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A water sliding device and a method for operating a water sliding device.

The invention relates to a method for operating a device (1) intended for practising water sliding sports, as well as to such a device, whereby water is displaced over a rising (in downstream direction) bottom at a generally supercritical velocity by means of a pumping plant (6) during normal use. During normal operation water is supplied in downstream direction to said rising (in downstream direction) bottom through at least one nozzle (8). When the

pumping plant is started up the nozzle(s) is (are) initially kept closed and the required velocity is imparted to the water by means of said pumping plant in a circulation circuit, whereupon the nozzle(s) is (are) opened and the flow in the circulation circuit is interrupted. The device is provided with a pump including a suction pipe and a pressure pipe (9), whereby a circulation pipe (12) is provided between the pressure pipe and the suction pipe.

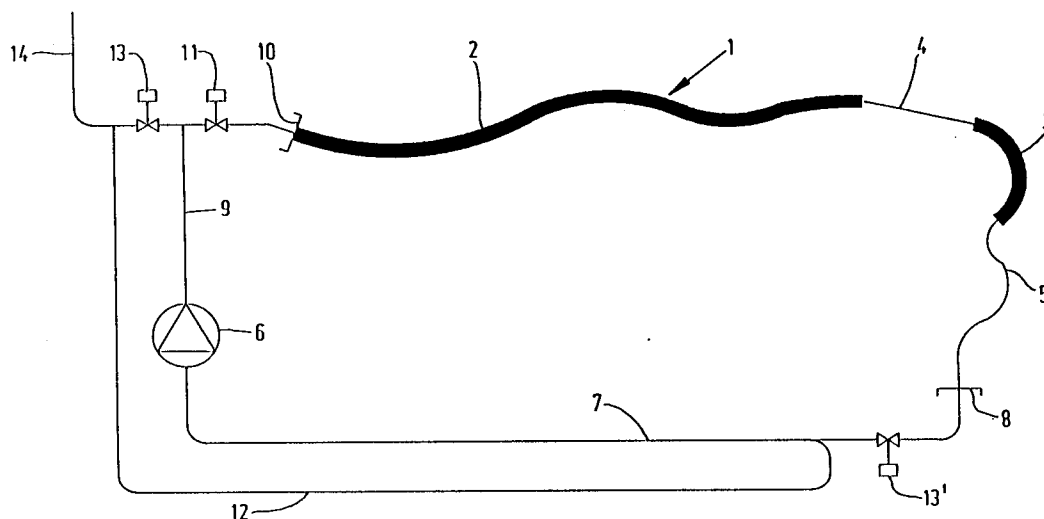


FIG. 1

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The invention generally relates to water sliding devices, as well as to methods for operating such water sliding devices. Such water sliding devices are known per se, for example from European Patents Nos. 0096216 and 0182923, and also from WO 92/04087.

In order to make it easier to read the description first a few definitions of the terms used will be given, viz.:

- water sliding device : a device for practising water sliding sports.
- water slider : a person who practises water sliding sports.
- water sliding surface : a surface suitable for practising water sliding sports.
- useful water sliding area : a water surface area where the bottom inclination, the water depth and the water velocity are such that a water slider of average dexterity is able to practise water sliding sports.
- water sliding sports : inter alia includes the following sports: surfing, body surfing, knee surfing, jump surfing, water skiing, tyre sailing and sliding, board sailing and sliding, surf kayaking and any further forms of sports, games and/or recreation to be practised on water.
- sliding means : a means used by the water slider in order to be able to practise water sliding sports.
- basic wave velocity or critical velocity : the velocity at which the Froude number 1 is; $Fr = v / \sqrt{g \cdot h}$, whereby v is the water velocity, g is the gravitational acceleration and h is the water depth.
- supercritical or shooting velocity - a velocity higher than the basic wave velocity ($Fr > 1$).
- subcritical or flowing velocity - a velocity lower than the basic wave velocity ($Fr < 1$).
- hydraulic jump : the transition from a supercritical to a subcritical flow.

More in particular the invention relates to a method for starting up a device intended for practising water sliding sports, whereby water is displaced over a rising (in downstream direction) bottom at a generally supercritical velocity by means of a pumping plant during normal use, which pumping plant supplies water in downstream direction to said rising (in downstream direction) bottom through at least one nozzle during normal operation.

With such a device the flow velocity of the water will be substantially supercritical at least along a certain part of the flow path during normal operation, but locally it may also be subcritical.

When such a water sliding device is started up the rising (in downstream direction) bottom is generally clear of water, because any stationary water

present on the bottom will strongly decelerate the water supplied via the nozzle(s) upon starting up.

If no further measures are taken, it appears that during start-up, when water is being supplied to the rising (in downstream direction) bottom in order to effect the desired flow, the water flow decelerates faster than is the case during normal operation of the device. Consequently the thickness of the water layer present on the rising (in downstream direction) bottom quickly increases in downstream direction and a hydraulic jump may be formed, which may travel upstream, so that a considerable part of the flow on the rising (in downstream direction) bottom will become subcritical instead of supercritical, thus being unsuitable for practising the water sliding sports aimed at.

In order to overcome this drawback it has been proposed in the aforesaid European Patent No. 0182923 to use a large water basin installed at a high position, from which, upon start-up of the device, a large amount of additional water is supplied besides the amount of water displaced by the pumping plant, as a result of which a quick, complete charging of the rising (in downstream direction) bottom can be effected.

Such a basin must have a comparatively large capacity and consequently occupies a large amount of space, whilst in addition to that the basin must be placed as close to the nozzle(s) as possible, near the lowest point of the rising (in downstream direction) bottom, therefore. This has a particularly adverse effect on the design of the water sliding device, since among other things it seriously interferes with the view which spectators have of the water sliding device from the surroundings.

In WO 92/04087 it has been proposed to discharge water continuously from the rising (in downstream direction) bottom via open side edges. This lateral discharge with respect to the intended direction of flow becomes larger as the flow velocity of the water decreases and the thickness of the water layer present on the rising (in downstream direction) bottom increases thereby. By using this measure it is attempted to prevent that too thick a water layer, possibly having a subcritical velocity, is formed on the rising (in downstream direction) bottom, which can no longer be pushed ahead at a supercritical velocity by the water flowing in, with all its consequences.

The disadvantage of leaving out the side edges along the rising (in downstream direction) bottom is, however, that the water sliders may slide off the bottom in lateral direction. The use of retaining nets to prevent this involves the risk of water sliders catching on said nets and/or injuring themselves when colliding therewith.

Furthermore the energy consumption is high, also during normal operation of such a water sliding device, because a comparatively large amount of water continuously flows sideways from the rising (in downstream direction) bottom, whilst a large part of said water still possesses sufficient kinetic energy required for practising water sliding sports.

According to the invention the nozzle(s) is (are) initially kept closed when the pumping plant is started up, and the required velocity is imparted to the water by means of said pumping plant in a circulation circuit, whereupon said nozzle(s) is (are) opened and the flow in said circulation circuit is interrupted.

When using the method kinetic energy is first imparted to the water in the circulation circuit. When subsequently the nozzle(s) is (are) opened the flow on the rising (in downstream direction) bottom is directly started, since the water in the pressure pipe of the pumping plant may already have at least the velocity that is normal during operation. As a result of this the starting losses caused by the deceleration of the water at the delivery side of the pumping plant towards the opening(s) of the nozzle(s) can be avoided.

A further aspect of the invention relates to a method for operating a water sliding device which is provided with a rising (in downstream direction) bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal use. As already explained above it is known to discharge water from the sides of the rising (in downstream direction) bottom when the water flow over the rising (in downstream direction) bottom is started. Generally, however, such a large discharge of water from the sides is undesirable during normal operation.

According to the invention, therefore, water is discharged sideways from the water flow over the bottom when a flow is started, whilst said discharge of water is reduced or stopped when the desired flow velocity of the water is reached. By using this method it will be possible to supply considerably less water during normal operation than is the case with the method referred to above, which has been usual so far.

A further method for operating a water sliding device as referred to above is according to the invention characterized in that, at least when the flow of water over the rising (in downstream direction) bottom is started, an additional amount of water is supplied under pressure in downstream direction to the flow of water, at some distance from the lowest point of the bottom. Because of this an extra acceleration of the flow of water may be effected, in particular when the water flow is started, as a result of which the desired flow of the water over the bottom can be achieved quickly and

effectively after the flow of water over the rising (in downstream direction) bottom has been started.

The invention will be explained in more detail hereafter with reference to the accompanying Figures.

Figure 1 is a diagrammatic view of an embodiment of a water sliding device with an associated pumping plant.

Figure 2 is a diagrammatic view of an embodiment of a water sliding device with a second embodiment of a pumping plant.

Figure 3 is a diagrammatic view of an embodiment of a water sliding device with a third embodiment of a pumping plant.

Figure 4 is a diagrammatic view of an embodiment of a part of the pumping plant shown in Figure 3.

Figure 5 shows the part of the pumping plant shown in Figure 4 in a different position.

Figure 6 is a diagrammatic perspective view of a bottom of a water sliding device.

Figure 7 is a diagrammatic cross-sectional view of the bottom of a water sliding device, whereby the left-hand part of Figure 7 shows a first position of a vertically adjustable side wall and the right-hand part of Figure 7 shows a second position of a vertically adjustable side wall.

Figure 8 is a diagrammatic cross-sectional view of a bottom of a water sliding device, whereby the left-hand part of Figure 8 indicates the water level during normal operation and the right-hand part of Figure 8 indicates the water level during start-up of the water sliding device.

Figure 9 is a sectional view corresponding with Figure 8 of a further embodiment of the bottom of a water sliding device.

Figure 10 diagrammatically shows a water sliding device provided with a pumping plant, by means of which water can be supplied at several locations spaced apart in the direction of displacement of the water.

Figure 11 is a larger-scale view of a part of the water sliding device shown in Figure 10.

