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Lombard

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[54] **SUPPORT DEVICE EMPLOYING A FLUID FILM**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **308/5,** 308/9, 308/122

[51] **Int. Cl.** **F16c 17/00**

[58] **Field of Search** 308/122, 5, 9

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Assistant Examiner—R. H. Lazarus
Attorney, Agent, or Firm—DeLio and Montgomery

[57] **ABSTRACT**

This invention relates to a device for supporting a body on a structure, employing a film of pressurised fluid, constituted by a conduit feeding pressurised fluid, which connects said film to a source of pressurised fluid, whilst a restriction is disposed on said conduit, wherein the structure is constituted by a main frame which comprises a cavity and by a male element which is introduced into said cavity and is delimited by a male surface which reproduces, at least partly, the female surface delimiting the cavity, said male surface of the element is constituted by a wall which is at least partly inclined with respect to the straight line perpendicular to the central zone of the film and the male element is coupled with the main frame of the structure by a link means adjusting its position with respect to said frame in a direction substantially perpendicular to the central zone of the fluid film, whilst the restriction is constituted by the space between said inclined wall of the element and the main frame of the structure.

5 Claims, 7 Drawing Figures

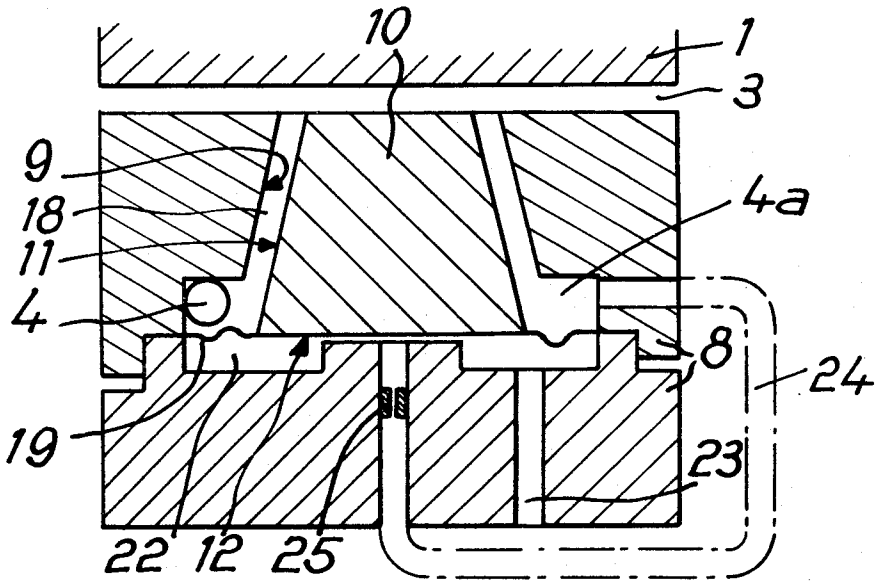

Fig 1

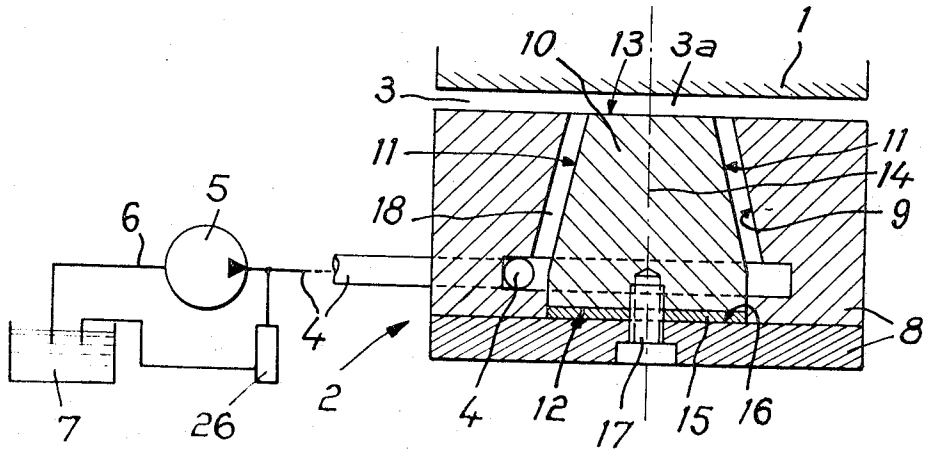
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Fig 2

