United States Patent

Thomas-Collignon

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[54] **TRANSPORT SYSTEMS UTILIZING A TRACK SUPPLIED WITH FLUID UNDER PRESSURE**

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[52] **U.S. Cl.** **302/31,** 137/81.5, 302/66

[51] **Int. Cl.**..**B65g 53/04**

[58] **Field of Search** 302/66, 31; 137/81.5

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[57] **ABSTRACT**

A track comprises a multiplicity of elemental nozzles controlled to discharge a layer of pressure fluid formed between the track and a load movable thereon when the presence of such load is detected, no pressure fluid being discharged in the absence of such load. This control is effected by means of a fluidic logic element responsive to a fluidic signal generated by a detector located on the track and sensitive to the presence of a load thereon.

12 Claims, 10 Drawing Figures

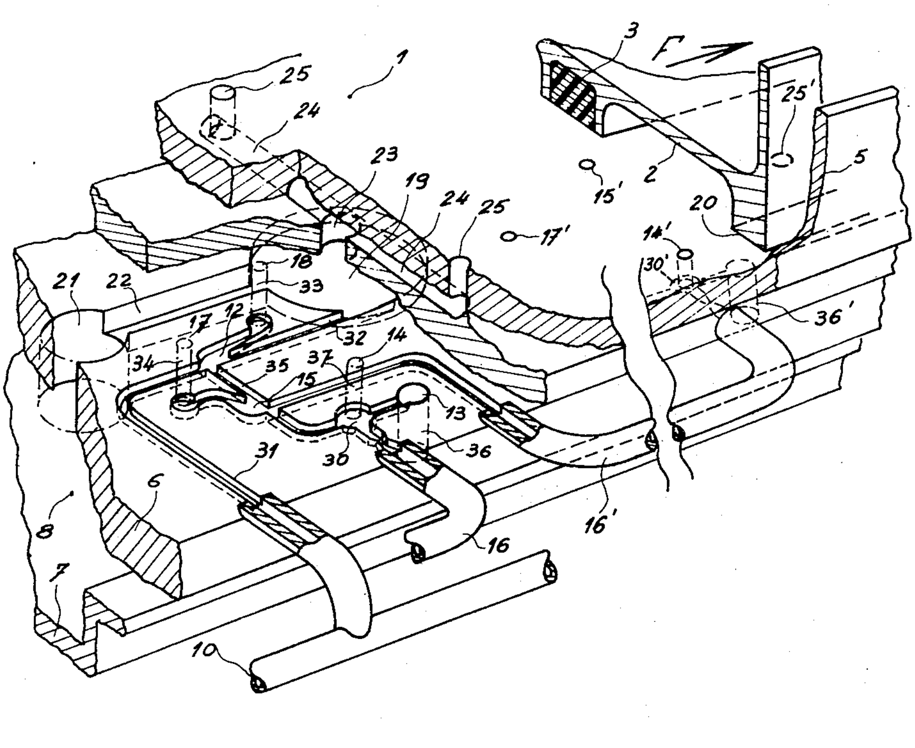


Fig. 3.

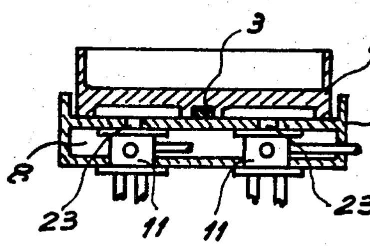


Fig. 1.

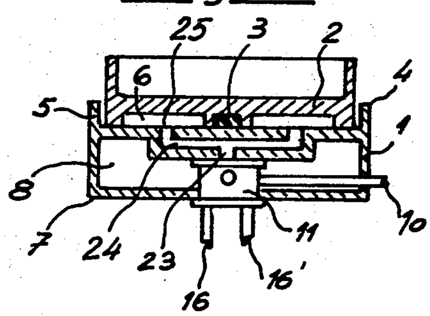
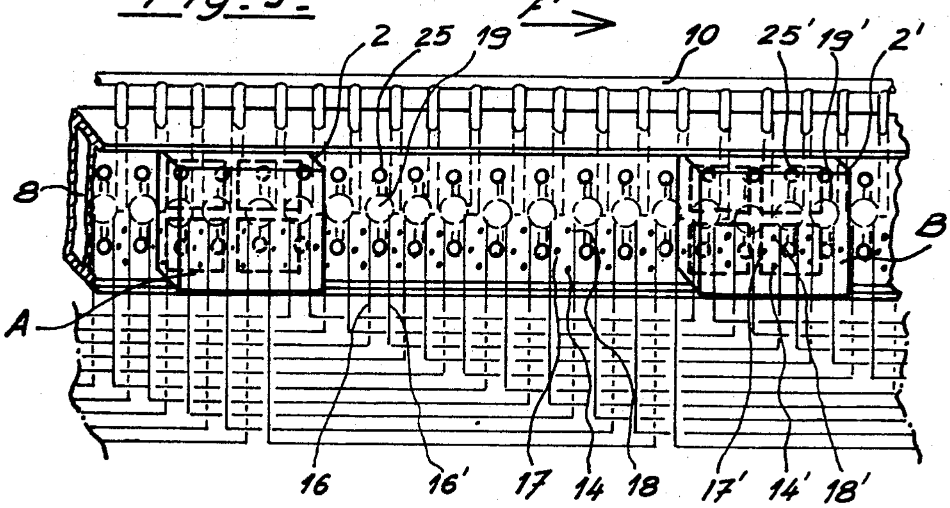


Fig. 9.



