MOBILE AIR LAYER TRANSPORTER


Filed Oct. 16, 1964, Ser. No. 404,423
Claims priority, application Switzerland, Oct. 22, 1963, 12,964/63
17 Claims. (Cl. 302—29)

This invention relates to a mobile air layer transporter. According to the present invention there is provided a mobile air layer transporter comprising a base including an internal chamber having an inlet for connection to a source of compressed air and including a top wall having an outer surface defining a glide path along which an object to be transported is to travel, a plurality of valve and proximity detector means mounted in said top wall to create within said object a mobile and localized layer of air as visible in FIGURE 1. These differential pistons all comprise, as may be seen in the case of piston 7, two heads: an upper head 11 and a lower head 12. The upper head 11 has an area substantially larger than that of the lower head 12. These two heads are connected by a rod 13. The upper head 11 is slidably mounted in a recess 14 formed in the top wall 1 of base 1 and the rod 13 extends slidably in a central hole 15 passing through the remainder of top wall 5. The upper head 11 is thus exposed to the outside air whereas the lower head 12 is located in chamber 2. The length of the rod 13 is such that in the raised position of the differential piston the upper head 11 is flush with the glide path 4 and the lower head 12 abuts against the inner face 4 of wall 5. Through rod 13 is formed an axial passage 16 one end of which merges with a radial orifice 19 in the side surface of rod 13 at a location such that this orifice be wholly clear of wall 5 when the upper head 11 is fully depressed in recess 14 and fully closed by said wall when the upper head 11 lies flush with glide path 4. A sealing ring 20 is embedded in wall 5 for engagement with the outer face of the rod 13 to prevent the escape of compressed air. The orifice 19 thus forms, together with hole 15, a slide valve which only allows air to escape from chamber 2 towards the outside when the upper head 11 of the differential piston is depressed in recess 14. Channels 21 and 22 connect the bottom of recess 14 with the bottoms of the corresponding recesses of the neighboring differential pistons, and constitute a network which communicates with the outside via a passage 23 to avoid the build-up of an air cushion beneath the upper head 11. The ratio between the area of upper head 11 and the area of lower head 12 is so chosen that the force exerted on the upper head 11 by the atmospheric pressure p_a is only slightly less than that exerted on the lower head by the pressure p_d prevailing in chamber 2.

In the absence of the object being transported, the upper head 11 is subjected to atmospheric pressure p_a whereas the lower head 12 is subjected to the pressure p_d prevailing in chamber 2. In view of the ratio between the areas of the heads, the differential piston is normally in its raised position, as shown for piston 7. The slide valve formed by the inner orifice 19 and by the hole 15 is thus closed and this differential piston position is termed the closure position. When the object being transported 6 reaches a differential piston and if this object is supported by a flow of air in the form of a layer located between itself and the glide path 4, which flow is represented by arrows 25, 26 and 27 in FIGURE 1, the pressure p_1 that prevails in this flow is greater than the atmospheric pressure p_a and, if the ratio between the areas of the upper and lower heads is suitably chosen, the force exerted by this pressure p_1 on the upper head is greater than that exerted on the lower head by the pressure p_d prevailing in chamber 2. Since channels 21 and 22 avoid the build-up of an air cushion beneath the upper head, the differential piston moves down. In the lowered position, termed the open position, the piston opens the slide valve thereby contributing to the formation of the air layer beneath the object. This is what is shown for piston 8. It will thus be observed that each differential piston acts as a proximity detector which actuates the corresponding valve formed by hole 15 and orifice 19 as soon as the object being transported 6 reaches the piston. Upon the object moving away, the atmospheric pressure again acts on the upper head so that the differential piston moves back to its closure position to close the valve. The layer of air supporting the object only exists beneath the latter: it is mobile and accompanies the object during its forward travel. The use of proximity detectors which react to a mere change of pressure brought about by the presence of the transported object to the exclusion of any direct mechanical contact with the latter, has the advantage of eliminating any friction between the object 6 and the base 1. In the above-described transporter, the proximity detector and the valve as such are combined in a single device fulfilling both functions. It will be understood that the proximity detector may well be entirely separate from the valve; the main consideration is that it actuates the valve as soon as the object comes to overlie it. Moreover, any kind of proximity detector may be envisaged provided it does not come into direct mechanical contact with the object. The nozzle 17 has the effect of imparting to the air escaping from the upper head the form of
a directed jet. The orientation of this jet is, as regards piston 8, perpendicular to the glide path 4 since the nozzle has an outlet 18 located in the alignment of channel 16. The jet then only exercises on the object 6 a purely supporting action and the valve producing such a jet may be termed a supporting valve. It is optional however to give to the jet an oblique direction in relation to the glide path. This is the case with differential piston 9 (FIGURE 3) whose nozzle 30 has an outlet 31 forming an angle with the corresponding channel 32. The jet then exercises in addition to a supporting action, a thrusting action parallel to the glide path 4. If this thrust is parallel to the direction of movement of the object, it contributes to the propulsion thereof. A valve whose jet is so directed constitutes a supporting-propelling valve. If the thrust is perpendicular to the direction of movement of the object, it contributes simultaneously to the propulsion and to the guidance of the object: such a valve acts as a supporting-propelling-guiding valve, whose thrust has a propulsion component and a guidance component.