Figure 12 is a view corresponding with Figure 11, wherein various parts of the pumping plant are shown in a different position.

Figure 13 is a diagrammatic view of a part of the water sliding device shown in Figure 10, provided with a covering.

Figure 14 is a diagrammatic plan view of a water sliding device, in which a circulation is effected.

Figure 15 is a diagrammatic cross-sectional view of a part of the device shown in Figure 14.

Figure 16 is a diagrammatic cross-sectional view of another possible embodiment of the device shown in Figure 14.

Figure 17 is a diagrammatic plan view of a variant of the device shown in Figure 14.

Figure 18 is a sectional view of Figure 17, along the line XVIII-XVIII in Figure 17.

Figure 19 is a sectional view of Figure 17, along the line XIX-XIX in Figure 17.

Figure 20 is a diagrammatic plan view of a further embodiment of a water sliding device according to the invention.

Figure 21 is a diagrammatic perspective view of an embodiment of a bottom of a water sliding device, which widens in the direction of flow.

Figure 22 diagrammatically shows a flow pattern on a bottom according to Figure 21.

Figure 23 diagrammatically indicates the embodiment of a water sliding device by means of which a hydraulic jump can be artificially produced.

Figure 24 diagrammatically shows a downwardly sloping (in the direction of flow) bottom of a water sliding device according to the invention, by means of which running waves can be generated in the water flow.

Figure 25 is a plan view of a water sliding board according to the invention.

Figure 26 is an elevational view of Figure 25.

Figure 1 is a diagrammatic plan view of a water sliding device 1 with a pumping plant forming part thereof. The water sliding device is conventionally provided with a more or less trough-shaped duct, which may for example be subdivided into two parts 2 and 3, with a generally rising (in downstream direction) bottom, over which the water is displaced at a supercritical velocity during normal operation, which parts possibly alternate with parts 4 and 5, where the water velocity is lower and/or where the bottom generally slopes downwards in downstream direction.

During normal operation the water will be circulated by means of a pump 6. The pump 6 is connected, via a suction pipe 7, to one or more discharge nozzles 8 or a collecting basin or the like, via which water flowing from the device 1 can be sucked in. Furthermore the pump is connected, via a pressure pipe 9, to one or more nozzles or openings 10 disposed near the beginning point of the duct, through which nozzles water may be supplied in the desired manner to the more or less trough-shaped duct or gutter. In the pressure pipe 9 has been mounted a shut-off valve 11, by means of which the communication between the pump 6 and the supply nozzle(s) 10 may be interrupted.

As is furthermore apparent from Figure 1, a circulation pipe 12 is connected between the suction side of the pump 6 and the delivery side of the pump, in which circulation pipe a shut-off valve 13 has been mounted near the connection to the pressure pipe 9. A shut-off valve 13' has been mounted in the suction pipe 7, between the discharge

nozzle(s) 8 and the connection of the circulation pipe to the suction pipe 7.

Furthermore the circulation pipe may be connected to the atmosphere via a vent pipe 14, at a position so high that no water will flow from the vent pipe during operation.

As already explained above, generally the trough-shaped means is at least substantially clear of water when the water flow over the water sliding device 1 is started.

With the above-described device first the shut-off valves 11 and 13' will be closed and the shut-off valve 13 will be opened in order to start the water flow, so that the water present in the pipes 7, 9 and 12 can be circulated in a closed circuit by the pump 6, so as to bring the water up to the desired velocity. It will be aimed at thereby to achieve that the amount of circulated water which is displaced per time unit is equal to or larger than the amount of water which must normally be supplied to the water sliding device per time unit.

After the pump 6 has thus generated the desired flow in the closed circuit formed by the pipes 7, 9 and 12, the shut-off valves 11 and 13' may be opened and the shut-off valve 13 may be closed. The water then flowing into the trough-shaped means through the nozzle(s) 10 will have a comparatively great velocity already from the start, so that the above-described problems which normal occur when starting up a water sliding device can at least substantially be avoided.

It is advantageous thereby for the amount of water supplied per time unit on start-up to be larger than the amount of water which must normally be supplied during operation. This may be effected by having the pump 6 run faster during start-up or by providing additional auxiliary pumps for the start-up.

By providing the vent pipe 14 it is prevented that undesirable sub-atmospheric pressures occur in the circulation pipe 12.

The embodiment shown in Figure 2 largely corresponds with the embodiment shown in Figure 1 and accordingly like parts are numbered alike in the various Figures.

In the embodiment shown in Figure 2 the circulation pipe 12 is connected to a water jet injector 15 mounted within the suction pipe 7, whereby additional water may possibly be sucked in from a water collecting basin or discharge nozzles 8 disposed at the end of the water sliding device. The further operation of said device upon start-up will correspond with the operation of the device shown in Figure 1.

Also the diagrammatically indicated device shown in Figure 3 largely corresponds with the device according to Figures 1 and 2 and accordingly like parts are numbered alike in this Figure as

well.

With this embodiment the circulated water may flow between the circulation pipe 12 and the suction pipe 7 via an open connection 16 and furthermore said circulated water may flow freely between the discharge end of the water sliding device and the suction pipe 7 or the circulation pipe 12 respectively, via an open connection 17.

All this may for example be realized in the manner indicated in Figures 4 and 5. In Figure 4 the communication between the pressure pipe 9 and the trough-shaped means 2 of the water sliding device 1 is interrupted by means of a shut-off valve 18, via which the water displaced by the pump 6 is returned to a pit 19 accommodating the pump, whose interior functions as a suction pipe 7 or circulation pipe 12 respectively.

When the water is circulated in a sufficiently large amount and at a sufficiently large velocity after the pump 6 has been put into operation, the valve 18 may be reset from the position shown in Figure 4 to the position shown in Figure 5, in which position the water displaced by the pump will start to flow through the trough-shaped means of the water sliding device 1 in the direction indicated by the arrow A. The water flowing back from the water sliding device 1 will be returned to the suction pipe 7 or the circulation pipe 12 respectively, as indicated by means of the arrows B.

It will be apparent that also with this embodiment the water flow in the trough-shaped means of the water sliding device can be started in a similar manner as described above with reference to Figures 1 and 2.

Figure 6 is a diagrammatical perspective view of a trough-shaped means 20, through which water is displaced during operation, in the direction indicated by means of the arrows C, which trough-shaped means is for example provided with a rising (in downstream direction) bottom part 21, a downwardly sloping (in downstream direction) bottom part 22 contiguous thereto and then, contiguous to said bottom part 22, again a rising (in downstream direction) bottom part 23. In the illustrated embodiment said bottom parts are thereby bounded at the sides by side walls 24 of the trough-shaped means 20.

According to the invention means are provided for removing and/or opening the side walls 24 completely or partly when starting the flow through the trough-shaped means, so that desired amounts of water can be discharged from the sides of the bottom parts. In this case in particular water is concerned which has already been decelerated to a higher degree while flowing over the trough-shaped means 20, and which consequently will have a correspondingly low velocity, whilst also part of the water may be discharged from the main

flow less slowed down by friction.

When the water, some time after the device has been started up, has at least substantially reached the aimed-at velocity that is usual during normal operation, the walls 24 may be returned to the normal position, in which they at least substantially close the trough-shaped means at the sides, as a result of which an unnecessary flow-out of water from the sides is prevented, which has an advantageous effect on the amount of water required per time unit for normal operation of the water sliding device, and thus on the energy consumption.

One possible embodiment of such a device is diagrammatically shown in Figure 7.

As is illustrated in Figure 7 the bottom 25 of a trough-shaped means is for example disposed within a basin 26. Hollow, vertically adjustable walls 27 are disposed near the sides of the bottom 25, whereby the left-hand part of Figure 7 shows an adjustable wall 27 in its highest position and whereby the right-hand part of Figure 7 shows an adjustable wall 27 in its lowest position.

As is furthermore diagrammatically indicated in the right-hand part of Figure 7, when the device is started up the water will tend to flow slower as a result of the friction encountered and under the influence of gravity, in particular on the rising (in downstream direction) bottom, as a result of which the water layer 28 on the bottom will become thicker and thicker, which will oppose the inflow of additional water supplied by means of the pumping plant. By putting the side walls 27 in their lowest position, as shown in the right-hand part of Figure 7, the water can readily flow out at the sides of the trough-shaped means, as indicated by means of the arrows D, as a result of which the undesirable increase in the thickness of the water layer on the bottom 25 of the trough-shaped means can be prevented. The water flowing out may be supplied to a pump 30 through a pipe 29, in order to be resupplied to the trough-shaped means or be used for other purposes.

During normal operation the side walls 27 will be in their highest position shown in the left-hand part of Figure 7.

Since the water is decelerated at the sides of the trough-shaped means thereby, it may be advantageous to provide a few outlet openings, as indicated in Figure 7, through which openings a small amount of decelerated water may flow out at the sides of the trough-shaped means during operation, as indicated by means of the arrows E. As is furthermore indicated in Figure 7, the water layer 31 will be less thick during normal operation than at the time of the start-up, as shown in the right-hand part of Figure 7.

As is diagrammatically indicated in Figure 8, variations to the above-described embodiment are conceivable. Thus it will for example be possible to provide fixed upwardly extending walls 33 comprising outlet openings, which join a bottom 32 of a trough-shaped means, through which walls water may be discharged as indicated by means of the arrows F through openings, one lying above the other, whereby at least the uppermost openings can be opened and closed as desired.

In addition to that passages may be provided for discharging water slowed down by the bottom 32, through which passages the water can flow out as indicated by means of the arrows G. Said outflow of water can be stopped by closing the shut-off valves 35 provided in the discharge pipes 34.