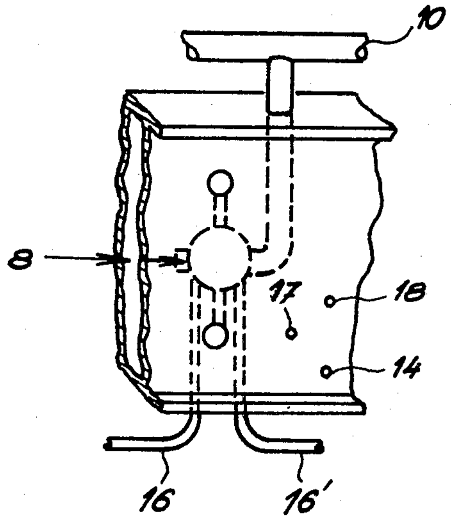


Fig. 8.

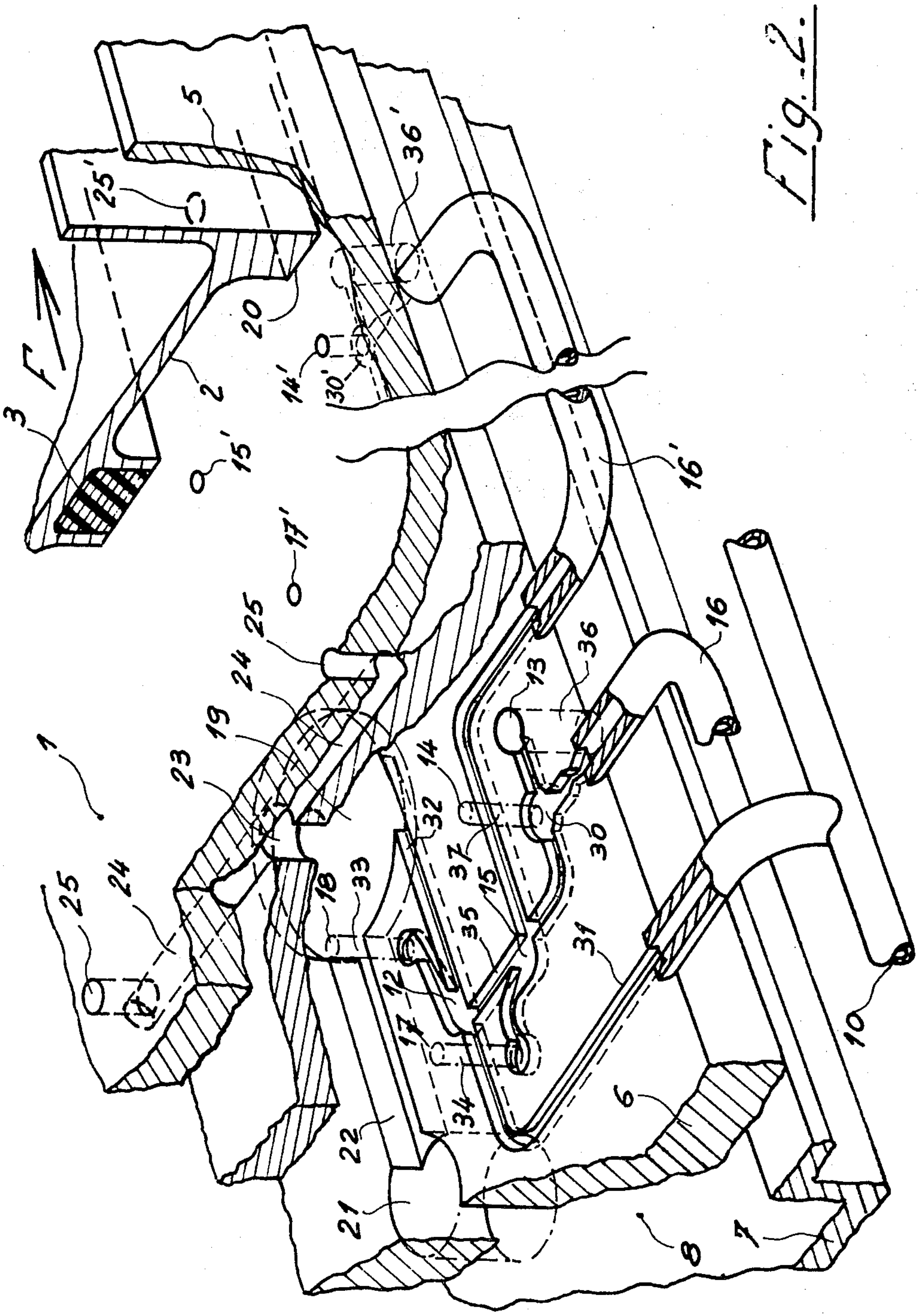

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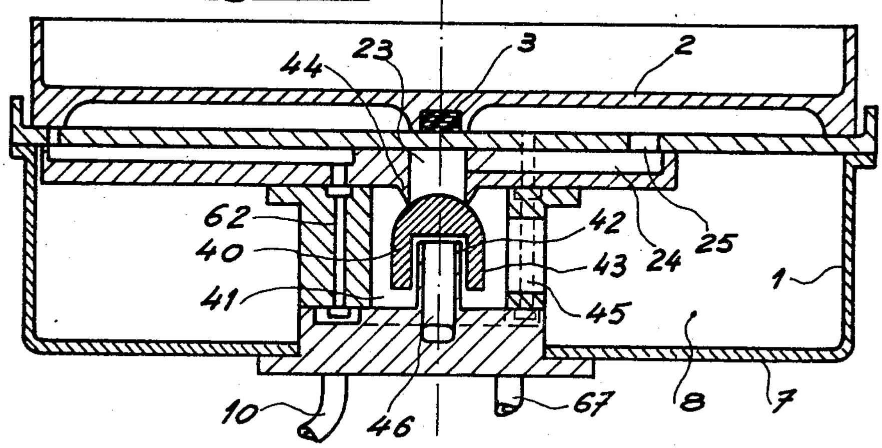
Fig. 2.

