 34 remains sealed even though the outer vacuum space 14 is closed by the top side 2 of the paper roll 3 and could be evacuated. The surface of the inner vacuum space 13 however is chosen in such a way that, in these instances, the suction said space does exert suffices to lift the paper roll 3 and to transport it while it is suspended, and there is no need for vacuum in the outer vacuum space 14 in such cases. However when depositing the load and then raising the vacuum lifter 1, the problem arises that here a vacuum is generated by the elastic motion of the annular seals 11, 12 in the outer vacuum space 14 -- because, contrary to the case of the vented inner vacuum space 13, no air can follow. This may result in the paper roll 3 raised by the vacuum lifter 1 being moved over some distance until the vacuum formed in the outer vacuum space is slowly eliminated by air entering through the material of the paper roll 3 until the paper roll 3 no longer is supported. Thereupon it crashes in uncontrolled manner.

In a preventive step, a compressed-air source 51 is provided which communicates through a compressed-air line 52 with a compressed-air reservoir 53 and through a magnetic valve 54 with the inside space 32 of the vacuum box 31. Ordinarily the magnetic valve 54 is closed. After the paper roll 3 has been deposited and the three-way valve has

been switched to the venting position, the magnetic valve 54 is opened by an automatic control not shown in further detail herein once the pressure in the vacuum space 13 has risen to nearly atmospheric. Thereby the inside space 32 of the vacuum box 31 is raised to excess pressure and also, by means of the through-pipe 33, the inner vacuum space 13. The check
5 valve 22 prevents the air from flowing out through the pipe 23 and through the three-way valve 20 in the venting position. The excess pressure building up in the inner vacuum space 13 suffices to raise the vacuum lifter 1 off the paper roll 3 and to overcome the vacuum force forming in the outer vacuum space 14 on account of the elastic motion of the annular seals 11, 12. The paper roll 3 no longer is carried away when it is not supposed to be. The supply
10 of compressed air is shut down at once after the vacuum lifter 1 has been raised, and this process is automatically controlled by corresponding pressure sensors.

The vacuum lifter 1 is centrally suspended from a crane travel works not shown herein in further detail. Its lower flange is connected with a support bolt 55 displaceably resting on slide blocks 56 in a vertical guide 57. The support bolt 55 widens at its lower side
15 and thereby rests upwards against a cup spring 58. A limit switch 59 is mounted in the lower part of the vertical guide 57 and will be actuated once the slide blocks 56 have reached their lower end position. The limit switch 59 is coupled by a control means not shown in further detail herein with the three-way valve 20.

When the paper roll 3 is deposited, the crane travel works becomes slack whereby the
20 slide blocks 56 together with the support bolt 55 will descend. By actuating the limit switch 59, the three-way valve 20 is switched from the shown position, wherein vacuum exists in the inner vacuum space 13, to the venting position, so that the inner vacuum space 13 automatically is connected to the atmosphere. Another limit switch not shown in further detail here is connected as a slack-cable safety device to the crane travel works and turns it off

automatically. Additionally the limit switch 59 may also be connected to the magnetic valve 54 of the compressed-air source 51, whereby the inner vacuum chamber 13 is not only vented but also simultaneously fed with compressed air. Thereupon the vacuum lifter 1 can be raised off the paper roll 3.

5 When the slide blocks 56 move away from the limit switch 59, a control system ensures that the three-way valve 20 shall not be switched, rather that this switching shall take place only after the vacuum lifter 1 is lowered again on a new paper roll, in the process of which the slide blocks 56 are lowered onto the limit switch 59. However a different logic circuit may also be provided, or the resetting of the three-way valve into the vacuum position
10 may be carried out by the operator.

 Additionally the vacuum lifter 1 comprises an emergency vacuum source 60 communicating through an emergency vacuum line 61 with the inner space of the vacuum vessel 5. The emergency vacuum source 60 also is secured by a check valve 62. The emergency source 60 is driven by a DC motor 63 connected by a pressure switch 64 to a
15 battery 65. The battery 65 is connected to a battery-charging apparatus 66 permanently connected to the power supply and in this manner is continuously kept optimally charged.

 The pressure switch 64 is connected to a test-value pickup 67 in turn connected through a test line 68 with the inside of the vacuum vessel 5. The test-value transducer 67 is set in such a way that it emits a close! signal to the pressure switch 64, which is a magnetic
20 switch, when the test line 68 ascertains that the vacuum in the vacuum vessel 5 has dropped below a specified minimum value. Thereby the DC motor 63 will be actuated, and hence the emergency vacuum source 60, and the vacuum drop in the vacuum vessel 5 will be compensated and the normal vacuum level shall be reached again. At the same time, a

signal generator 69 emits a malfunction signal to reliably alert the operator that the vacuum produced by the vacuum source 16 is inadequate to move the paper roll 3.

A remote control line 70 also starts from the pressure switch 64 to allow an operator to actuate the pressure switch 64 also independently from or alternatively to the above described automated system in order to start the emergency vacuum source 60.

Illustratively a drop in vacuum may be caused by a malfunction of the vacuum source 16, but also because the vacuum-grip properties of a paper roll 3 have degraded the time-dependent visco-elastic and hygroscopic behavior to such an extent that the vacuum source 16 no longer suffices for sufficient vacuum. In that case the emergency vacuum source 60 may additionally be used as required by the operator.

Furthermore, the term vacuum is to be construed as a pressure less than atmospheric.