Another possibility to support the starting-up process is to supply pressurized water, through holes provided in the bottom 32 and the side walls 33, in downstream direction to the water mass flowing over the bottom 32 in order to accelerate the water present near the supply openings, instead of discharging water through said holes. When the water flow over the bottom 32 has acquired the normal velocity suitable for use, said supplying of pressurized water may generally be strongly decreased or stopped altogether.

With the embodiment diagrammatically indicated in Figure 9 a construction has been opted for, whereby the upper ends of the side walls 37 bounding the sides of a bottom 36 of the trough shaped means, extend above the bottom 36 over a height corresponding with the usual thickness of the water layer 38 present on the bottom 36 during normal operation. During the start-up of the water sliding device the thickness of the water layer 38 will generally be greater, as illustrated in the right-hand part of Figure 9, whereby the excess water can flow out over the upper edge of the wall 37, as will be apparent from the right-hand part of Figure 9. As is furthermore indicated in Figure 9, also in this embodiment the bottom 36 and the side walls 37 may be provided with holes for discharging water and/or supplying pressurized water.

Figures 10 - 13 diagrammatically show another possible embodiment of a water sliding device, in which water is supplied in several spaced-apart locations.

As is apparent in particular from Figures 11 and 12, means for supplying water to the trough-shaped means 39, whose design corresponds with that of the means shown in Figures 4 and 5, are disposed near the beginning point of the trough-shaped means 39 of the water sliding device, which is shown diagrammatically in this Figure, and accordingly those parts in Figures 9 and 10 that correspond with the parts shown in Figures 4 and 5 have been given the same reference numerals as

in Figures 4 and 5; consequently it will not be necessary to describe this part of the water sliding device shown in Figure 10 once again.

As will furthermore be apparent from Figures 10 - 12, several spaced-apart pits 40 are disposed under the trough-shaped means 39 in this embodiment, in which pits pumps 41 are provided.

Pressure pipes 42 are connected to the pumps, which pressure pipes are in communication with one or more nozzles, which preferably extend across the width of the trough-shaped means, so that pressurized water may be added in the intended direction of flow to the amount of water flowing through the trough-shaped means 39 in several spaced-apart locations along said trough-shaped means, as is indicated by means of the arrows G in Figure 13.

As is furthermore indicated in Figure 12 valves 44, which are adjustable by means of setting cylinders 43, are provided near the ends of the pressure pipes 42. In the position of the valves 44 shown in Figure 11 the nozzles are closed and the delivery side of the pump is in open communication with the suction side. In the position of the valves 44 shown in Figure 12 the communication between the delivery side and the suction side of the pump is interrupted and the water may be discharged by the pumps 41 via the nozzles.

As is furthermore indicated in Figures 11 and 12, the water may be supplied to the pump 41 through a supply pipe 45 connected to the pit 40. Said water may for example come from collecting basins 46, which may for example be disposed near the end of the trough-shaped means 39.

It is also possible to provide openings, which can preferably be closed, in the bottom and/or the walls of the trough-shaped means 39 near a pit 40, so that a water layer, which has been decelerated on the bottom and/or the walls of the trough-shaped means, can be sucked off at desired locations on the trough-shaped means, if desired, as indicated by means of the arrows H in Figure 12, and be resupplied under pressure to the water layer by means of the pump 41.

It will be apparent that such an arrangement, with supply locations which are spaced apart in the longitudinal direction of the trough-shaped means, may also be used with the devices known from the aforesaid publications.

The embodiment described with reference to Figures 10 - 13 is also eminently suitable for using a trough-shaped means 39 having a comparatively small width and a great length. Since it is possible thereby to generate an effective flow in upstream direction along the entire length, the device may also be used for propelling the water slider upwards along the rising (in downstream direction) bottom of the trough-shaped means. Furthermore a

construction of this type lends itself particularly well for more complicated configurations of the trough-shaped means. The trough-shaped means may thereby be provided with a covering 47 (Figure 13), if desired.

By using an embodiment of this type, in particular including a possibility to supply pressurized water to the water sliding device in several locations, elongated embodiments of the water sliding device may be effected and/or steeper inclinations and/or more complicated shapes may be used, which may add considerably to the attractiveness of the device.

Of course also combinations of the various embodiments described in the present application, for example comprising slides, rivers or the like are conceivable.

Thus Figure 14 shows a water sliding device, wherein the water sliding surface is at least substantially round, seen in plan view. The bottom 48, on which the water sliding surface is formed, preferably slopes slightly upwards towards the outside from an opening 49 located near the centre of the bottom, as will be apparent from Figure 15.

As is diagrammatically indicated in Figure 14, regularly spaced-apart nozzles 48 will thereby be provided on the surface 48, from which nozzles pressurized water will be supplied over the surface 48, as is indicated by means of the arrows K.

Part of the water will flow from the bottom 8 along the outer and inner boundary walls, as indicated by the arrows L and M, and be resupplied to a pump 51, by means of which the water is pressed towards the nozzles 50. A device of this type may efficiently be designed to have a water depth of less than a few decimetres and a minimum water depth of more than a few centimetres. The energy consumption of such a device will be comparatively limited, whilst the device is particularly suitable for non-swimmers and/or for less experienced water sliders.

The return duct 52 located at the outside of the device, through which water flowing out along the outer edge of the bottom 48 is returned to the pump 51, may be closed by a grid 53 or the like at the upper side, as indicated in Figure 15. Another possibility is to design the duct 54 intended for returning water, which is located at the outside of the bottom 48 (Figure 16), as an open duct, in which a certain amount of flow in circumferential direction will still be present during operation, which duct may for example be used for swimming or for floating on boards, tyres or the like.

Preferably the passage through the opening 49 located in the centre of the bottom 48 can be closed to a larger or smaller degree, for example by means of the vertically adjustable closing means 55, so that large amounts of water can flow

out via the central opening 49 when the device is started up, in order to prevent that decelerated or stationary water will interfering with the starting of the desired flow over the bottom 48, whilst said discharge via the opening 49 may be strongly reduced or interrupted once the water circulates over the bottom 48 at the desired velocity and in the desired amount.

Figures 17 - 19 shows variants of the constructions illustrated in Figures 14 - 16. Corresponding parts have thereby been given the same reference numerals in the various Figures.

As a comparison between Figure 14 and Figure 17 will show, the essential difference between the two embodiments is that in the embodiment according to Figure 17 the bottom 48 is not circular, but more in the shape of an elongated closed curve, over which a circulating flow can be generated, likewise by means of nozzles 50.

As is apparent from Figures 18 and 19 thereby, the upper surface of the bottom 48 may slope towards the outside or be horizontal, whereby possibly the sloping parts may be alternated with horizontal parts.

Furthermore it is not necessary for the nozzles 50 to be rectilinear, they may also be bent or curved, so as to generate a desired optimum flow pattern of the water being displaced over the floor 48.

Figure 20 shows an embodiment of a water sliding device which has a dish-shaped bottom 56, as do the water sliding devices described with reference to Figures 14 - 19. In this embodiment water is supplied to the dish-shaped bottom 56 from a water sliding device 57 or for example the construction described above with reference to Figures 1 - 13. Instead of a water sliding device 57 it is also possible to use a water duct for the supply of water via which said water is supplied at a velocity which is considerably greater than the basic wave velocity or critical velocity and also greater than the velocity of the water being displaced over the bottom 56 in a more or less circular path.

The water flowing on the bottom 56 will be accelerated by the water thus flowing from the device 57 onto the dish-shaped means 56 at a comparatively great velocity, whilst water will be discharged along the edges of the bottom 56 in a similar manner as described above.

Preferably the bottom 56 will be dish-shaped again, more or less having the shape of a spiral casing, when seen in plan view.

The height of the edge bounding the dish-shaped bottom 56 at the outer side may gradually decrease in the direction of flow, so that water having a lower kinetic energy can be evenly discharged over the edge.

By designing the bottom 56 in the shape of a spiral casing it is effected that the water sliders arriving from the device 57 at a comparatively high velocity will initially move along the outer side of the bottom 56, whilst the water sliders already present on the bottom 56 will be closer to the centre of the bottom, as a result of which collisions will be avoided.

Also in this embodiment an outlet opening 59 having an adjustable passage may be provided near the centre of the bottom 56, in a similar manner as in the embodiments described with reference to Figures 14 - 19.

In order to improve the ratio between the useful water sliding area and the energy consumption for displacing the water, for driving the device, therefore, the rising (in downstream direction) surface of the water sliding device may for example be widened more or less gradually, from a width b to a width b' greater than b . When in a construction of this kind the water is slowed down as a result of the conversion of kinetic energy into potential energy and/or as a result of friction loss, the increase in the thickness of the water layer caused by the lower average velocity will be less than is the case when the width of the water sliding surface of the water sliding device is constant. The widening of the water flow in downstream direction can be promoted by making the bottom slightly convex and/or by an adapted nozzle, from which the exiting water already fans out.

As is diagrammatically indicated in Figure 22 the thickness of the water layer will gradually increase, for example with a constant width of the water sliding device, as is indicated by means of the line 60 in Figure 22, whilst in case of a gradual widening the thickness of the water layer may be kept more or less constant, as is indicated by means of the dotted line 61 in Figure 22. As a result of this the possible occurrence of a hydraulic jump may be moved further downstream, whilst in case of a gradual widening of the water sliding device in downstream direction it is still possible to maintain a water layer which is sufficiently thick for water sliding.

A further possibility for achieving an improvement with regard to the amount of energy required for circulating the water is diagrammatically illustrated in Figure 23.

As is indicated in this Figure, the water sliding device may be constructed in such a manner, that a downwardly sloping (in downward direction) part 63 joins the rising (in downward direction) part 62 of the water sliding device at a location such that the water flowing through the water sliding device still has a supercritical velocity near the transition from the rising to the downwardly sloping part.