Fig.-4-



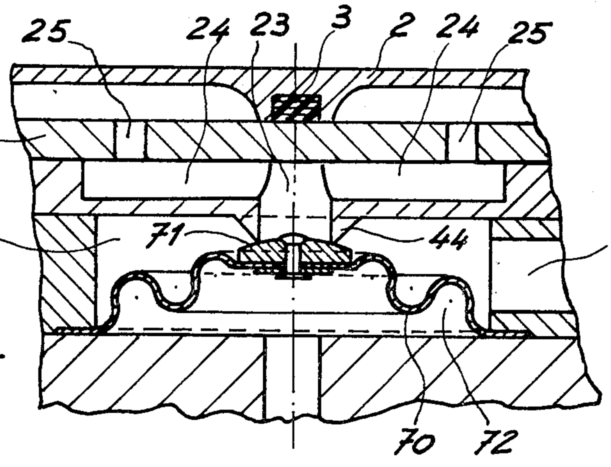


Fig-6-

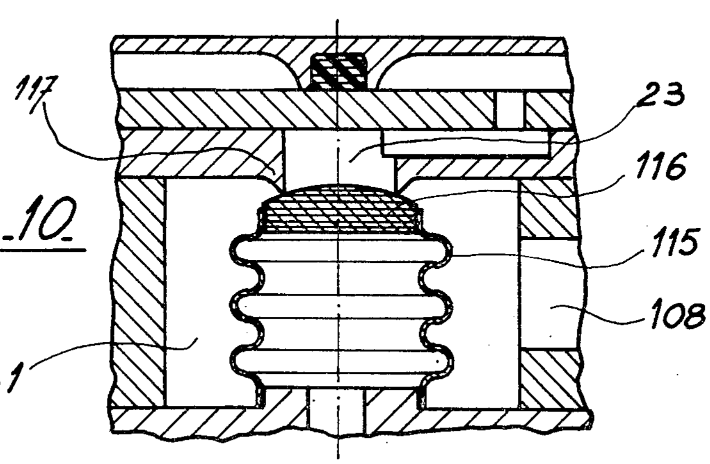


Fig.-10-

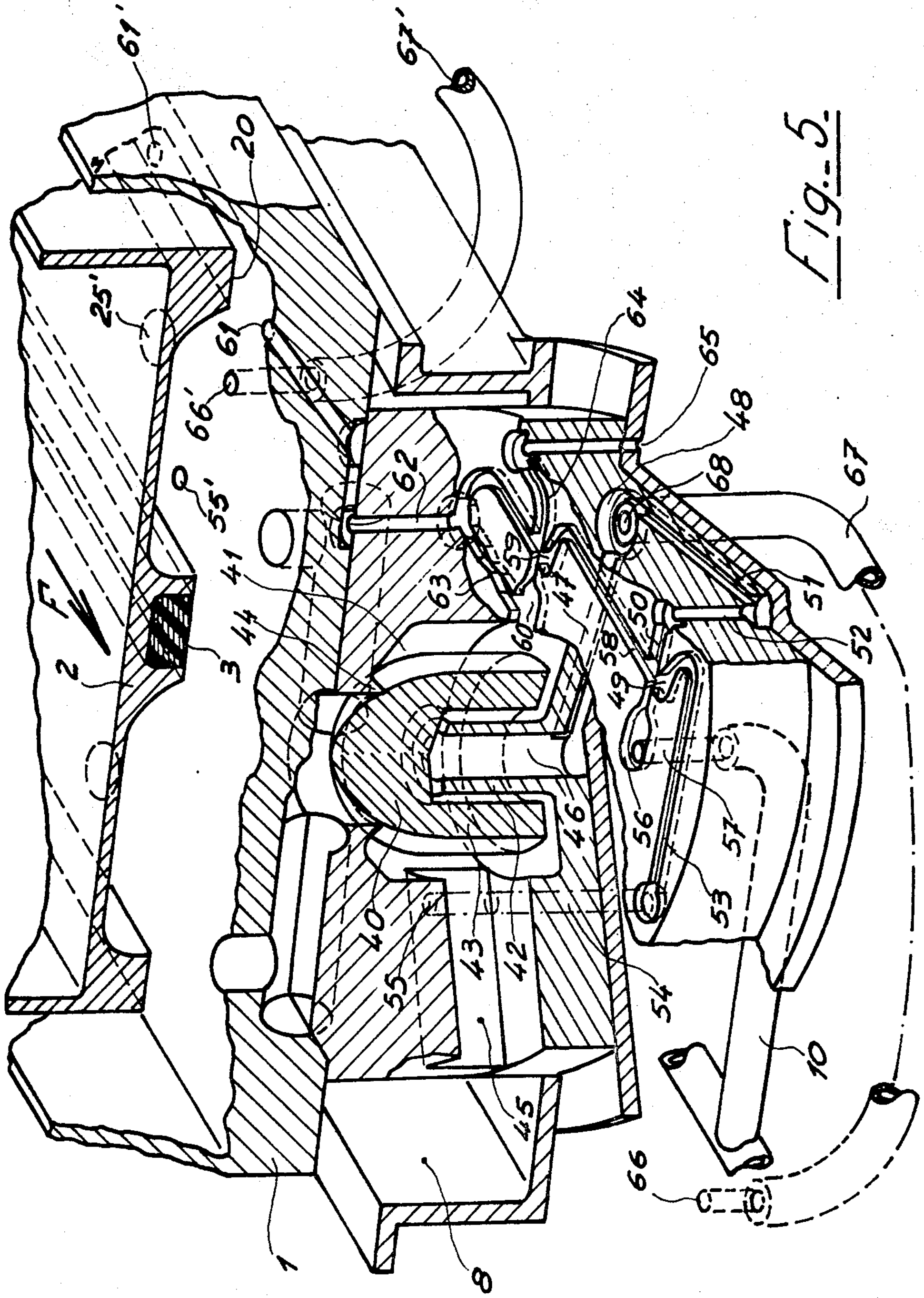

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Fig. 5

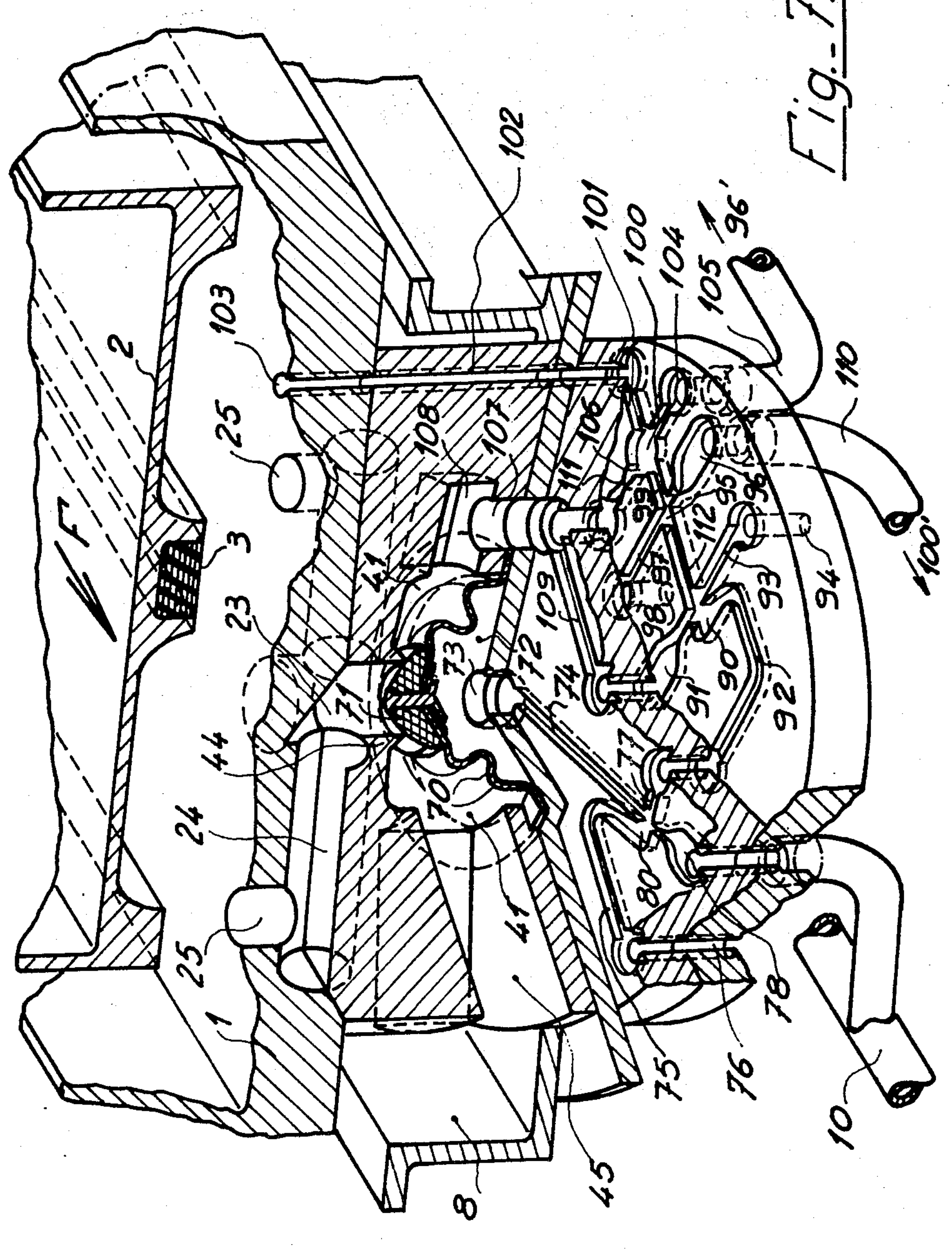

Fig. 7

TRANSPORT SYSTEMS UTILIZING A TRACK SUPPLIED WITH FLUID UNDER PRESSURE

The present invention relates to transport systems which include a track and a movable load capable of travelling along the same, a layer of fluid under pressure being delivered between the load and the track through openings connected by at least one conduit to a chamber forming part of the track.

In accordance with the invention, the track includes a chamber or enclosure delivering fluid-pressure through openings connected thereto through at least one conduit and is provided with conduit obturating means and with control means of the latter, said control means being formed in part at least by fluidic logic elements. Each control means is associated to a track element and is connected to means for detecting the presence of a movable load on that track element and downstream thereof.

The detection means may be formed by venting orifices capable of being partly obturated as a result of the passage of a movable load. The logic elements are formed by fluidic amplifiers comprising preferably monostable flip-flops.

The control means permit of admitting or cutting off the pressure-fluid which provides lift for the loads as they travel along; concurrently, a safety interval between consecutive loads is maintained and the rate of travel of the load is monitored.

The injection of pressure fluid beneath the load to be supported, which ensures safety and minimum expenditure of power, is enabled only when the load is located above the particular track element in question, a certain downstream distance along the track being devoid of all other loads.