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CLAIMS:

1. A vacuum lifter (1) for the transport of loads (3) having an adherent surface, with at least one suction head (5) having suction face which has a plurality of protruding ring seals (10, 11, 12) thereon forming vacuum spaces (13, 14) enclosed by the said ring seals and which are connected to a vacuum generator (16, 60), wherein the vacuum generator is connected to at least one of said outer vacuum spaces via valves (34) which are controlled via sensors (43) each of which scans the size of the adherent surface, characterised in that a compressed air device (51, 52, 53) is associated with at least one of the vacuum spaces (13) and a controller is provided which connects the compressed air device (51, 52, 53) for a certain time after detecting an interruption of a connection to the vacuum generator (16) and after aeration of the said vacuum space (13), wherein a stop valve (22) is provided for interrupting said aeration.

2. A vacuum lifter according to claim 1, characterised in that the stop valve (22) is constructed as a non-return valve.

3. A vacuum lifter according to claim 1 or 2, characterised in that the compressed air device (51, 52, 53) is only connected to the inner vacuum space (13).

4. A vacuum lifter according to any one of claims 1 to 3, characterised in that a pressure sensor which detects pressure within the associated vacuum space (13), forms part of the automatic control system, which pressure sensor influences the automatic control system in such a way that the compressed air device (51, 52, 53) is not connected until the pressure in the associated vacuum space (13) increases above a particular value.

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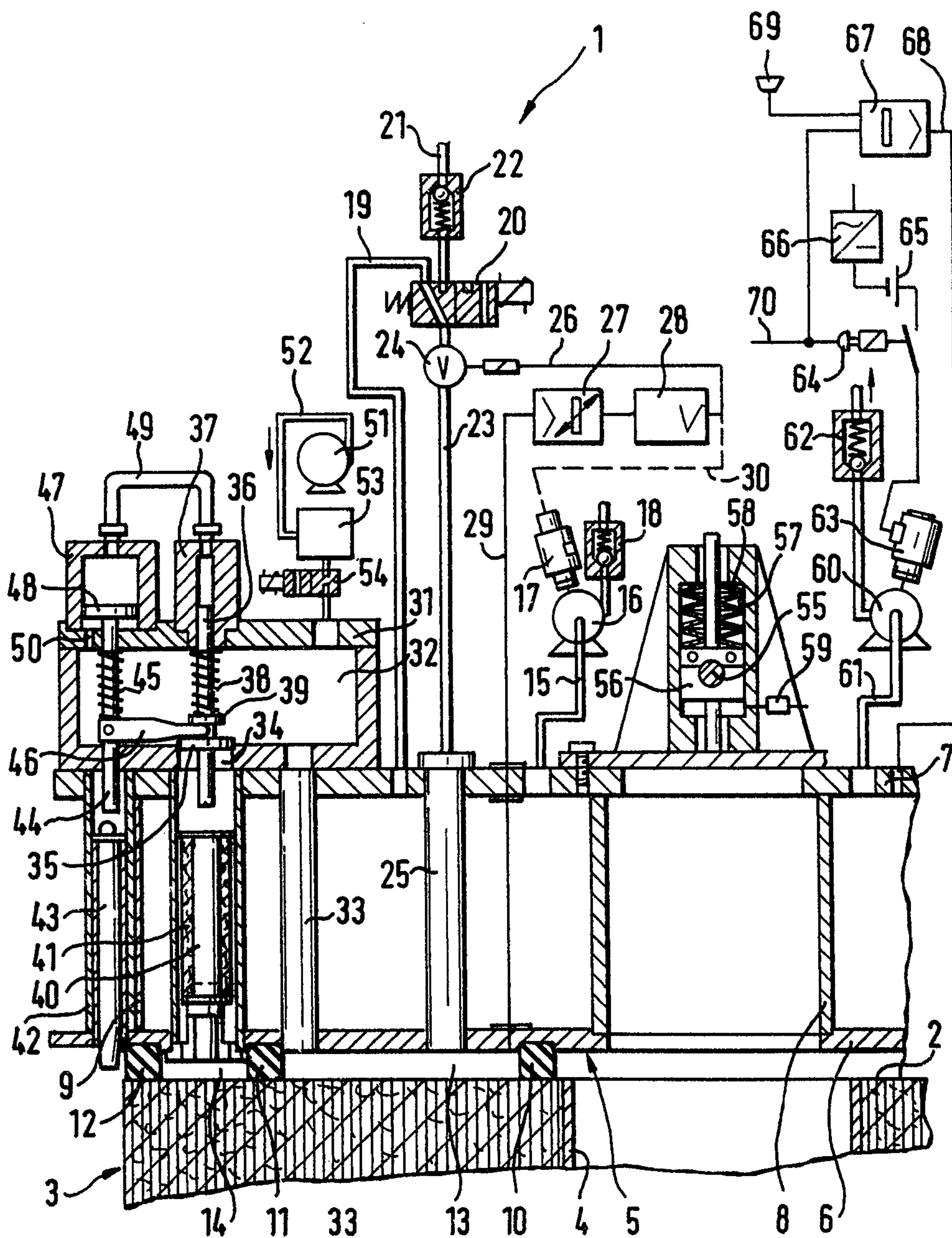
5. A vacuum lifter according to any one of claims 1 to 3, characterised in that a time function element forms part of the automatic control system and influences the automatic control system in such a way that the compressed
5 air device (51, 52, 53) is not connected until the pressure in the associated vacuum space (13) increases above a particular value.

6. A vacuum lifter according to any one of claims 1 to 5, characterised in that the compressed air device (51)
10 is provided with a compressed air reservoir (53).

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