As a result of the movement over the downwardly sloping (in downstream direction) part 63 the water velocity will even be increased. Preferably a part 64 having a steeper inclination joins the end of the downwardly sloping part 63, whilst said part 64 at its other end joins an at least substantially horizontal part 65. As a result of this construction of the device it will be possible to realize a hydraulic jump with a whirling flow at the transition from the sloping part 64 to the horizontal part 65 without making use of any further auxiliary means, as is indicated by arrows in Figure 23, whereby water sliding is also possible near said hydraulic jump.

Other measures, such as a sudden narrowing of the trough-shaped means, through which the water flows and/or the provision of nozzles for supplying pressurized water may be used as well, both in order to start the hydraulic jump and to influence the shape of the hydraulic jump.

Preferably the velocity of the supercritical water is higher than 4 m/s, whilst the Froude number must be higher than 2.5, preferably higher than 4.5 but lower than 9, so that a hydraulic jump which has good water sliding characteristics can be realized.

Due to the steeply inclined bottom 64, which may slope down discontinuously, it is possible to realize a sufficiently high hydraulic jump which is not unduly long.

With a Froude number $Fr = 4.5$ and a bottom inclination $tg > 0.2$, for example, it is possible to obtain a water level after the jump which is at least ten times the level before the jump and a length of about forty times the water level before the jump; in the accompanying Figure, with $Fr = 4.5$, h' is more than 10 h and l is about 40 h .

With a water sliding device according to the invention it is also possible to use a downwardly sloping (in the direction of flow P) trough-shaped means 66, as is diagrammatically indicated in the accompanying Figure 24.

Said trough-shaped means of rectangular section is provided with very smooth upright walls and a bottom, and during operation care is taken that the Froude number is at least 1.5. So-called roller waves, which are of the running type, may be generated in the trough-shaped duct 66 thereby. This creates an effect similar to waves occurring at sea, which makes the device very attractive to skilled sliders.

With such a downwardly sloping (in downstream direction) duct the starting problems involved in starting the water flow are negligible, since an advantageous flow can be generated at once while comparatively little energy is consumed. In addition to this a duct of this type may readily be given forms deviating from the rectilinear form diagrammatically illustrated in Figure 24. Fur-

thermore the duct may efficiently be connected with its lower end to a rising (in downstream direction) bottom, as described with reference to the preceding embodiments.

In order to accelerate the wave-forming process resonance-generating means may for example be provided, such as water supply nozzles and/or water discharge nozzles opening and closing during operation and/or moving boundary walls and/or chambers, which may be changed locally by means of pressurized air, etc.

The thinner the water layer to be used, the less the amount of energy that is required for displacing the water through the device, of course. The depth of the water is partly dependent on the design of the sliding means used by the water slider. In addition to that it is important to keep the length of the sliding means within bounds, in order to make it possible to admit as many sliders to a certain area as possible. Increasing the width while decreasing the length is generally not disadvantageous thereby, so that the total area of the sliding means may remain approximately equal.

An advantageous embodiment of a sliding means in the shape of a sliding board is shown in the accompanying Figures 25 and 26. As is shown in these Figures the water sliding means is in the shape of a short board 68, which is slightly curved in longitudinal direction. A few small plates or fins 69 extending parallel to each other are provided under the board, which fins may for example be made of a soft plastic material, such as polyethylene, rubber or the like.

As is apparent from Figure 26 thereby, said fins 69 preferably extend between approximately the lowest point of the curved surface of the board 68 and the rear side of the board.

The following board dimensions are quite suitable:

$$\begin{aligned} l &= 0.75 - 1.5 \text{ m,} \\ b &= 0.4 - 0.75 \text{ m,} \\ h &= 0.03 - 0.1 \text{ m.} \end{aligned}$$

The number of fins or profile parts 69 may for example range from 1 - 10, partly dependent on the strength of the material used.

The longitudinal and transverse stability of a board of the above-described type is satisfactory, in spite of its compact construction and relatively small height, as a result of which the board can also be successfully used in shallow water.

Claims

1. A method for starting up a device intended for practising water sliding sports, whereby water is displaced over a rising (in downstream direction) bottom at a generally supercritical velocity by means of a pumping plant during

normal use, which pumping plant supplies water in downstream direction to said rising (in downstream direction) bottom through at least one nozzle during normal operation, characterized in that said nozzle(s) is (are) initially kept closed when the pumping plant is started up, and the required velocity is imparted to the water by means of said pumping plant in a circulation circuit, whereupon said nozzle(s) is (are) opened and the flow in the circulation circuit is interrupted.

2. A method according to claim 1, characterized in that the required velocity is imparted to the water by means of said pumping plant in a closed circulation circuit.

3. A method according to claim 1, characterized in that the required velocity is imparted to the water by means of said pumping plant in a circulation circuit, to which a water outlet of the device intended for practising water sliding sports is connected via an injector.

4. A method according to claim 1, characterized in that a circulation pipe is in open communication with a suction pipe of said pumping plant and with a discharge pipe of the device intended for practising water sliding sports.

5. A method according to any one of the preceding claims, characterized in that for the start-up, in addition to the pump(s) which is (are) used during normal operation for maintaining the intended flow, (a) further pump (s) is (are) connected and/or the speed of the pumping plant is increased to start the water flow aimed at.

6. A device suitable for carrying out the method according to any one of the preceding claims, characterized in that said device is provided with a pumping plant including a suction pipe and a pressure pipe, whereby a circulation pipe is provided between said pressure pipe and said suction pipe and a shut-off valve is disposed between said pressure pipe and said circulation pipe, whilst furthermore a shut-off valve is provided between said pressure pipe and the nozzle(s) through which water is supplied to the device intended for practising water sliding sports.

7. A device according to claim 6, characterized in that a shut-off valve is provided between said suction pipe and a discharge pipe of the device intended for practising water sliding sports.

8. A device according to claim 6, characterized in that said circulation pipe is connected to said suction pipe via an injector, whilst furthermore a discharge pipe of a device for practising water sliding sports is connected to said injector. 5
9. A device according to claim 6, characterized in that the shut-off valves provided between said circulation pipe and said nozzle(s) are combined in a single shut-off valve, which in a first position interrupts the supply of water from the pump to the nozzles and bypasses the water displaced by the pumping plant to the circulation pipe, whilst in a second position said valve effects an open communication between the pump and the nozzles, thereby shutting off the discharge to the circulation pipe. 10 15
10. A method for operating a water sliding device which is provided with a rising (in downstream direction) bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal use, characterized in that water is discharged sideways from the water flow over the bottom when a flow is started, whilst said discharge of water is reduced or stopped when the desired flow velocity of the water is reached. 20 25 30
11. A method according to claim 10, characterized in that water is discharged from the flow of water over the bottom at desired locations near said bottom and/or said walls. 35
12. A water sliding device which is provided with a rising (in downstream direction) bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal operation, characterized in that upright walls are provided along the sides of the bottom, said walls being provided with means for regulating the level of the water on the bottom. 40 45
13. A water sliding device according to claim 12, characterized in that said walls are vertically adjustable.
14. A water sliding device according to claim 13, characterized in that said walls are adjustable to a position, in which the upper ends of said walls are located at substantially the same level as the bottom. 50 55
15. A water sliding device according to any one of the claims 12 - 14, characterized in that in a highest position of the walls the upper edges of the walls are located at substantially the same level as the desired upper level of the water surface.
16. A water sliding device according to any one of the preceding claims 12 - 15, characterized in that outlet openings, one lying above the other, are provided in said walls.
17. A water sliding device according to claim 16, characterized in that at least the uppermost openings provided in the walls can be closed.
18. A water sliding device according to any one of the preceding claims, characterized in that outlet openings for discharging water are provided in said bottom and/or said walls that may be present.
19. A method for operating a water sliding device which is provided with a rising (in downstream direction) bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal operation, characterized in that, at least when starting the flow of the water over the rising (in downstream direction) bottom, additional pressurized water is supplied in downstream direction to the water flow in a position spaced from the lowest point of the bottom.
20. A method according to claim 19, characterized in that said additional water is supplied under pressure via the passages provided in the side walls bounding the water flow.
21. A method according to claim 19 or 20, characterized in that additional water is supplied under pressure via passages provided in said bottom.
22. A water sliding device provided with a bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal operation, characterized in that at several spaced-apart locations, seen in the direction of displacement of the water during normal operation, means are provided by which pressurized water can be supplied to the water flow in downstream direction.
23. A water sliding device provided with a bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal operation, characterized in that the bottom is more or less in the shape of a closed loop or circle and that means for supplying pressurized water are provided in

spaced-apart locations on the bottom.

24. A water sliding device according to claim 23, characterized in that the bottom of the water sliding device is generally dish-shaped, seen in sectional view. 5
25. A water sliding device provided with a bottom, over which water is displaced at a generally supercritical velocity during normal operation, characterized in that a further water sliding device or a water duct, in which water can be displaced at a supercritical velocity, is connected to said water sliding device with a view to supplying water. 10 15
26. A water sliding device according to claim 25, characterized in that the bottom is in the shape of a spiral casing. 20
27. A water sliding device according to 23 - 26, characterized in that the bottom is surrounded by a gutter for discharging water flowing over the upper edge of the bottom. 25
28. A water sliding device provided with a bottom, over which water is displaced at a generally supercritical velocity by means of a pumping plant during normal operation, characterized in that said bottom slopes down in downstream direction and that the construction of the device is such that running roller waves are produced during the flow over the bottom. 30
29. A water sliding device according to claim 28, characterized in that said device is provided with means for generating running and/or standing waves. 35
30. A water sliding device according to any one of the preceding claims, characterized in that the width of the rising (in downstream direction) surface over which the water flows increases in downstream direction. 40 45
31. A water sliding device according to claim 30, characterized in that the bottom is slightly convex.
32. A water sliding device according to claim 30, characterized in that the nozzle supplies the water to the surface in a fanning-out manner. 50
33. A sliding board for practising water sliding sports, characterized in that said sliding board is at its bottom side provided with profiles extending in the longitudinal direction of the sliding board in side-by-side relationship, said 55

profiles being made of a slightly flexible material and having a maximum height of ± 10 cm.