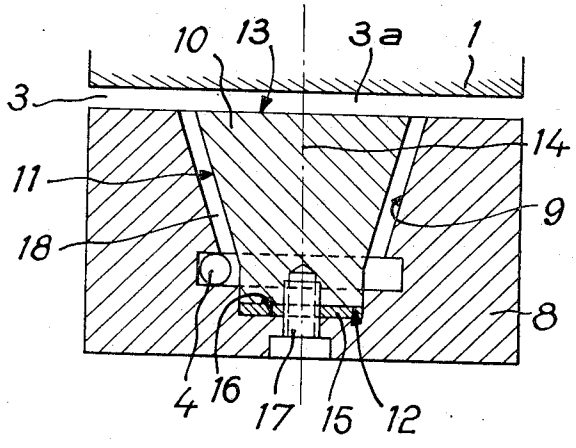
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FIG. 3

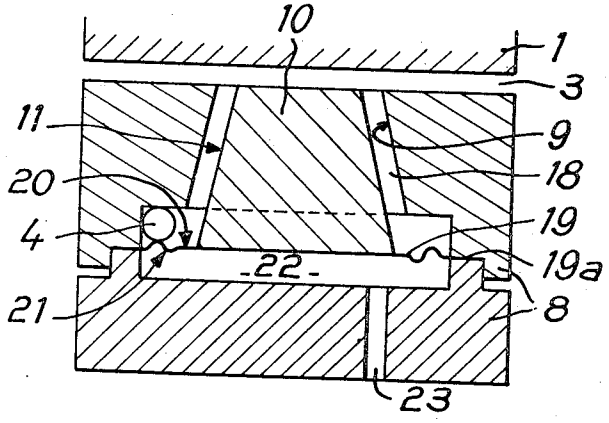

FIG. 4

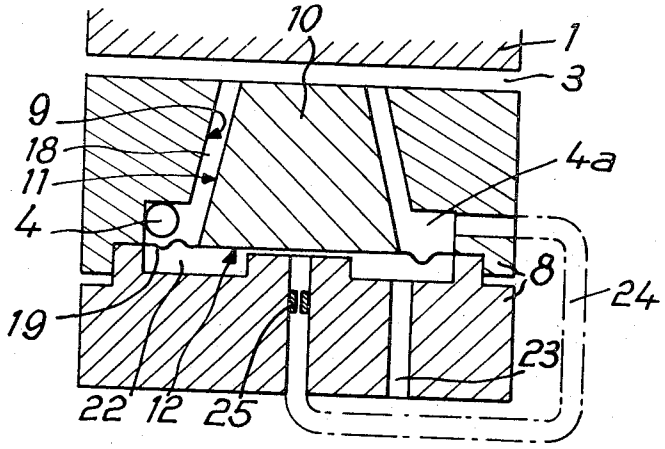

FIG. 7

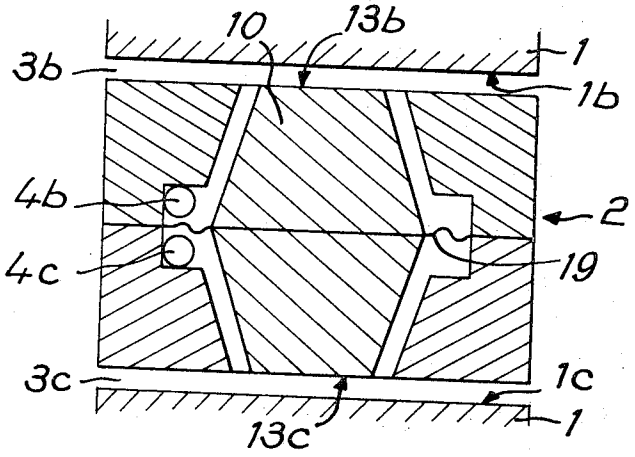

FIG. 5

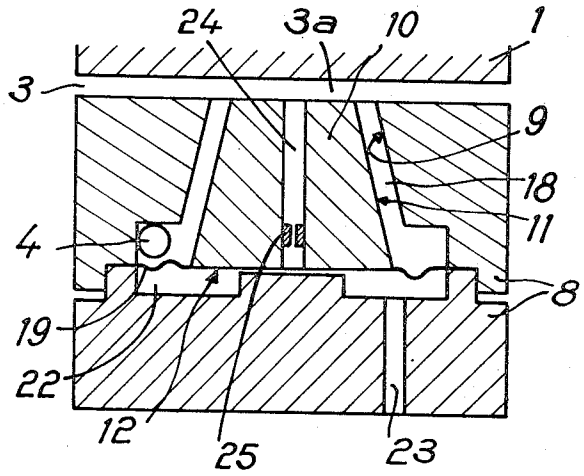
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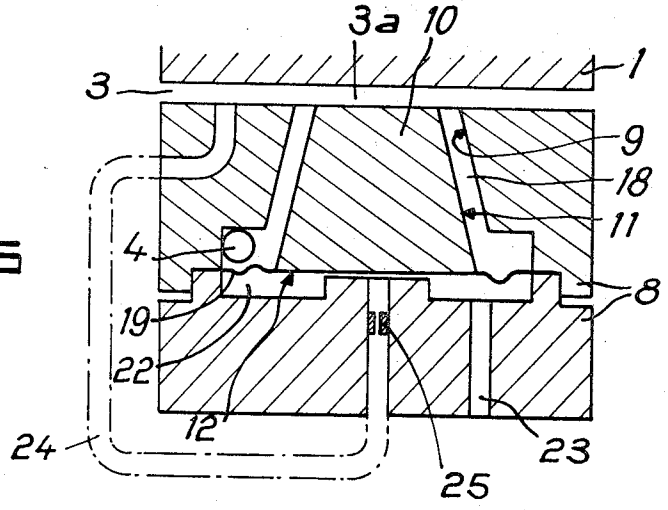
FIG. 6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SUPPORT DEVICE EMPLOYING A FLUID FILM

The present invention relates to new arrangements which make it possible to produce support devices employing a fluid film such as, in particular, slideways and bearings, whether the fluids used are compressible or not.

Support by fluid film, known per se, consists in introducing a pressurised fluid between two pieces; a restriction may furthermore be disposed on the supply conduit which connects the film to a source of pressurised fluid.

However, it has been ascertained that it was advantageous to place the restriction as near as possible to the film and also to reduce the value of the volume of said film as much as possible, these arrangements having to be respected in order to obtain a correct functioning of the support, more particularly when a compressible fluid is used.

Furthermore, the assembly of the support devices generally comprises a plurality of circuits which should theoretically be identical but their respective restrictions are difficult to adjust.

It has therefore appeared necessary to propose a new support device whose restriction is located very near the fluid film and which may easily be adjusted.

The invention proposes a device of this type for supporting a body on a structure by means of at least one film of pressurised fluid, said device being constituted by a conduit supplying pressurised fluid, which connects said film to a source of pressurised fluid, whilst a restriction is disposed on said conduit.

The structure is constituted by a main frame which comprises a cavity and by a male element, which is introduced in said cavity and is delimited by a male surface, which reproduces, at least partially, the female surface delimiting the cavity. Said male surface of the element is constituted by a wall which is at least partly inclined with respect to the straight line perpendicular to the central zone of the film, whilst the male element is coupled to the main frame of the structure by a link means for adjusting its position with respect to said frame in a direction substantially perpendicular to the central zone of the fluid film. The restriction is then constituted by the space between said inclined wall of the element and the main frame of the structure.