The description which follows with reference to the accompanying non-limitative exemplary drawings will give a clear understanding of how the invention can be carried into practice.

In the drawings:

FIG. **1** is a schematic sectional view of a system according to the invention;

FIG. **2** shows in perspective with partial cutaway and on an enlarged scale the system of FIG. **1**;

FIG. **3** is an alternative embodiment of FIG. **1**;

FIG. **4** is a sectional view of an enlarged scale of another alternative embodiment;

FIG. **5** is a partial perspective view of the system shown in FIG. **4**;

FIG. **6** is an alternative embodiment of FIG. **4**;

FIG. **7** is a partial perspective view of the system shown in FIG. **6**;

FIG. **8** is a diagrammatic perspective view of a system according to this invention;

FIG. **9** is an overall view of the system according to this invention; and

FIG. **10** is an alternative embodiment of FIG. **6**.

Referring to FIG. **1**, there is shown thereon a transport system such as a conveyor system, formed by a track **1** over which travels a pallet which may be a container or a passenger cabin driven by a motor (not shown). Beneath its chassis, the container includes chambers separated by a schematically illustrated seal **3**. Preferably, the track **1** is hollow and is formed by a box member **8** which in cross-section is substantially of double-bottomed U-shape, the free vertical walls **4** and **5** of which guide the pallet while the horizontal surfaces

6 and **7** form the sealed enclosure **8** jointly with the extensions of walls **4** and **5**. This enclosure is supplied with pressure fluid through a conduit (not shown). A monitoring distribution unit **11**, portrayed schematically in FIG. **1**, is supplied with pressure fluid through a conduit **10** which supplies the control pressure.