The base 1 is provided with a plurality of valves actuated by differential pistons. There are various possibilities as regards the nature and arrangement of these valves. In a first case, all of the valves are supporting valves: the base then only supports the transported object, the propulsion thereof being carried out by any suitable means independently of the supporting action. In a second case, the plurality of valves includes both supporting valves and supporting-propelling valves: the base thus serves both to support and to propel the object. If the arrangement includes moreover supporting-propelling valves disposed so that their guiding thrust be directed towards the middle of the base, the latter can then serve simultaneously to support, propel and guide the object. The same applies if the valves are all supporting-propelling-guiding valves whose guidance components are directed towards the middle of the base. FIGURE 2 shows a base provided with the four kinds of valves, the nonpurely supporting valves being identified by arrows appended to some of them, which arrows represent the thrust exerted by the directed jet issuing therefrom. Thus, arrow 49, which, starting from the outlet 43 of valve 42, points in the direction of the movement of the transported object 6, as represented by arrow 44, indicates that valve 42 is a propelling valve. Arrow 45 of valve 46 is perpendicular to this direction of movement: this valve 46 is a guiding valve whose thrust is directed towards the longitudinal axis 47 of base 1; valve 48, which is symmetrical to the latter in relation to the longitudinal axis 47 of the base, is also a guiding valve whose thrust is directed, as shown by arrow 49, in a direction opposite to that of valve 46, but, as in the case of the latter, towards the longitudinal axis 47. As regards valve 50, it is of the mixed type: the thrust it exerts, represented by arrow 51, is oblique in relation to the direction of movement 44 of object 6 and directed towards the axis 47 of the base, so that the thrust of this valve 50 has a propulsion component and a guidance component, the latter being directed towards the middle of the base.

The transporter operates as follows: The object 6 is carried by a layer of air, represented by arrows 52. The valves successively encountered by this object open under the action of the proximity detectors; the propulsion thrusts cause it to move forward and the guidance thrusts prevent it from slipping sideways in relation to its intended direction of movement. The distribution of the valves of different kinds as illustrated in FIGURE 2 which shows one central row A of supporting propelling valves, two rows B1 and B2 of supporting propelling-guiding valves and four rows D1, E1 and D2, E2 of supporting-guiding valves, is, clearly, arbitrary. The only condition to be respected is that any thrust perpendicular to the longitudinal axis 47 of the base be directed towards the latter. Apart from this condition, any distribution is permissible; only the weight, the size and the shape of the object may make it preferable to resort to a particular distribution.

As stated earlier, the valves are always closed in the absence of object 6 and only open under the action of the pressure prevailing within the air layer that supports the object. To cause the valves to open when an object is laid on the base and to create the initial air layer, some nozzles are provided with a boss or raised portion, such as the annular flange 34 of nozzle 30 of the differential piston 9 (FIGURE 3). This boss slightly taps the upper head 33, by a height such that when an object is laid on this piston, it causes the latter to be depressed thereby partially opening the valve; the resultant leak initiates the air layer and the valve then opens fully. The height of this boss is however sufficiently low not to come into contact with the object when the object is fully open. This arrangement is useful not only when the object is being loaded on the transporter, but also when the operation of the latter is being resumed after an interruption in the course of which the base remains loaded, for example when resuming work in a plant. It is however possible to conceive that all the valves are provided with such a boss: it suffices that some are so provided, in particular at the loading points of the transporter.

If the objects to be transported always have an identical shape, the glide path may assume the form of a trough having a cross-section which follows, at least partially, the shape of the object as shown in FIGURE 4 wherein the base 1 has a glide path 4 corresponding to the contour of the lower portion of object 6.

