Jan. 9, 1968 E. F. MACKS 3,362,755

CONVEYING DEVICE UTILIZING PRESSURIZED FLUID FLOW

Original Filed Feb. 19, 1958

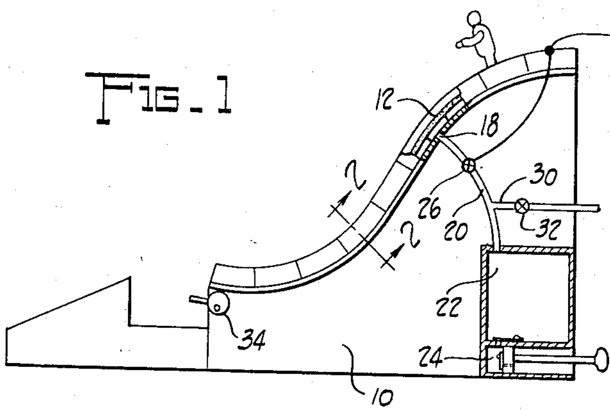

FIG. 1

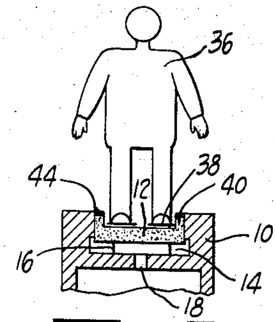

FIG. 2

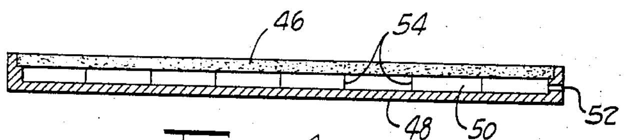

FIG. 4

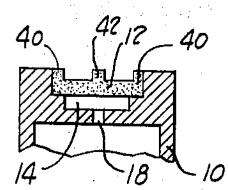

FIG. 3

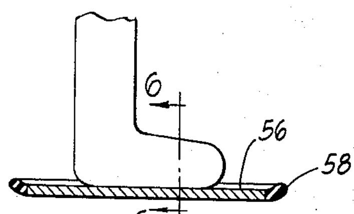

FIG. 5

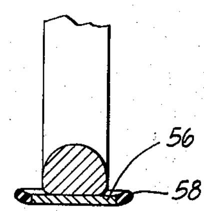

FIG. 6

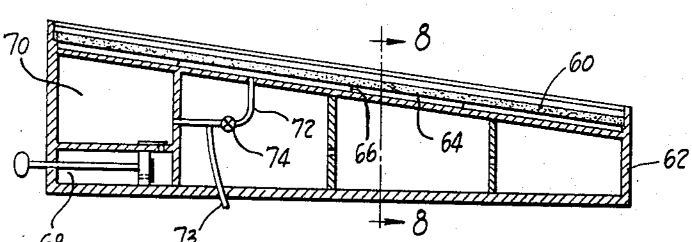

FIG. 7

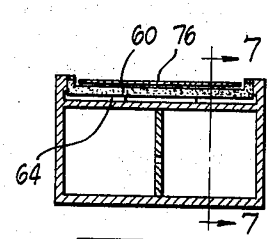

FIG. 8

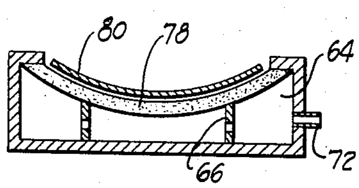

FIG. 9

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CONVEYING DEVICE UTILIZING PRESSURIZED FLUID FLOW

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Continuation of application Ser. No. 716,243, Feb. 19, 1958. This application Aug. 23, 1962, Ser. No. 223,863
2 Claims. (Cl. 302—29)

The present application in a continuation of my copending application, Ser. No. 716,243, filed Feb. 19, 1958, which is a continuation-in-part of application Ser. No. 446,025, filed July 27, 1954, and now abandoned.

This invention relates to supporting devices and more particularly to supporting slides and conveyors wherein a fluid is utilized as a supporting film for a moving element.

It has been discovered that an object may be supported for free, substantially frictionless movement on a thin film fluid under pressure. To lift an object for free relative movement, fluid under pressure is provided over an an entire confined area of confrontation defined by complemental surfaces of a slide support and the obpect to be supported.

This discovery may be utilized by providing a slide support having a cavity and a foraminous wall defining a smooth open supporting surface. When a base surface of an object is placed in facial confrontation with the smooth slide support surface, fluid under pressure may be passed through the foraminous wall to lift the body. To accomplish this, fluid under pressure is introduced into the cavity. The fluid passes through the foraminous wall in a unform fashion over the entire surface. Thus, a thin film of fluid under pressure is formed between the object base surface and the slide support surface.