FIG. **2** is a perspective view showing details of the unit **11** which is integrated into the upper track surface **6** and is devoid of moving parts. Upper panel **6** is preferably formed of a plurality of superposed bonded plates, made for example of moulded plastic and embodying appropriate cutouts. The unit **11** consists of a vortex valve **19** which delivers the pressure fluid through a conduit **24** which debouches on to the track through orifices **25**. Vortex valve **19** communicates with the pressurized track enclosure **8** through a duct **21** and a duct **22** and debouches on to track **1** through two supply orifices **25** via a duct **23** and conduit **24**. Between vortex valve **19** and conduit **10** are provided means for detecting a pallet and for automatically controlling opening or shutting off of the pressure-fluid supply. These means are formed by two fluidic flip-flops **12** and **15** and a distributor **30**. On its upstream side, flip-flop **12** is connected to conduit **10** through a duct **31** and on its downstream side assures delivery either into duct **32** debouching tangentially into vortex valve **19** (in the event of absence of any control action), or into a venting orifice **18** on the track via a duct **33** (in the event of control action being applied). The upstream side of flip-flop **15** is connected to the pressurized track enclosure **8** through distributor **30**, and on its downstream side to a venting track orifice **17** via a duct **34** and also to flip-flop **12** via a duct **35**, which duct is utilized for controlling the flip-flop **12**. Distributor **30** is connected to the pressurized track enclosure **8** through a duct **36** debouching at **13** and to a venting track orifice **14** through a duct **37**.