The fact that the outlet such as 18 of channel 16 (FIGURE 1), or 31 of channel 32 (FIGURE 3), should be formed in a nozzle, such as 17 or 30, has the advantage of making it possible readily to mould the valve-out of the base. It suffices that these nozzles be interchangeable to enable a change in the distribution of the supporting forces and of the thrusts by modifying the distribution of the straight outlet nozzles and of the oblique outlet nozzles. Moreover, this construction makes it possible to modify the propelling thrust and guidance thrust distribution: it suffices to modify the orientation of the outlet oblique nozzles. Blocking means for preventing inadvertent changes in orientation during use must however be provided. One possibility consists in making these nozzles out of plastic material and to provide them with a retaining head 24 which enables them to be mounted with a tight fit, this head serving to retain the nozzles within the head and to prevent inadvertent changes in orientation.

As regards the differential pistons, they can be constructed in various ways. A first modified construction is illustrated in FIGURE 5. The upper head is formed by a disc 35 which is peripherally connected to a skirt 36 by a thin and flexible annular portion 37 acting as a joint. This skirt 36 is mounted with a force fit in the recess 14 formed in the top wall 5. Skirt 36 and disc 35 form a unit with rod 38 and are, for example, made in one piece out of plastic material. A split annular clip 39' is mounted at the end 39 of rod 38, which acts as the lower head of the differential piston. The clip has a conical outline thus enabling the arrangement to be placed in position by simultaneously forcing skirt 36 into recess 14 and clip 39 into hole 38, the clip expanding upon emerging in chamber 2 to form a unit that prevents disc 35 from projecting above the guide path 4. The disc 35 is provided with a nozzle 35' similar to the previously described nozzle.

It may be advantageous, when using a plastic material,
to mould together several discs similar to disc 53 (FIGURE 6) and to make a sheet 53 for covering the glide path 4. This sheet 53 is provided with a plurality of thin and flexible annular zones, such as 54, the portion 55 inside each of these zones, constituting the upper head of a differential piston, being provided with a protuberance acting as a rod for the latter. Each rod is provided with a spring clip 57 having a conical outline, similar to clip 39 of the previous modified construction, and the distance between adjacent annular zones is such that the latter are located opposite the recesses 14 formed in the top wall 5 of the base. This sheet 53 is applied over the glide path 4, with clips 57 being forced through holes 15, and is held in place by means of flat-headed screws screwed through holes 58 into threaded holes 59.

Another modified construction for the differential piston, shown in FIGURE 7, consists in giving to the upper head of the piston the shape of a deformable diaphragm 60 which is connected at its centre to rod 61 and which is secured at its periphery to the glide path 4. In this arrangement also, it may be advantageous to connect together several diaphragms so as to form a sheet 62 which is rendered locally flexible at alternate recesses 14 formed in the top wall 5 of the base, said sheet covering the glide path and being secured thereto by any suitable means, for example by screws 63.

We claim:
1. A mobile air layer transporter comprising a base including an internal chamber having an inlet for connection to a source of compressed air and including a top wall having an outer surface defining a glide path along which an object to be transported is to travel, a plurality of valve and proximity detector means mounted in said top wall to create beneath said object a mobile and localized layer of pressurized air capable of supporting said object while moving along therewith, each of said valve means including a normally closed compressed air leakage valve connecting said chamber with the outside and adapted to open upon said object being located thereover, but out of contact with said valve, to form, in cooperation with neighbouring valves, said air layer beneath said object, and a proximity detector adjacent to each valve for detecting the presence of said object, said proximity detector being disposed within said top wall for movement therein, and being operatively associated with said valve for actuation therefrom from a closed position to an open position when said object is located in the vicinity thereof and from said open position to a closed position when said object moves away therefrom, and wherein said valve having a nozzle for imparting to the compressed air in said passage and applied at said open position the form of a directed jet oriented in a pre-determined direction in relation to the said top wall.

2. A transporter according to claim 1, wherein said proximity detectors are responsive to the pressure exerted thereon by said air layer.

3. A transporter according to claim 2, wherein said base includes for each of said proximity detectors a recess formed in the outer portion of said top wall and a passage extending through the remaining portion of said top wall from the bottom of said recess to said chamber, and each of said proximity detectors includes a first head movably mounted in said recess and subjected to pressure exerted thereon outside said base, a rod extending slidably through said passage and having one end connected to said first head, and a second head at the opposite end of said rod and subjected to the pressure exerted thereon by said compressed air in said chamber, said first head having an area greater than that of said second head in order to form together a differential piston, said base further including means for preventing the build-up of an air cushion in said recess when said first head is depressed therein.