The film consists of a moving fluid which is constantly escaping around the periphery of the area of confrontation and being replenished by a fresh supply of fluid passing through the foraminous wall.

As fluid under pressure is passed through a restriction, a pressure drop is experienced. The greater the flow the greater the pressure loss, and conversely, the lower the fluid flow the lower the loss.

Thus, when fluid is passed through a foraminous wall having an area of confrontation on one side, a fluid film having load supporting characteristics will be formed over the area of confrontation. If the ratio

$$\frac{\text{weight of object to be supported}}{\text{area of confrontation}}$$

is high, the load supporting film will be of high pressure in a properly designed system so as to support the object. The flow of fluid on the other hand will be relatively low, and hence the pressure drop will be low. Conversely, if the object is light, the flow and the pressure drop will be relatively high and the pressure of the film will be relatively low.

If the object is formed symmetrically, the film will be of uniform dimension. The film will, however, generally be of varying thickness and pressure since the weight of the object will not be symmetrically distributed. The heavy side of the object will be relatively close to the slide support and the film will be thin and of high pressure. The fluid flow on the heavy side will thus be low as will the pressure drop. Conversely, on the light side of the object, the film pressure will be low and the pressure flow and drop relatively high. Thus, even though the confronting surfaces are not precisely parallel, a thin lubricating and supporting film will be maintained. This feature of a properly designed system is known as "automatic zone feedback compensation" or simply as "load zone compensation."

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One of the principal objects of this invention, then, is to provide a slide support having a smooth, open surface and a foraminous wall through which fluid under pressure may be passed to form a lubricating and supporting film having load zone compensation.

In the present invention a slide support which provides such a thin film of supporting fluid by means of a porous wall is disclosed. It has also been discovered that an object may be supported and lubricated by a thin film provided by the object itself. This concept is disclosed in more complete detail in the copending application for patent Ser. No. 433,946, filed June 2, 1954, entitled "Method and Apparatus for Providing Mobility," now abandoned in favor of continuation-in-part application Ser. No. 737,969, filed May 26, 1958.

While it will be apparent to a mechanic skilled in the art that the principles of this invention are applicable to many devices in which relative unconfined movement along an open surface is desired, an amusement device is here set out as one embodiment of the invention and to disclose related improvements pertaining to this particular embodiment.

One of the objects of this invention is to provide a slide support in which a foraminous member having a source of fluid under pressure connected therewith forms a relatively frictionless surface for slidably supporting a moving element.

Another object of this invention is to provide a toy in which a foraminous wall is formed in turns and dips and is connected to a source of fluid under pressure for carrying an element thus simulating a roller coaster, ski slide, or other amusement device.

A still further object of this invention is to provide an amusement device in which a fluid foraminous floor is connected with a source of fluid under pressure, the upper surface of the floor having a film of fluid thereon for supporting in a relatively frictionless manner an individual having flat bottom skis or runners on which to stand during skating movements over the floor.

Another important object of this invention is to provide a conveyor wherein an inclined wall is permeable to allow the passage of fluid conducted thereto from a source of supply, thus establishing the film of fluid between the wall and a tray, belt, or a series of interconnected trays traversing the surface of the inclined wall.

The embodiments of this invention include a wall of foraminous material capable of allowing the restricted passage of fluid therethrough in such a manner that a cooperating device such as a tray or pan is supported free of the wall on a relatively frictionless film of fluid. The foraminous wall is incorporated in a structure having a plenum chamber or duct in communication with the wall. Air, water, or other fluids may be utilized as the supporting medium depending on the desired characteristics. The foraminous wall is formed to the desired shape to guide and support a moving body throughout a path of either a straight incline or dips and curves or over a horizontal straight path.

The structure of the foraminous or permeable wall is such that as the fluid flows therethrough, a pressure drop results even if the flow is unrestricted at the surface by the presence of an object to be supported by the load supporting film. At this condition the residual pressure at the surface would be less than the supply pressure. If a portion of the permeable wall is covered by a tray, flat plate, belt, or similar device, the flow through the wall would be restricted in that area with the result that the pressure drop through the wall would be reduced thus producing a residual pressure between the wall and the plate approaching that of the source of supply. Accordingly, considerable loads may be placed on trays or belts which are supported out of contact with the slide with the only resistance to movement being the very small friction produced by the viscosity of the fluid being utilized. The usefulness and novel effects which can be achieved by utilizing this invention result in articles of manufacture of unusual nature.