The above-described arrangement is repeated at substantially regular intervals along the track. Interconnection between these several assemblies is provided, on the one hand, through the pressurized enclosure **8** extending along the whole length of the track, and on the other through pressure-fluid supplying conduit **10** and through a conduit **16** which communicates the distributor **30** with the flip-flop **15** of an assembly located at a predetermined downstream safeguarding distance that depends on the length of each pallet and on the rate of travel thereof.

For greater clarity, like parts in the next assembly will be designated by like reference numerals followed by a dash mark '.

FIG. **8** schematically illustrates an assembly as described precedingly, while FIG. **9** portrays, along the length of the track, the manner of spacing a succession of assemblies which are interconnected in pairs, the safe spacing being chosen so that the first detector of pallet A be connected, for instance, to the tenth downstream detector which is the last detector of pallet B.

The theory of operation of an installation as hereinbefore described is as follows:

The direction of travel of pallet **2** along track **1** is shown by the arrow F. A supply of pressure fluid is bled from enclosure **8** through duct **36** and vented on the track via distributor **30** and orifice **14** (provided that the latter is not obturated and consequently performs the function of a detector). The orifice **14** is so positioned along the track as to lie beneath the pallets as the same move along. If a pallet lies above orifice **14**, the latter is blocked, for instance by the pallet element **20**, whereby venting of the pressure fluid no longer occurs freely and the supply of fluid is routed to flip-flop **15**. Should another pallet lie above the downstream orifice **14'**, at the corresponding safety distance, the pressure fluid bled through conduit **36'** is routed through conduit **16'** and actuates flip-flop **15**. The supply of pressure fluid delivered through conduit **36** is diverted and discharged into the open air at **17** through duct **34**. If the orifice **14'** located at the safe downstream distance is not blocked by a pallet, the supply of pressure fluid issuing from conduit **36** flows through flip-flop **15** without being diverted and actuates flip-flop **12**. The supply of high-pressure fluid which previously supplied vortex valve **19** tangentially through duct **32** is then injected into duct **33** and discharged into the open air through orifice **18**. Being no longer supplied tangentially through duct **32**, vortex valve **19** then delivers its full output into duct **23** and thereafter into the conduits **24**, whereby the pressure fluid is delivered at the surface of the track through orifices **25** to provide lift for the pallet. After the pallet has moved past this particular assembly, the portion **20** no longer blocks orifice **14** and the pressure fluid is again channeled through duct **35** into the flip-flop **12** which accordingly supplies the vortex valve **19** tangentially through duct **32**. Valve **19** is then unprimed and thereafter discharges only a very small fraction of pressure fluid into the surrounding atmosphere.

FIG. **3** shows an alternative embodiment in which two vortex valves have port directly through their associated orifices **23**.

Reference is next had to FIGS. **4** and **5** for a showing of another alternative embodiment of the invention, in which pressure fluid is caused to be delivered beneath pallet **2** by the opening of a valve **40** which is controlled and actuated by a fluidic circuit preferably integrated into the valve body.

FIG. **5** is a perspective showing of the arrangement of valve **40** in track **1**. Valve **40** is contained in a housing **41** provided in the pressurized enclosure **8**. At its center, housing **41** is provided with a hollow pivot **42** over which is placed the valve **40**, the top of the latter being substantially hemispherical and its lower part being formed by cylindrical sleeve **43**.

Upward movement of valve **4** inside housing **41** is limited by a protrusion **44**, the space confined between valve **40** and housing **41** communicating with pressurized enclosure **8** via a duct **45**. The portion of valve **40** located above protrusion **44** lies in the duct **23** which debouches on to the track via a conduit **24** and two orifices **25**.

The internal passage **46** of pivot **42** communicates with pressure fluid supply conduit **10** via a vortex valve **48** and a flip-flop **49**. Communication between passage **46** and vortex valve **48** is through a duct **47**, and a downstream branch **50** of flip-flop **49** is connected to tangential supply duct **51** of vortex valve **48** via a duct **52**, the axial branch **68** of the vortex valve being vented at **66** through a duct **67**. The second downstream branch **53** of flip-flop **49** is connected to a vent **55** on the track via a duct **54**. The drive jet discharging nozzle **56** of flip-flop **49** is connected to pressure-fluid conduit **10** through a duct **57**.

Further, the actuating branch **58** of flip-flop **49** forms one output of a flip-flop **59**. Flip-flop **59** communicates with housing **41** via its drive jet delivering nozzle **60**, and its other output is vented at **65** through a duct **64**. The control conduit of said flip-flop associated to the control conduit-branch **58** is connected to nozzle **60** (i.e., to housing **41**) via a diaphragm **63**, and is vented at **61** via a duct **62**.