34. A sliding board according to claim 33, characterized in that the length of said sliding board varies between ± 75 cm and ± 150 cm and that the width of said sliding board varies between ± 40 cm and ± 75 cm.
35. A sliding board according to claim 33 or 34, characterized in that said profiles extend approximately along half the length of the sliding board.

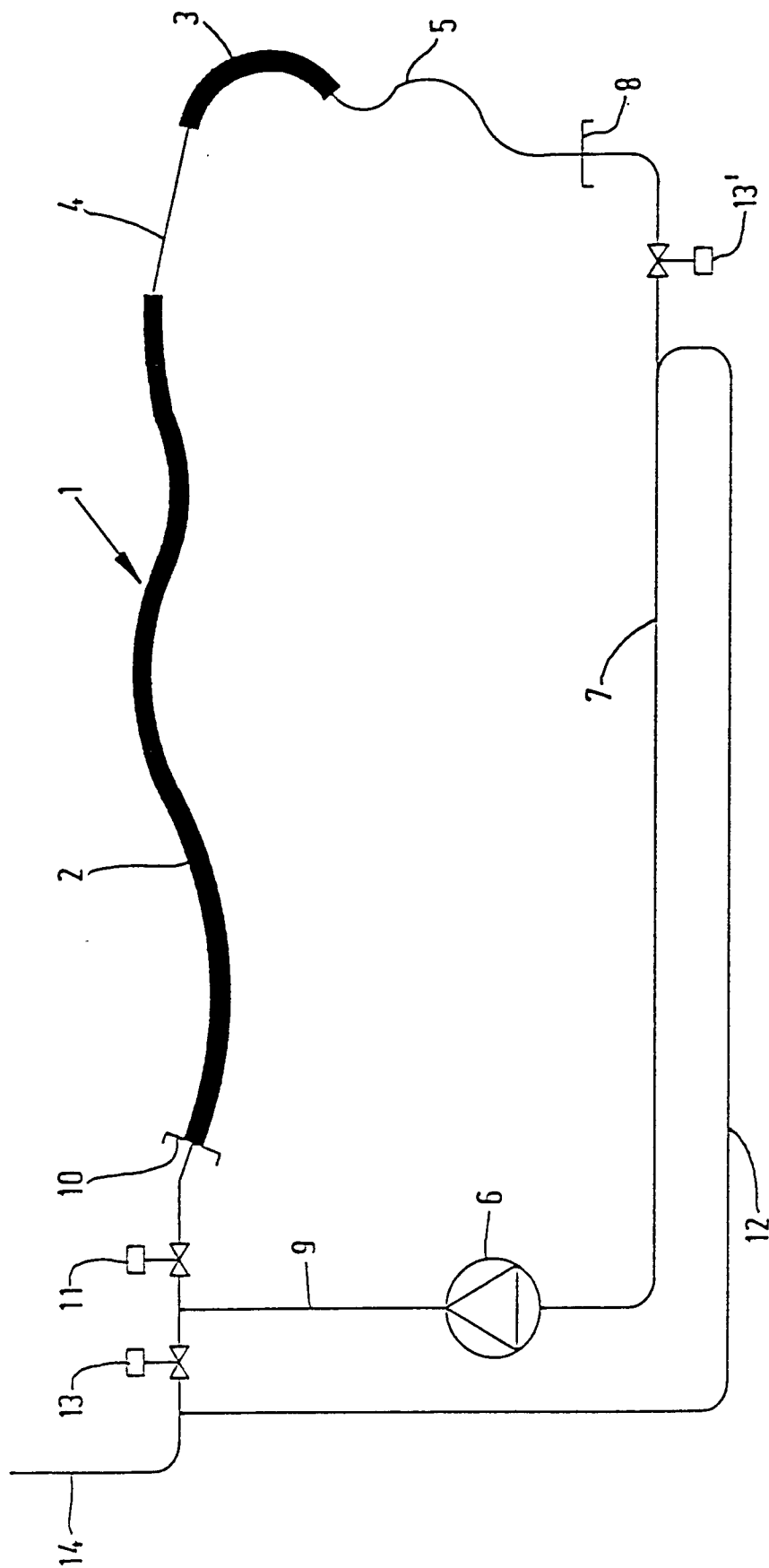


FIG. 1

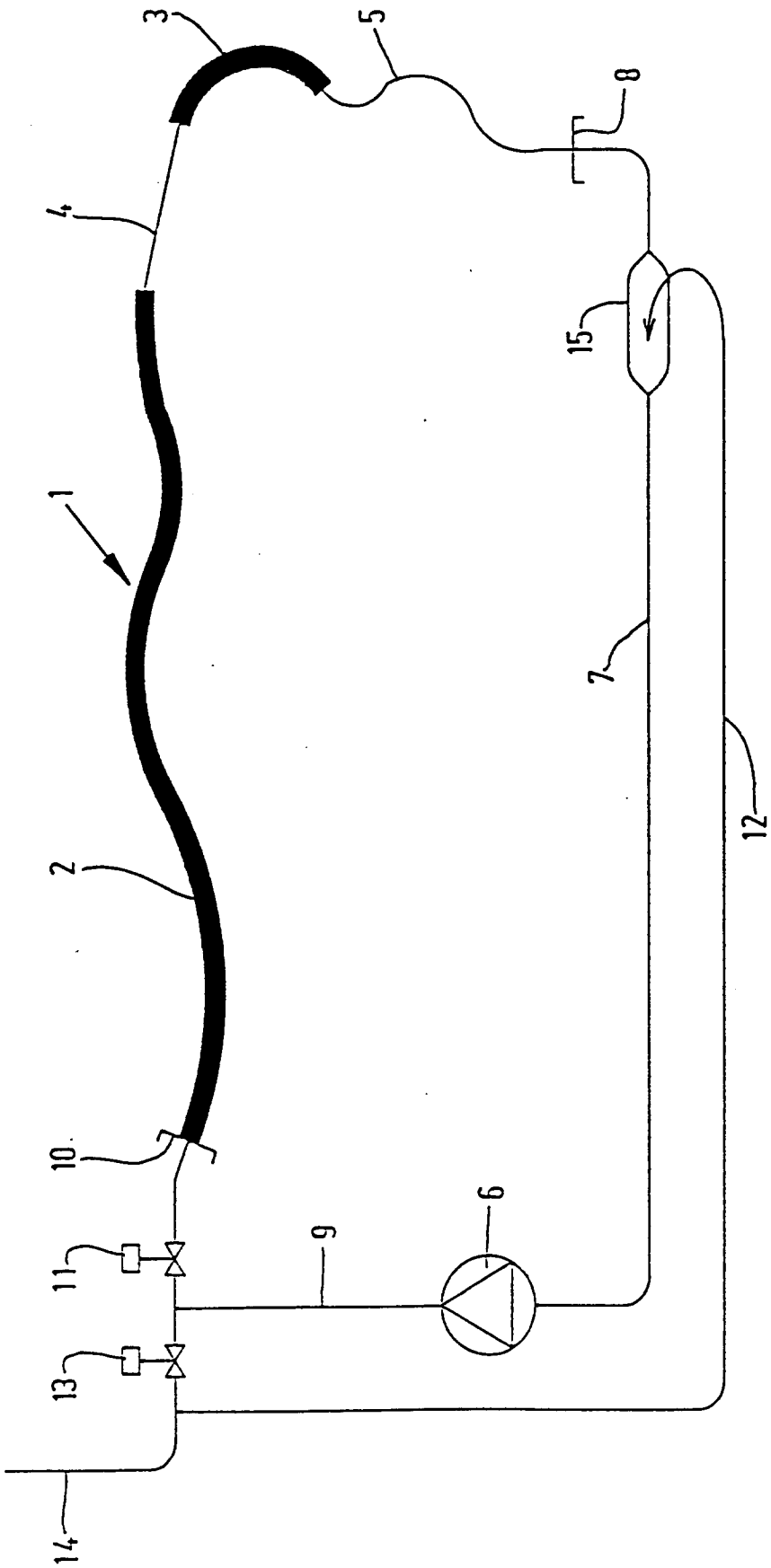


FIG. 2

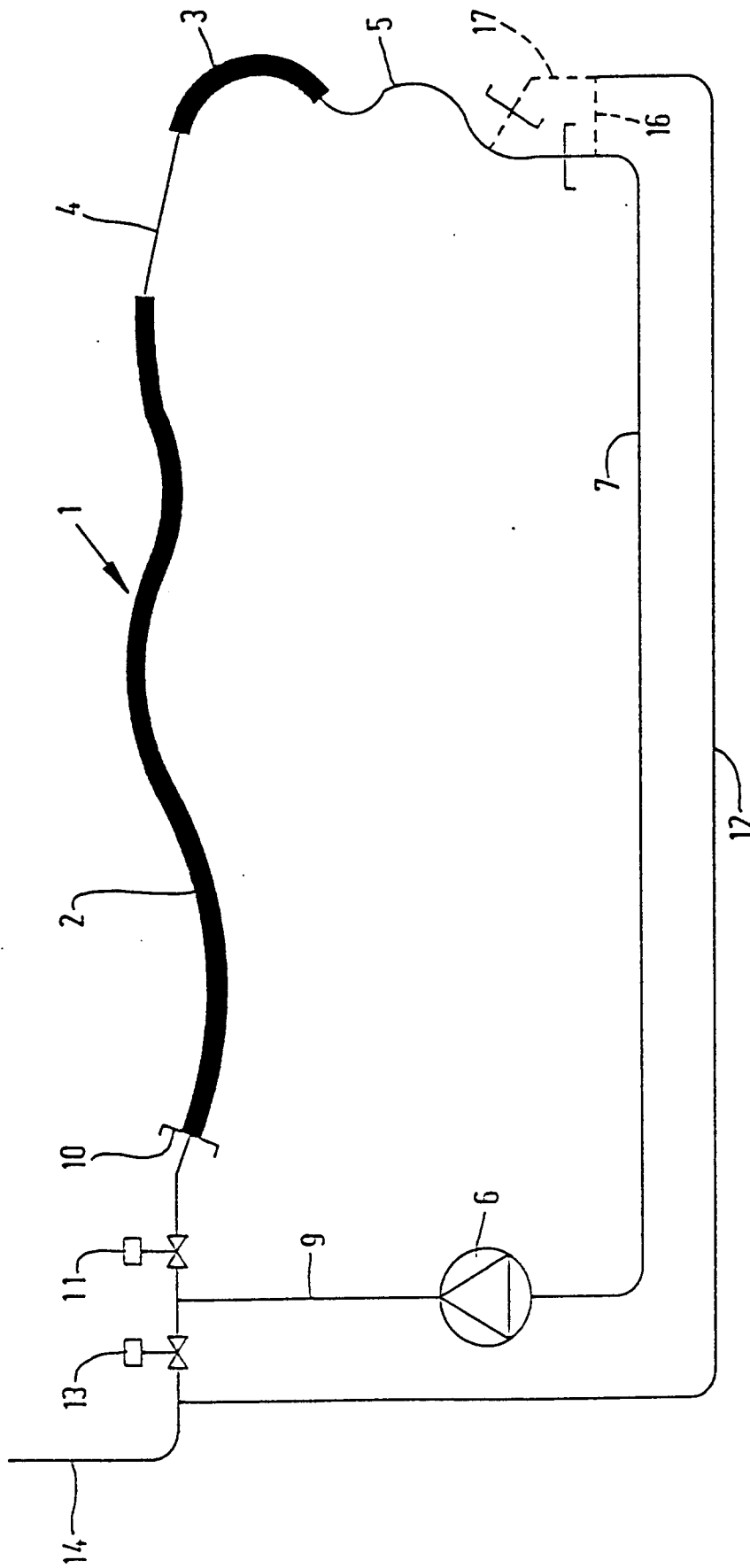
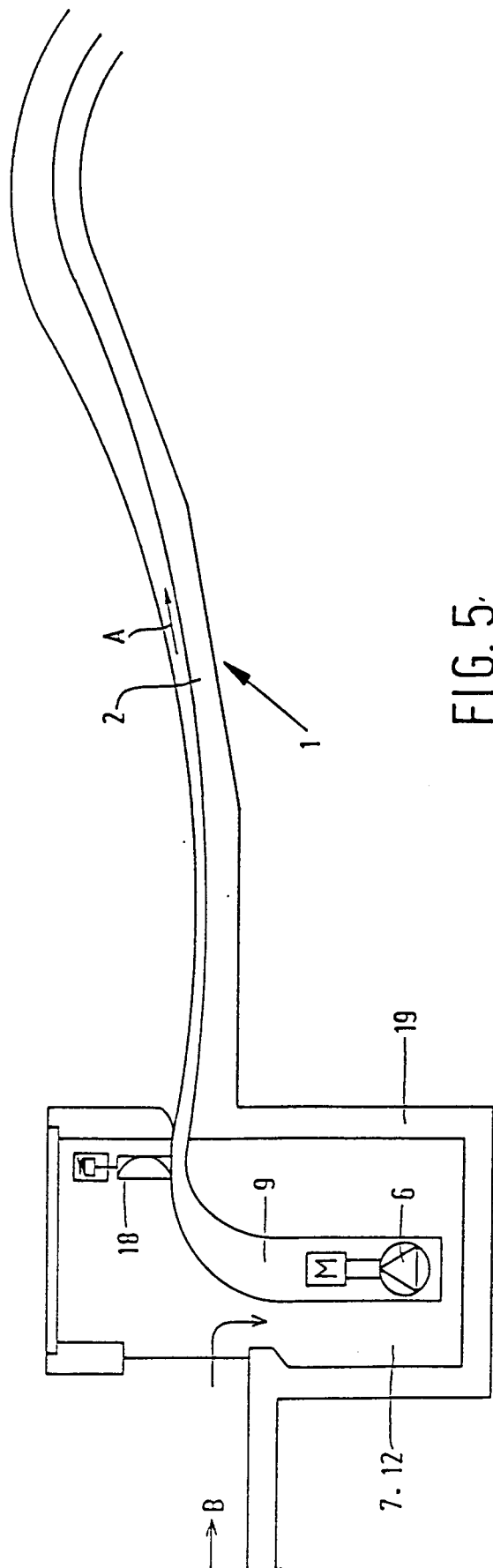
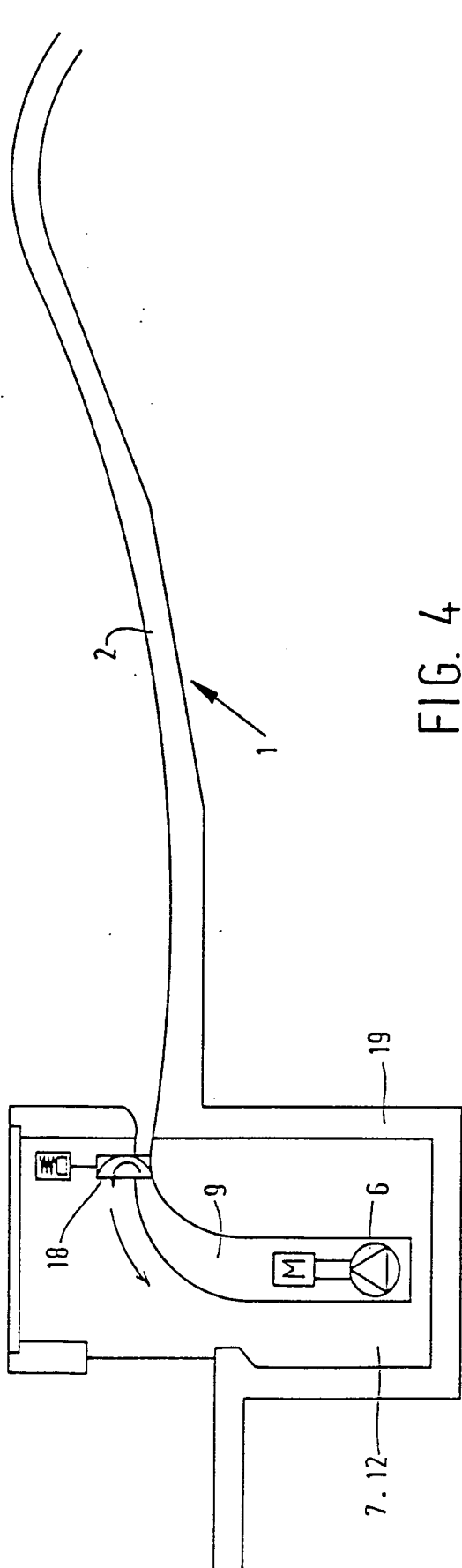