Accordingly, it is one of the most important objects of this invention to provide a structure in which a wall of foraminous material regulates the flow of fluid over an area to establish a supporting film of the fluid on which elements may be moved with relatively little force required.

Other objects and advantages, more or less ancillary to the foregoing, and the manner in which all the various objects are realized will appear in the following description, which considered in connection with the accompanying drawings, sets forth the preferred embodiment of the invention.

In the drawings:

FIGURE 1 is an elevational view of a ski slide embodying my invention;

FIGURE 2 is a sectional view taken along line **2—2** of FIGURE 1;

FIGURE 3 is a view similar to FIGURE 2 showing a modified form of the ski slide;

FIGURE 4 is a sectional view of a skating floor;

FIGURE 5 is a side view of a runner for operation on the skating floor;

FIGURE 6 is a sectional view taken along line **6—6** of FIGURE 5;

FIGURE 7 is a sectional view of a conveyor taken along line **7—7** of FIGURE 8;

FIGURE 8 is a sectional view taken along line **8—8** of FIGURE 7; and,

FIGURE 9 is a view similar to FIGURE 8 of a modified form of the conveyor.

The invention is incorporated in a ski-slide type of device shown in FIGURE 1 wherein the frame of the slide is designated by the numeral **10**. A track **12** is supported by the frame **10** in the desired configuration as required by the type of toy design. In FIGURE 1 the toy is illustrated as a ski slide but it is understood that it may also be in the form of a roller coaster utilizing turns and additional dips. This slide apparatus may be used wherever it is desired for an object to move along a predetermined path, the only force required for imparting motion to the object being that of gravity. The frame **10** serves as a housing having a relieved area which together with the slide **12** defines a cavity **14** in such a manner that a wall of the slide **12** is exposed to the interior of the cavity **14**. Supporting struts **16** are disposed between the slide **12** and the frame **10** to strengthen the slide **12** in order to carry the loads imposed thereon. The struts **16** are perforated to allow intercommunication between the sections of the cavity **14** and are so arranged that they do not cover an appreciable part of the surface of the slide **12**.

The floor **12** must be sufficiently foraminous to permit fluid under pressure to flow from the cavity **14** through the floor **12** to the outer surface of the floor in order that a film of fluid under pressure may be formed at any location on the floor. Thus, when an object being supported is moved across the floor **12** in translational movement, the supporting film is created wherever the object is. To accomplish this there must be a plurality of small holes or pores in the body. A sintered material such as a sintered bronze is an excellent example of a workable material since relatively uniform porosity is provided throughout the entire floor or track. A plurality of holes may be drilled or formed in an otherwise solid material to provide the same effect. The term foraminous has been selected because it is a term which defines all types of porosity operable in this invention including both orifice and permeable types of restrictions to obtain the desired load zone compensation. The degree of porosity will vary

widely according to the fluid, the weight and size of the object being supported, and other variables.

To obtain proper load zone compensation and the above-mentioned desirable operating characteristics with an optimum overall system, the foraminous wall and confronting surfaces must be carefully engineered. To provide adequate load zone compensation and a safe value of minimum load supporting film thickness while yet maintaining a low rate of fluid flow under all operating conditions the following relationship should be maintained:

p_0/p_1 is from 1.25 to 5.0 where

p_0 is the supply pressure,

p_1 is the average film pressure of the load supporting film in the case of a porous surface or the load supporting film pressure at the orifice exit in the case of other means of zone compensation.

Many operating and design variables such as orifice size and roughness, wall thickness, fluid viscosity, temperature, etc. must be properly considered so as to provide the safe minimum load supporting film thickness—generally under 0.005 inch and normally about 0.001 inch.

The foraminous support surface may be porous (such as sintered bronze) or may contain other forms of load zone compensation such as an orifice-pool configuration or it may simply contain a series of very small orifices drilled, or punched or otherwise formed. Examples of various types of foramina may be found in the copending application for patent Ser. No. 643,665; filed Mar. 4, 1957 for a seal, now Patent No. 2,907,594, issued Oct. 6, 1959. In all cases, however, the ratio p_0/p_1 is greater than 1.25.

Expressed in another way, the load zone compensation should provide an average pressure drop of about ⅕ to ⅘ as fluid is passed from the source of supply to the load supporting film when the device is in operation. Thus, the average pressure in a load carrying film will be no more than ⅘ and at least ⅕ of the pressure of the supplied fluid in the chamber or cavity **14**.