Considering the direction of travel of pallet **2** to be that shown by arrow F, the theory of operation of the above-described arrangement is as follows:

Valve **40** is kept normally closed, that is to say pressed against protrusion **44** by the pressure of the fluid contained in pressurized enclosure **8**. It is opened by direct venting of duct **46**, whereupon valve **40** drops under gravity. Venting is effected through the central orifice **68** of vortex valve **48** which is vented at **66** via a duct **67**.

The arrival of a pallet **2** upstream of the orifices **25** associated to valve **40** is detected by reason of the ensuing blocking of the discharge **61** by pallet element **20**. This blocking effect activates flip-flop **49** to its downstream conduit-branch **53**, causing the same to discharge into the open air at **55** and to thus cut off the tangential supply **51** to vortex valve **48**. The duct **46** associated to valve **40** is then no longer pressurized, so that valve **40** drops on to pivot **42** and allows the pressure fluid contained in enclosure **8** to supply the orifices **25** via duct **45**, housing **41**, duct **23** and conduit **24**.

As soon as the pallet has passed the assembly in question, orifice **61** is vented once more. Flip-flop **59** discharges into the open air at **65** via its downstream branch **64**, while flip-flop **49** discharges via its downstream branch **50** into duct **52** and supplies the vortex valve **48** tangentially through duct **51**. Valve **48** discharges via duct **47** into duct **46**, thereby thrusting valve **40** against protrusion **44** and communicating duct **46** with pressurized enclosure **8** via duct **45**.

Reference is next had to FIGS. **6** and **7** for an alternative embodiment on that of FIGS. **4** and **5**. The blocking effect on the duct **23** supplying pressure fluid to orifices **25** is obtained by means of a flexible membrane **70** the rigid valve member **71** of which presses against protrusion **44** of duct **23**.

The detection system is formed by a track vent **103** which communicates via a duct **102** with the way **101** of a distributor **100** having four ways **101**, **104**, **106** and **99**. Way **106** comprises a flow limiting diaphragm **111** and communicates with pressurized enclosure **8** via ducts **107** and **108**, housing **41** and duct **45**. Way **99** controls an inhibitor **95** the second branch **97** of which debouches into the open atmosphere at **98** and the third branch **112** of which controls a flip-flop **90**. The drive jet delivering nozzle **91** of flip-flop **90** communicates with pressurized enclosure **8** via a duct **109**, duct **107**, duct **108**, housing **41** and duct **45**. A downstream branch **93** of flip-flop **90** is vented at **94**, and its second downstream branch **92** is the control means of a flip-flop **80**. The drive jet delivering nozzle **78** of flip-flop **80** is supplied via conduit **10**. A downstream branch **75** of flip-flop **80** is vented at **76** and its second downstream branch **74** communicates with the interior **72** of membrane **70** via a duct **73**. The drive jet delivering nozzle **96** of inhibitor **95** is connected through a duct **110** to the distributor **100'** located downstream of pallet **2** (the arrow F showing the direction of travel thereof). The fourth way **104** of distributor **100** is connected through a duct **105** to the drive nozzle **96'** of the inhibitor located upstream of pallet **2** (as determined by the direction of travel shown by the arrow F).

The theory of operation of the above-described system is as follows:

Rigid valve member **71** of membrane **70** is maintained closed in pressure contact against protrusion **44** through application of the control pressure for the pressure fluid delivered through conduit **10** into chamber **72** via the branch **74** of flip-flop **80**. Opening of valve **71** is caused by venting at **76** of chamber **72**, with the drive jet reaching flip-flop **80** in response to a pressure applied in duct **77**. When a pallet **2** overlies the calibrated leak **103**, the pressure rises in distributor **100** and actuates flip-flop **90** provided that inhibitor **95** is not blocked through the arrival of another pallet, at a safe downstream distance, above the corresponding leak **103'**. Since flip-flop **90** is controlled by the overpressure in branch **112**, the fluid delivered through drive nozzle **91** is diverted into the downstream branch **92** and reaches flip-flop **80** via actuating duct **77**. With the pressure fluid delivered, conduit **10** is connected to downstream branch **75** of flip-flop **80** and escapes into the surrounding atmosphere at **76**. Chamber **72** being no longer supplied via duct **74**, the pressure therein decreases greatly and the overpressure prevailing in housing **41** acts on membrane **70** to lower the valve **71** whereby to allow the pressure fluid in enclosure **8** to discharge into the orifices **25** via duct **23** and conduit **24**.

If a pallet **2** should be present at the safe downstream distance above the corresponding distributor **100'**, inhibitor **95** would remain blocked and continue to vent at **98**, the mass flow being limited by diaphragm **111**, thus preventing distributor **100** from acting on flip-flop **90**.

It is thus possible to maintain the required intervals.