FIG. 3



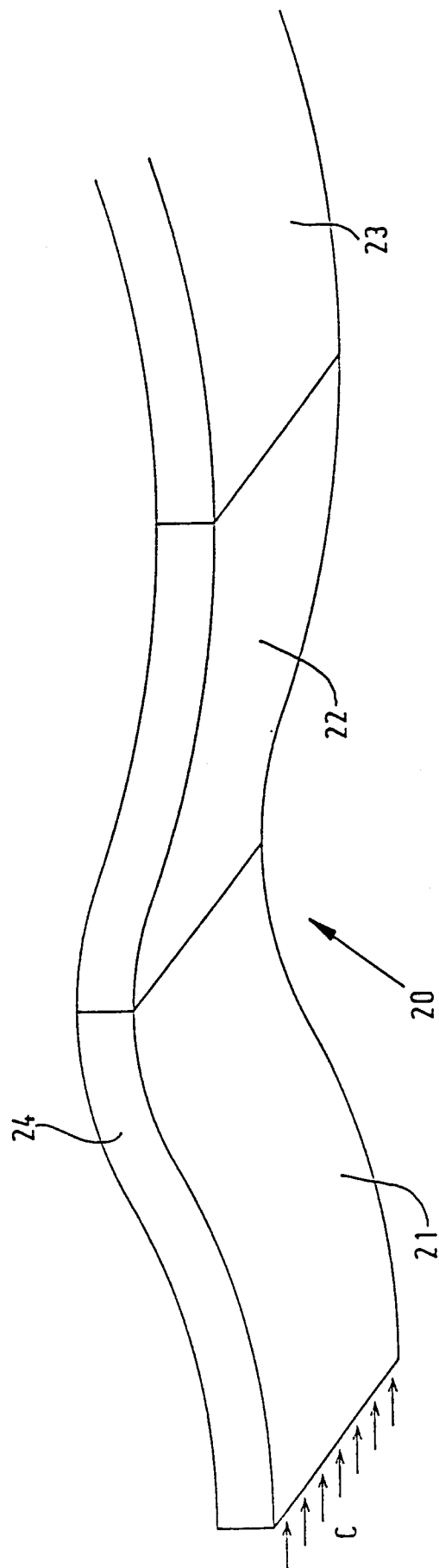


FIG. 6

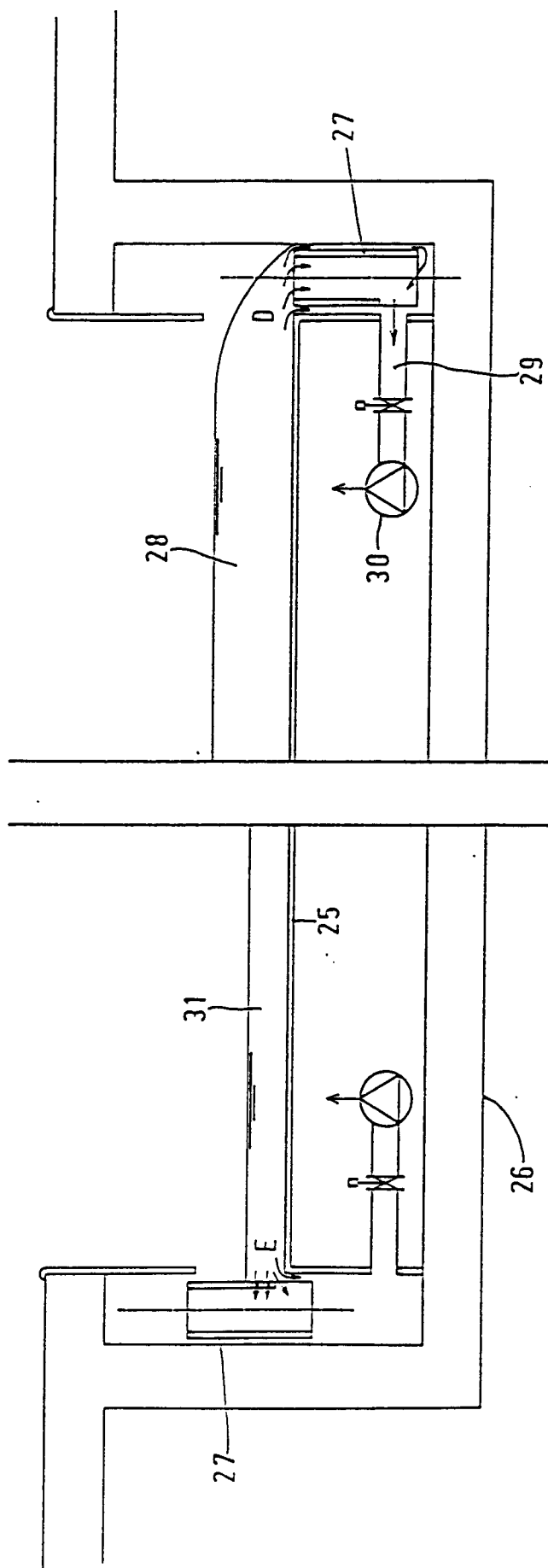


FIG. 7

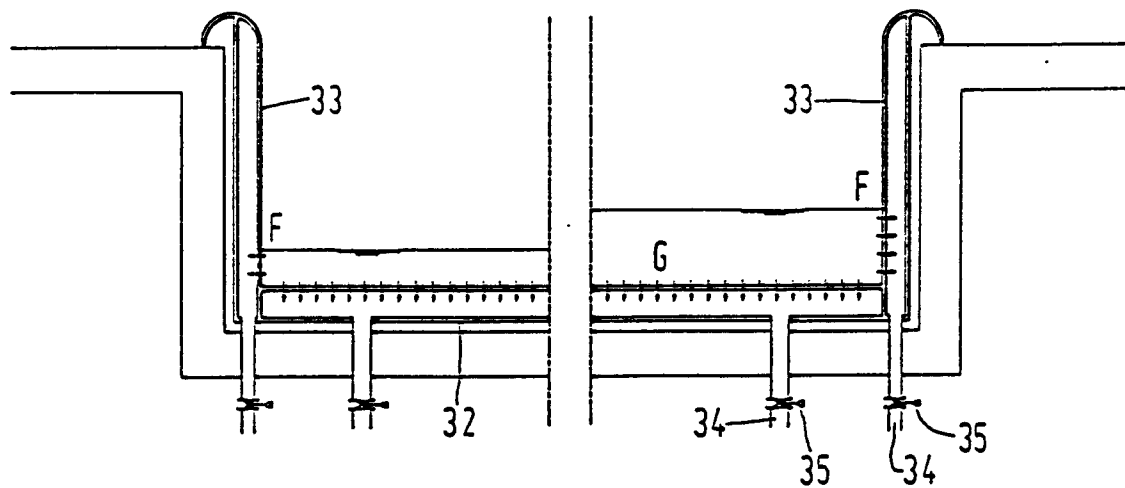


FIG. 8

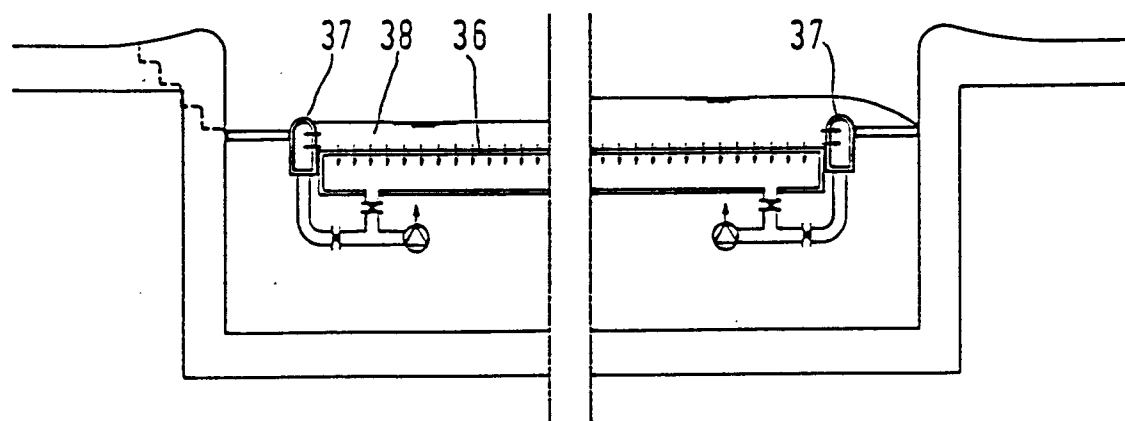


FIG. 9

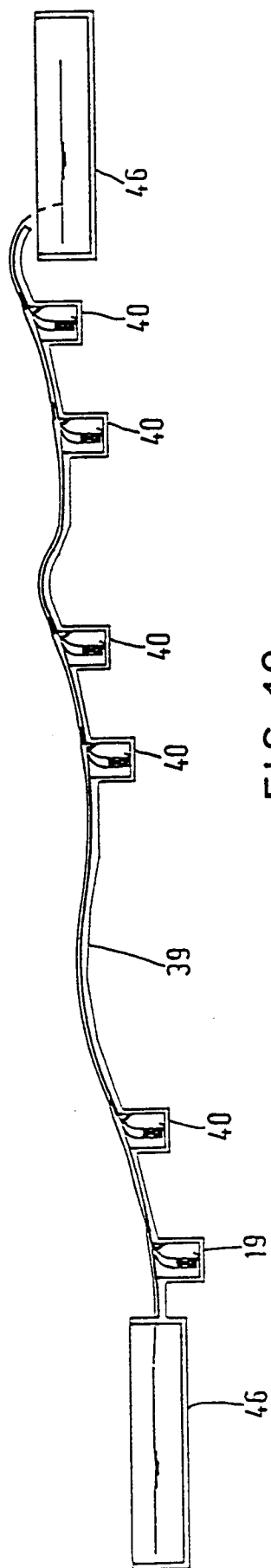


FIG. 10

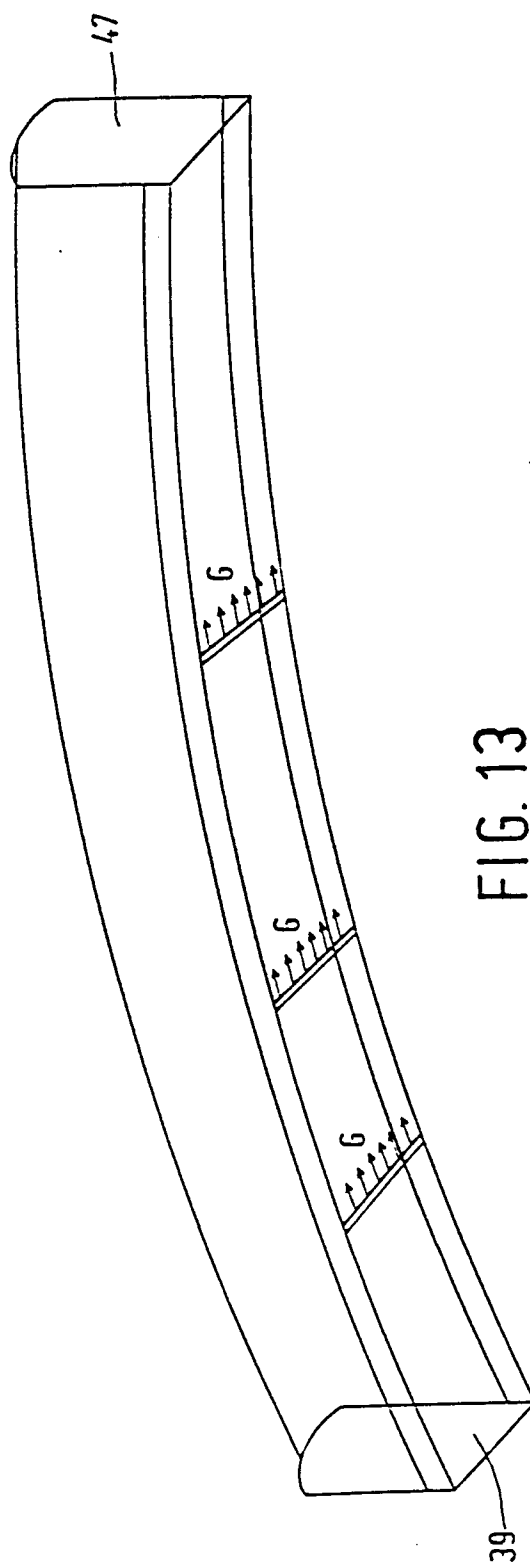