In a first advantageous embodiment of the invention, the link means coupling the male element to the main frame is constituted by a disc interposed between the base of said male element, substantially parallel to the central zone of the film, and the base of the cavity, and by a means, known per se, for connecting the male element, the disc and the main frame.

According to a second embodiment, the conformation of the adjusting link means depends upon the value of the thickness of the fluid film.

Said link means is therefore often constituted by an elastic membrane fixed to the main frame and the male element is integral with a face of said link, whilst the action of the elastic membrane on said male element is antagonistic to that of the variation of the pressure of the fluid of the film.

Furthermore, the male element which comprises a first face disposed opposite the fluid film and a second face opposite the first, may be such that said second face delimits with the main frame a chamber, whilst said element is guided in said main frame by guide means known per se, and a connecting conduit places said chamber in communication with the film of fluid, a second restriction being disposed on said connecting conduit.

According to an advantageous embodiment, when the body comprises two distinct, substantially parallel walls, opposite each of which is disposed a fluid film, a single male element is coupled to the main frame.

Finally, it is often preferred to delimit the male element and the cavity, each by a truncated wall with an axis of revolution substantially parallel to the straight line perpendicular to the substantially flat zone of the film.

The invention will be more readily understood upon reading the following description with reference to the accompanying drawings, in which:

FIGS. 1 to 7 are sections of support devices according to the invention in various variant embodiments.

Referring now to the drawings, a body **1** is supported on a structure **2** by means of a film **3** of pressurised fluid. To this end, a conduit **4** connects the delivery of a fluid pump **5** provided with a pressure regulator **26**, to the film **3**. The pump **5** has its suction connected by a conduit **6** to a fluid tank **7**. It will be specified now that although, in the example shown, the fluid is of hydraulic nature and is therefore almost incompressible, the device could also function with a compressible fluid, for example compressed air. In this latter case, a compressor would obviously replace the pump **5**.

The structure **2** comprises a main frame **8** in which a cavity **9** is arranged. A male element **10** is disposed inside the cavity **9** and is delimited by walls **11**, by a base **12**, opposite the fluid film **3** and by a face **13** which is disposed opposite a substantially flat zone **3***a*, of said film **3**. More generally, the central zone **3***a* of the film **3** is shaped to conform with the function to be fulfilled and may, for example, be flat, cylindrical or spherical. It will be noted that the walls **11** are inclined with respect to the straight line **14**, which is perpendicular to the zone **3***a* of the film **3**. Moreover, the walls **11** are male surfaces which substantially reproduce the surfaces opposite the cavity **9**.

A disc **15** of given thickness is interposed between the base **12** of the element **10** and the base **16** of the cavity **9**, whilst a screw **17** connects the element **10** and the disc **15** with the frame **8**.

A space **18** is made between the element **10** and the frame **8**. The conduit **4** opens out into this space **18** and, through said space **18**, opens out into the fluid film **3**. The section of passage of the space **18**, measured at right angles to the walls **11**, along a plane parallel to the zone **3***a* of the film **3**, is however small so that the space **18** acts as a restriction for the conduit **4**.

It will further be specified that, in the embodiment of FIG. **1**, the walls **11** converge towards the zone **3***a*. Moreover, according to a preferred embodiment, adopted for the different embodiments shown in FIGS. **1** to **7**, the element **10** is truncated in sahpe so that, in FIG. **1**, the small base of the conical frustum is constituted by face **13**.

In FIG. **2**, the same constituents are found as in FIG. **1**, except that the element **10** which is still constituted by a conical frustum, has its small base merged with its base **12**.

As a variant of the embodiments of FIGS. **1** and **2**, the disc **15** is eliminated and the height of the male element **10** is chosen accordingly.