Because of the weight of the pallets to be conveyed, it may sometimes happen that the capsule form described in FIGS. **6** and **7** is unable to adapt to the load. FIG. **10** accordingly proposes a capsule of substantially cylindrical shape **115**, formed by a bellows made of plastic for example, preferably reinforced with metallic trelliswork to enable it to withstand high pressures. Valve **116** and seat **117** may be made either of metal or plastic.

The various devices described in the present invention are positioned along the track in accordance with the same safeguarding arrangements described with reference to FIGS. **8** and **9**. The valve delivering pressure fluid can consequently be active only provided that its companion valve at the safeguarding distance away is free of any load.

It goes without saying that many changes and substitutions of parts may be made in the above-described exemplary embodiments without departing from the scope of the invention as set forth in the appended claims.

I claim:

1. A method of controlling obturation of a fluid supply conduit connected to orifices opening on a track for conveying ground effect loads with the interposition of a fluid layer between a given section of said track and a movable load located in registry with said track section, said fluid supply conduit extending within and all along said track, said method comprising the steps of sensing the state of presence or absence of said load at such location, generating accordingly a fluidic signal representative of said state, applying said fluidic signal as pilot signal to govern the operative condition of a twin-output fluidic logic element, selectively venting said fluidic logic element through one of the outputs thereof and putting the obturation of said fluid supply conduit under the control of said fluidic logic element through the other output thereof.

2. Method as claimed in claim **1**, comprising the further steps of sensing the state of presence or absence of a load located in registry with another section of said track at a distance from said given section, generating accordingly another fluidic signal representative of said last-mentioned state, and applying said other fluidic signal as further pilot signal to govern said operative condition of said fluidic logic element.

3. Method as claimed in claim **2**, wherein said other track section is selected at a distance ahead of said given track section with respect to the displacement direction of said loads along said track.

4. A ground effect transport system of the kind comprising a track for the conveyance therealong of movable loads floated on an interposed layer of fluid discharged from nozzles opening on said track and supplied with pressure fluid from a conduit extending within and all along said track, means for detecting the presence or absence state of a load thereon and generating accordingly a fluidic signal representative of said state, and obturator means under the control of said fluidic signal for controlling fluid supply to said nozzles, wherein the improvement comprises a fluidic logic element fitted between said detecting means and said obturator means and comprising at least one fluidic flip-flop arranged to be piloted by said fluidic signal and having an output adapted to deliver a power jet for the control of said obturator means, and a further output opening into the atmosphere, the two outputs being in branched relationship.

5. System as claimed in claim **4**, wherein said fluidic logic element further comprises a control passage associated with said further output, a distributor under the control of said detecting means for delivering pressure fluid to said control passage, and a pressure fluid source connected to said distributor, the arrangement being such that, upon detection of the presence of a load by said detecting means, pressure fluid is delivered to said control passage to deflect said power jet towards the corresponding output whereby to open said obturator means.

6. System as claimed in claim **5**, further comprising a second load detecting means at a distance from the former-mentioned load detecting means, a second fluidic flip-flop having a power jet producing nozzle connected to said distributor, an output which is said control passage and another output opening into the atmosphere, a further control passage associated with said other output, and a further pressure fluid distributor under the control of said second load detecting means for delivering pressure fluid to said further control passage, the arrangement being such that, upon detection of the presence of a load by said second detecting means, pressure fluid is delivered to said further control passage of said second flip-flop to deflect the power jet produced by said nozzle thereof towards said other output opening into the atmosphere, whereby said former-mentioned flip-flop has its power jet left unaffected.

7. System as claimed in claim **4**, comprising a first fluidic flip-flop having an output opening into the atmosphere, a control passage under the control of said detecting means and supplied with pressure fluid, and another output, a second fluidic flip-flop having a control passage which is said other output of said first flip-flop, an output opening into the atmosphere, and another output, and a vortex valve having a vent under the control of a further load detecting means and a radial output conduit adapted to deliver motive fluid to actuate said obturating means.

8. System as claimed in claim **4**, further comprising a first distributor with a first branch opening into the atmosphere, a second branch having a power nozzle supplied with pressure fluid, a third branch connected to an upstream track section, and a fourth branch, a second like distributor with four branches the third of which is connected to a downstream track section, an inhibitor circuit to which said fourth branch of said first distributor leads and which is connected to said third branch of said second distributor, said inhibitor circuit comprising a way which opens into the atmosphere and another way, a first fluidic flip-flop under the control of said other way of said inhibitor circuit and having an output opening into the atmosphere and another output, and a second fluidic flip-flop having a control passage which is said other output of said first flip-flop, an output opening into the atmosphere and another output connected to said obturator means.

9. System as claimed in claim **4**, wherein said obturator means comprise vortex type fluid valves respectively connected tangentially to a flip-flop output adapted to deliver a power jet for the control of said obturator means.

10. System as claimed in claim **4**, wherein said obturator means comprise free type valve members having one face cooperating with a valve seat and another face exposed to the power jet delivered by a respective flip-flop output.

11. System as claimed in claim **4**, wherein said fluidic logic element is integrated into said track and is purely static, having no movable part.

12. System as claimed in claim **4**, wherein said fluidic logic element and said obturator means are incorporated into a box-like unit associated with the track surface.

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