A conduit **20** is connected to the frame **10** to open into a fluid accumulator **22** through aperture **18**. A pump **24** compresses the air in the accumulator **22** for subsequent discharge through the conduit **20** and into the cavity **14**. A valve **26** in the conduit **20** controls the flow of fluid therethrough and may be remotely actuated by a trip device **28** at the starting point of the ski slide. An alternate fluid supply may be connected to conduit **20** by a conduit **30**. A check valve **32** in conduit **30** prevents the loss of fluid when pump **24** is being used as the compressor.

A control **34** such as a cam and lever arrangement positions the end of the slide **12** and the portion of the frame forming the cavity thus controlling the path of flight of an object which has just traversed the slide. In FIGURE 2 a toy skier **36** is shown having skis **38** affixed thereto for confronting the upper surfaces of the slide **12**. Slide **12** has upwardly extending portions **40** having their inner surfaces arranged to discharge fluid laterally against the skis **38** thus maintaining the skis **38** spaced from the portions **40**. In this way the skier **36** is guided and supported along the slide **12**.

In FIGURE 3 a slide **12** is shown having a center guide **42** in addition to the portions **40** for maintaining the direction of travel of a skier. The foraminous material forming the slide **12** has its faces sealed which are not opened to the cavity or do not function with the object to be supported and guided. This seal may be accomplished by portions of the frame including a sealing lip **44** which prevents the loss of fluid from surfaces having no function. Burnishing, tape, paint, cement, or other materials may also be applied to the permeable material to regulate the areas from which the fluid is to be discharged.

The ski slide **12** is adaptable for use as a slide for sporting events out of season since the slide **12** and the skis **38** may be proportioned to support the weight of a man and provide conditions even more frictionless than snow or ice.

A skating floor or rink **46** is shown in FIGURE 4, the floor **46** being formed from foraminous material which will allow fluid to permeate to the upper surface thereof. A base **48** has a fluid-tight lower wall and sides for supporting the floor **46** with a cavity **50** adjacent the lower face thereof for receiving fluid from an inlet **52** which is connected to a source of fluid under pressure which may take the form of a pump and accumulator, water supply system, overhead tank, or other system capable of continuously supplying fluid at a nominal pressure. A plurality of struts **54** support the floor **46** and the load carried thereby.

To better illustrate the principles embodied in the device of FIGURES 4 through 6 dimensions of a relatively large embodiment of this invention are provided. The foraminous floor **46** in a a skating rink may, for example, have a dimension of 10 feet by 20 feet. A fluid such as water is supplied to the cavity **50** under the foraminous floor **46** to provide the desired fluid under pressure to create the film. In this example the water would be supplied under a pressure of approximately 5 pounds per square inch, and it will flow through the foraminous floor **46** at the rate of about $\frac{1}{40}$ gallon per minute per square inch when the rink is not in use. When the rink is in use, the flow, of course, will be reduced in those areas where skaters are present because, as has been previously described, the pressure drop will decrease and therefore the flow will reduce. In this embodiment the flow is preferably circulated by a built-in pump.

The total pressure applied against the foraminous floor from the cavity side is approximately 5 pounds per square inch. In the present example, as in the other embodiments of this invention, sintered bronze is a suitable material for construction of the foraminous floor. The floor **46** in the 10 by 20 foot embodiment would be approximately one and one-half inches in thickness. In this instance the strut supports **54** would be about one-quarter inch in diameter and one-sixteenth inches in length and would be provided about the foot apart to reinforce the floor.

Sizes of skates such as those shown in FIGURES 5 and 6, vary with the size of the skater. As an example, a skater having a weight under 100 pounds would use a pair of skates each of which has approximately 40 square inches of surface and each of which would be approximately 4 by 10 inches in dimension. A skater of from one hundred to two hundred pounds would require skates having about 80 square inches each. Such skates can suitably be constructed 5 by 16 inches in dimension.

The skate which is used on the floor **46** is illustrated in FIGURES 5 and 6 in which a flat plate **56** having a plane bottom on which the user stands. The bottom of the skate may be rigid or flexible. A resilient edging **58** is mounted on the periphery of the plate **56** and functions as an edge to propel and brake the skater when the skate is tilted. This edge also functions as a bumper to prevent damage to another skate and the permeable floor or to prevent injury to the body of a wearer. The flat undersurface plate **56** when confronting the floor **46** and approximate thereto is supported by the film of fluid which is distributed over the surface of the floor by the permeable nature of the material and the cavity acting as a plenum chamber beneath the lower surface of tthe floor **46**. The fluid pressure and the area of the plate **56** are adjusted to support the weight of the individual standing on the plate **56**.