In the embodiment of FIG. 3, the element 10 is no longer fixed to the base 16 of the cavity 9 by a screw 17 with the interposition of a disc 15, but is rendered integral with an elastic membrane 19 which is fixed, by its periphery 19*a* wedged between two parts of the frame 8, on said frame. The membrane 19 is fastened to the frame in substantially sealed manner. The element 10 being fixed to a face 20 of said membrane 19, this latter delimits, with the frame 8, by means of its face 21 opposite the face 20, a chamber 22 which is connected to the atmosphere by a conduit 23 arranged in the frame 8.

It will be noted that the action of the membrane 19, on the element 10, is, during the operation of the device, antagonistic of that of the variation in pressure of the fluid of the film 3. In other words, when the pressure of the film 3 increases, and tends to separate the element 10 from the body 1, the membrane 19 tends, on the contrary, to neutralize this tendency, and to oppose the separation of said element 10.

FIG. 4 shows the arrangements already described with regard to FIG. 3. However, it will be noted that, although the membrane 19 in the embodiment of FIG. 3 has two main functions, on the one hand elastic return of the element 10 and on the other hand holding said element 10 in position and guiding it in the cavity 9, it has, in the embodiment of FIG. 4, only one main role: that of holding and guiding. Of course, it continues to ensure a function of elastic return, but this function may be considered as being secondary. In other words, although it is indispensable, in the embodiments similar to those of FIG. 4, to provide means for guiding the element 10 in the cavity 9, which means are constituted in the present case by the membrane 19, it is not necessary to provide an elastic return by means of a mechanical spring such as said membrane.

In fact, as the chamber 22 was constituted by connecting the element 10 to the frame 8 by a sealed, but not necessarily elastic envelope, in the present case by membrane 19, and as said element 10 is guided in cavity 9, in the present case likewise by membrane 19, the base of said element 10 is subjected to the action of a hydrostatic spring connected to the fluid film 3. To this end, a conduit 24 connects the chamber 4*a*, into which the conduit 4 opens out, to the chamber 22 and opens out into said chamber 22 opposite the base 12 of the element 10. A restriction 25 is disposed on said conduit 24.

The variant embodiments of FIGS. 5 and 6 are similar to the embodiment of FIG. 4, except that in the case of FIG. 5, the conduit 24 is arranged in the element 10 itself, and connects the central zone 3*a* of the film 3 to the chamber 22, whilst, in the embodiment of FIG. 6, the conduit 24 directly connects the film 3 to said chamber 22.

Finally, the embodiment of FIG. 7 refers to the case of the body 1 having to be supported on the structure 2 by two bearings 1*b* and 1*c*. To this end, two fluid films 3*b* and 3*c* are created, fed respectively by conduits 4*b* and 4*c*. However, by adopting an embodiment similar to that of FIG. 3, there is advantage in resorting to only one single element 10, guided and elastically returned by a single membrane 19, but having two faces 13*b* and 13*c*, which are disposed opposite films 3*b* and 3*c* respectively.

The advantages to be had from adopting the arrangements described will be indicated hereinafter in the description of the functioning obtained.

Of course, the essential advantage resides in the position of the restriction constituted by the space 18 and in the simple regulation of this restriction.

In FIG. 1, it may be noted that the space 18, which is disposed on the conduit 4 which connects the pump 5 to the film 3 of fluid under pressure, is in direct communication with the fluid 3 and is therefore located as near as possible to this film, as is advantageous in the technique of support by fluid film. However, the proximity of the space 18 to the film 3 does not hinder the adjustment of the value of the restriction constituted by said space. In fact, it is sufficient, in order to increase or reduce the section of passage of this restriction, to reduce or increase, respectively, the thickness of the adjusting disc 15. On this subject, the embodiment of FIG. 2 may sometimes be preferred in order to effect the adjustment of the restriction constituted by the space 18, by an action on the disc 15 opposite that of the embodiment of FIG. 1. It will also be noted that the value of the restriction could be adjusted by judiciously selecting the height of the male element 10, without interposing the disc 15. However, the adjustment by means of the disc 15 remains advantageous due to its easy production.