4. A transporter according to claim 3, wherein said first head has an area such in relation to the area of said second head that the force exerted on said second head by the pressure is less than that exerted on said first head by the pressure prevailing in said air layer, and greater than that on said first head by the ambient room pressure, thereby to depress said first head, when said object is located in the vicinity thereof, towards the bottom of said recess to move said differential piston from a valve closing position to a valve opening position, and thereby to move said first head, when said object has moved away therefrom, from the bottom of said recess to return said differential piston from said valve opening position to said valve closing position, said rod having a length such that in the valve closing position of the differential piston said second head abuts the inner surface of said top wall and said first head is substantially flush with said glide path.

5. A transporter according to claim 3, wherein the means for preventing the build-up of an air cushion in said recess includes a plurality of balancing channels connecting the bottom portion of said recess to the bottom portions of neighbouring recesses to form a network of such channels.

6. A transporter according to claim 3, wherein said first head consists of a disc slidably mounted in said recess and in substantially fluid-tight engagement with the side walls of said recess.

7. A transporter according to claim 3, wherein said first head consists of a disc, said recess is lined by an annular member mounted in said recess with a tight fit, and said disc and said annular member have therebetween a thin and flexible annular recess sealing member.

8. A transporter according to claim 3, wherein said first head consists of a disc having at the periphery thereof a thin and flexible annular recess sealing member secured to the adjacent portion of said outer surface of said top wall.

9. A transporter according to claim 3, further comprising a sheet covering the non-recessed portion of the top wall of said base, and wherein said sheet and the upper head of each of said differential pistons have therebetween a thin and flexible annular recess sealing member.

10. A transporter according to claim 3, wherein said nozzle is provided in said differential piston upper head, said valve further having a passage extending through said piston rod, said passage having one end communicating with said nozzle and the opposite end terminating at an orifice formed in the side surface of said rod at a location such that said orifice is closed by the wall of said hole when said differential piston is in said valve closing position and communicates with said chamber when said piston is in said valve opening position, whereby said valve constitutes a slide valve.

11. A transporter according to claim 3, wherein said differential piston upper head has a recess of circular cross-section in which said valve nozzle is removable and rotably mounted with a tight fit to prevent undesired movement thereof, said valve further having a passage extending through said piston rod, said passage having one end communicating with said nozzle and the opposite end terminating at an orifice formed in the side surface of said rod at a location such that said orifice is closed by the wall of said hole when said differential piston is in said valve closing position and communicates with said chamber when said piston is in said valve opening position, whereby said valve constitutes a slide valve.

12. A transporter according to claim 1, wherein said nozzle of at least some of said valves has an outlet passage perpendicular to the adjacent portion of the outer surface of said top wall, whereby said valves constitute object supporting valves.

13. A transporter according to claim 1, wherein said nozzle of at least some of said valves has an outlet passage which is oblique in relation to the adjacent portion of the outer surface of said top wall and which is directed towards the mean course of said glide path and perpendi-
cularly thereto, whereby said valves constitute object supporting and guiding valves.

14. A transporter according to claim 1, wherein said nozzle of at least some of said valves has an outlet passage which is oblique in relation to the adjacent portion of the outer surface of said top wall and which has a component directed parallel to said glide path, whereby said valves constitute object supporting and propelling valves.

15. A transporter according to claim 1, wherein said nozzle of at least some of said valves has an outlet passage which is oblique in relation to the adjacent portion of the outer surface of said top wall and which is directed towards the mean course of said glide path and at an angle thereto, whereby said valves constitute object supporting, guiding and propelling valves.

16. A transporter according to claim 1, wherein said valve and said proximity detector of each of said valve and proximity detector means are combined to form a unit and wherein at least some of said units have a raised portion projecting slightly beyond the upper surface of said top wall only in the closed position of said valve.

17. A transporter according to claim 1, wherein the upper surface of at least some of said plurality of valve means has a raised portion comprising an annular bead disposed about the nozzle thereof, said bead projecting slightly above said top wall only in the closed position of said valve means.

References Cited by the Examiner

UNITED STATES PATENTS

756,600 4/1904 Dodge --------- 302—31
2,176,307 10/1939 Lamb ---------- 302—17
2,678,237 5/1954 Allander et al. ----- 302—31
2,785,928 3/1957 Hanson --------- 302—17

EVON C. BLUNK, Primary Examiner.
ANDRES H. NIELSEN, Examiner.