In FIGURES 7, 8 and 9 a conveyor is shown embodying the invention disclosed herein having a slide **60** formed from a foraminous material, the slide **60** being sloped to allow the force of gravity to produce translation of the object to be conveyed. A fluid-tight frame **62** supports the slide **60** and forms a cavity **64** for receiving fluid under pressure to be discharged through the slide **60**. A plurality of struts **66** support the slide **60** and the load thereon, the struts **66** being perforated with relatively large holes or slots to allow intercommunication between the sections of the cavity **64**. A pump **68** provides the fluid under pressure which is pressurized in an accumulator **70** and piped to the cavity **64** through a conduit **72** having a control valve **74** therein for regulating the flow of fluid through the cavity. An alternate fluid supply may be connected to conduit **72** by a conduit **73**. The load to be conveyed is placed on a pallet **76** which has bottom and side surface conforming to the surface of the slide **60**. The pressure of the fluid in the cavity **64** produces flow through the slide **60** and develops a continuous film of fluid intermediate the slide **60** and the pallet **76** which is relatively friction-free. Since the friction is so small a slight inclination in the slide **60** is sufficient for the pallet **76** to gravitate therealong with no external urging required. The pallet **76** may take the form of an individual tray, a series of connected trays, or of a continuous belt which is driven by an external means in either a horizontal or inclined direction.

In FIGURE 9 the slide **78** is curved to provide a concave upper surface for carrying a concave tray or belt **80**. Slide **78** is formed of a permeable material and supports the tray **80** in the same manner as the slide **60** supports the tray **76**. The arcuate slide **78** and the correspondingly shaped tray **80** is particularly adapted for carrying small articles or granular material which would not repose on a flat tray. Further, the tray **80** is self-centering since the force of gravity would tend to hold the tray **80** in the lowermost area of the slide **78**. This shape is particularly desirable in the operation of a conveyor belt since any material carried thereon would not tend to be lost from the belt surface. It is understood that slides of other shapes are contemplated as might be required for special purposes and would fall within the scope of this invention.

The runners, pallets, belts, and trays which form the movable load supporting members confronting the permeable wall may be of either rigid or flexible material to conform to the supporting surface or accomplish a function required by the object being carried. The embodiments of this invention are illustrated in general as toys or amusement devices. However, it is contemplated that essentially these same structures and principles are usable in large scale and in industrial applications, for example, the conveyor system.

A device has thus been described which has a foraminous wall with a smooth, open outer surface and an inner surface communicating with means for supplying fluid under pressure to provide a zone compensated supporting and lubricating film of fluid between the outer surface and a complemental surface on an object to be supported when the object is placed with such outer and complemental surfaces in face-to-face relationship.

Although the foregoing description is necessarily of a detailed character, in order that the invention may be completely set forth, it is to be understood that the specific terminology is not intended to be restrictive or confining; and that various rearrangements of parts and modifications of design may be resorted to without departing from the scope or spirit of the invention as hereinafter claimed.

What is claimed is:

1. A fluid lubricated conveying device for facilitating movement of an object comprising in combination a foraminous wall, said wall having a bottom surface, an upper, object-confronting surface, and upwardly extending side walls extending above said object confronting surface, said side walls and said object-confronting surface defining a channel-shaped conveying path for said object, means for suppling fluid under pressure to said wall to produce a supporting film of fluid between the object and said object-confronting surface by fluid flow through said wall and to laterally center the object in said chan-

nel-shaped conveying path by fluid flow through said side walls, and means on at least the portion of the wall including said bottom surface and said object confronting surface for restricting the rate of fluid flow therethrough to produce an average pressure drop thereacross in the absence of an object on said object-confronting surface.

2. A lubricated conveying device for facilitating movement of an object comprising in combination a channel-shaped foraminous support, said support having a bottom surface, an upper object-confronting surface, and opposed side walls extending above said object-confronting surface, a foraminous center guide between said side walls and coextensive therewith, said side walls and said center guide having formainae arranged to discharge fluid laterally against an object disposed contiguous to said object confronting surface, means for supplying fluid under pressure to the bottom surface of said support and to said side walls and said center guide so that a fluid film is formed between the object and said object confronting surface and so that the object is centered between said guide and said side walls, and means on at least the portion of the support forming said object confronting surface to produce an average pressure drop thereacross even in the absence of an object on said object confronting surface.

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