In the embodiments of FIGS. 1 and 2, the adjustment of the restriction constituted by the space 18 is invariable during the functioning of the support device. However, it may be advantageous to adjust the thickness of the film 3 of fluid. To this end, one of the embodiments of FIGS. 3 to 7 will be chosen.

In these embodiments, for example in that of FIG. 3, when the body 1 tends, for some reason, to crush the fluid film 3, the pressure of said film increases. The effects of this variation in pressure on the element 10 contribute to repelling said element 10 from the body 1. The section of the space 18 hence increases and the addition of pressurised fluid coming from conduit 4 also increases, this contributing to returning the thickness of the film 3 to its initial value. At this moment, the elastic membrane 19 returns the element 10 into its initial position and also returns the space 18 to its initial conformation. An increase in the thickness of the film 3 would have been neutralised by a process very similar to the preceding one. The adjustment of the position of the element 10 therefore depends upon the thickness of the film 3 and the thickness of said film 3 is consequently adjusted.

The position of the element 10 in the cavity 9 may obviously be adjusted, in manner known per se, by means of a hydrostatic return spring. This is what has been adopted in the embodiments of FIGS. 4 to 6, in combination with the elastic return due to membrane 19. It may be specified on this subject that, in accordance with the known performances of the hydrostatic springs, very considerable tightness may be obtained for the return force of the element 10, as has been confirmed by calculation and experiments on the embodiments produced. An excellent regulation of the thickness of the fluid film 3 and a very good quality support are consequently obtained. By way of indication, it will be noted that the restriction of the embodiments of FIGS. 5 and 6 could, as a variant, be eliminated.

Finally, in addition to its functioning which is similar to that of the embodiment of FIG. 3, the embodiment

of FIG. 7 is advantageous by the small number of pieces that it comprises, and by its ease to be constituted.

Of course, it will have been understood that the gist of the invention consists in rendering the element **10** and the frame **8** adjustable in position with respect to one another, but that it is of little importance whether it is the frame **8** or element **10** which is fixed with respect to the film **3**.

What is claimed is:

1. A support device including a structure comprising a frame and a male member, whereby said structure is adapted to support a body by means of a film of pressurized fluid, said device further including:

a conduit feeding said pressurized fluid to said film from a source of pressurized fluid;

said frame having a cavity, a wall of said cavity defining a female surface;

said male member being movably received in said cavity; a surface of said male member defining a male surface reproducing said female surface, said male surface comprising a wall which is at least partially inclined with respect to a straight line perpendicular to the central zone of the film, said male member having opposing first and second faces, said first face being positioned for contact with said film;

a restriction on said conduit for varying the pressure of said fluid therein, said restriction being defined by the space between said inclined wall and said frame;

a link means coupling said male member to said frame and adapted to adjust the position of said male member with respect to said frame in a direction substantially perpendicular to said central zone of said film, said link means comprising an elastic membrane wherein one face of said membrane is affixed integrally with at least a portion of the second face of said male member, said elastic membrane being resiliently deformable with respect to said frame in said substantially perpendicular direction in response to variation in thickness of said film, the action of said elastic membrane on said male member opposing that of the variation of pressure of said pressurized fluid on said film;

a chamber defined by the space between the other face of said membrane and said frame; and

a link conduit connecting said chamber to said source of pressurized fluid.

2. Support device according to claim **1**, wherein said link conduit connects said chamber to the pressurized fluid of said support device, and wherein said link conduit has a fixed restriction disposed thereon.

3. Support device according to claim **1**, wherein said link conduit connects said chamber to said film of fluid.

4. Support device according to claim **3**, wherein an additional restriction is disposed on said link conduit.

5. Support device according to claim **1**, wherein said body comprises two distinct substantially parallel walls, opposite each of which is disposed a film of fluid, and wherein a single male element is coupled to said main frame.

* * * * *