FIG. 13

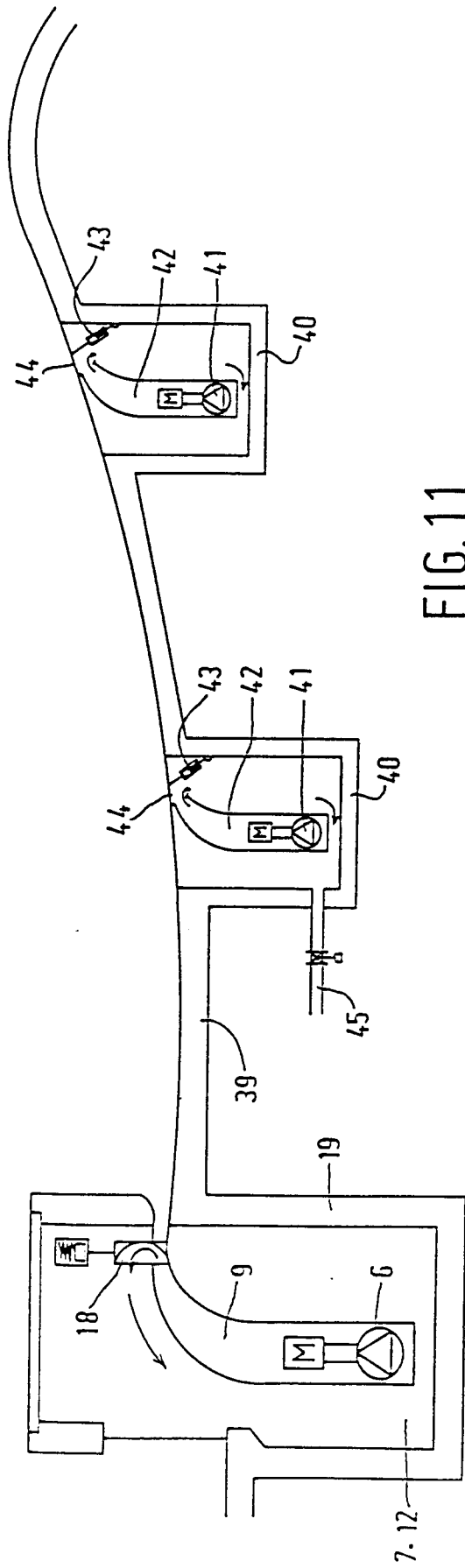


FIG. 11

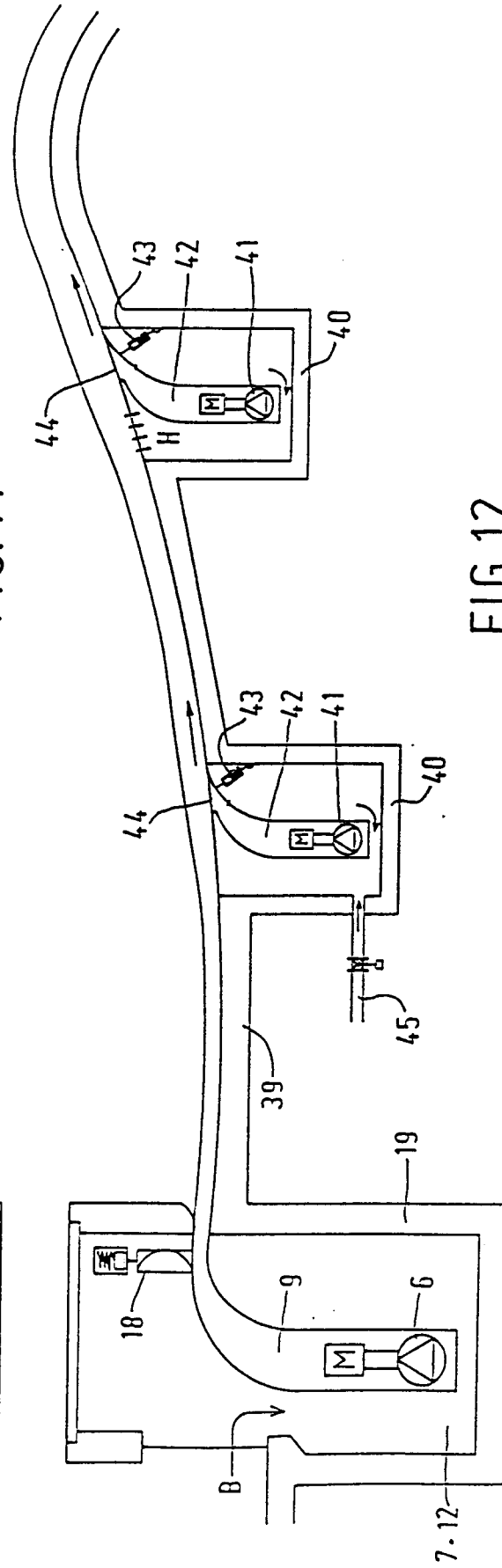


FIG. 12

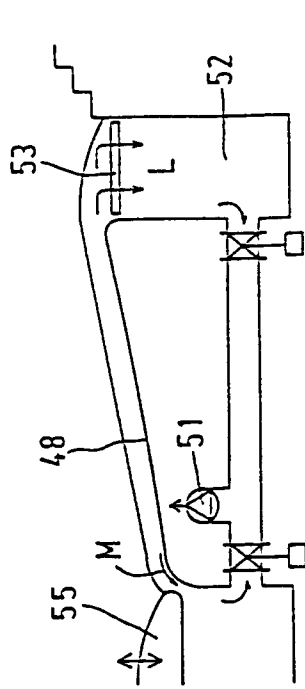
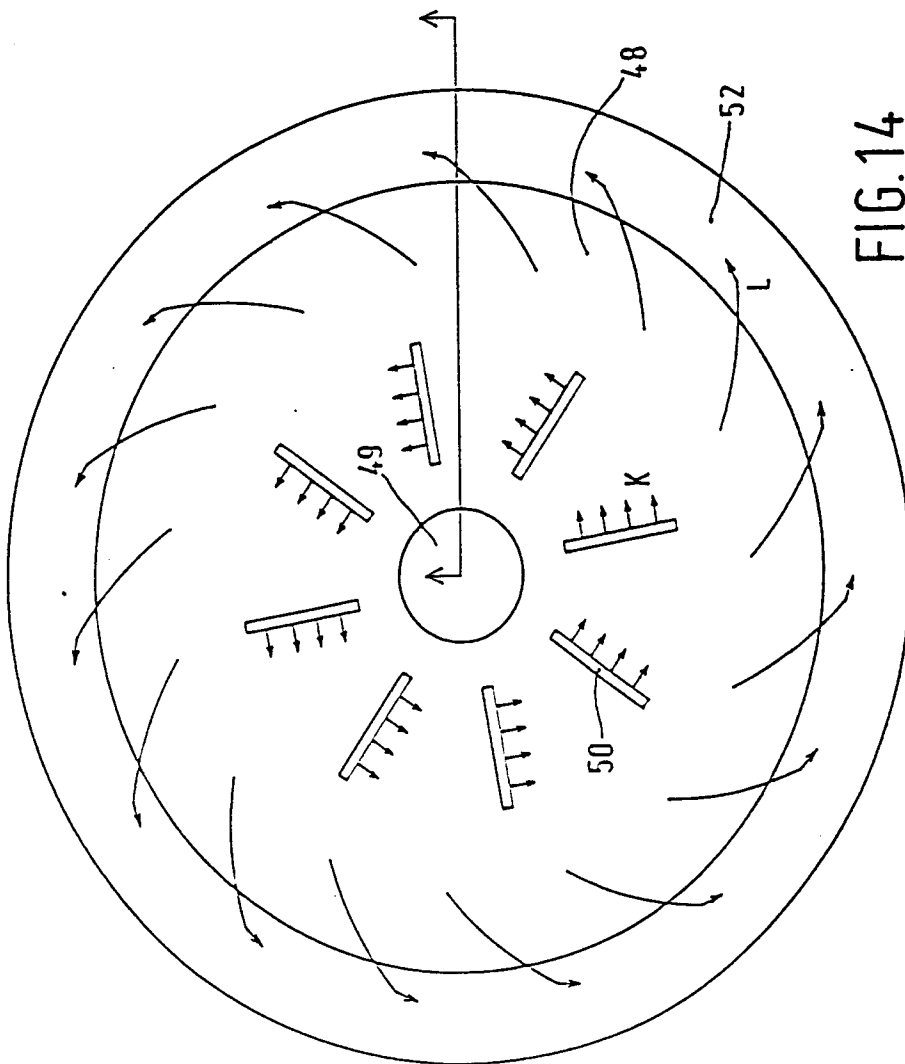


FIG. 15

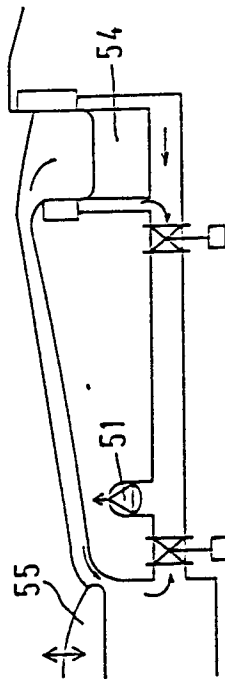


FIG. 16

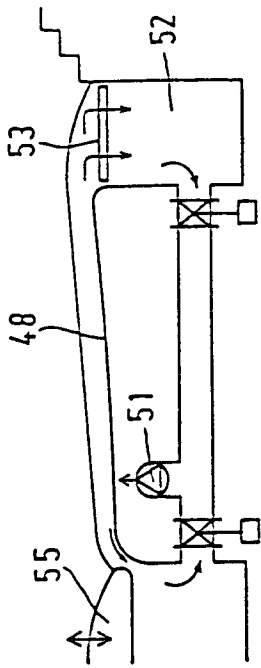
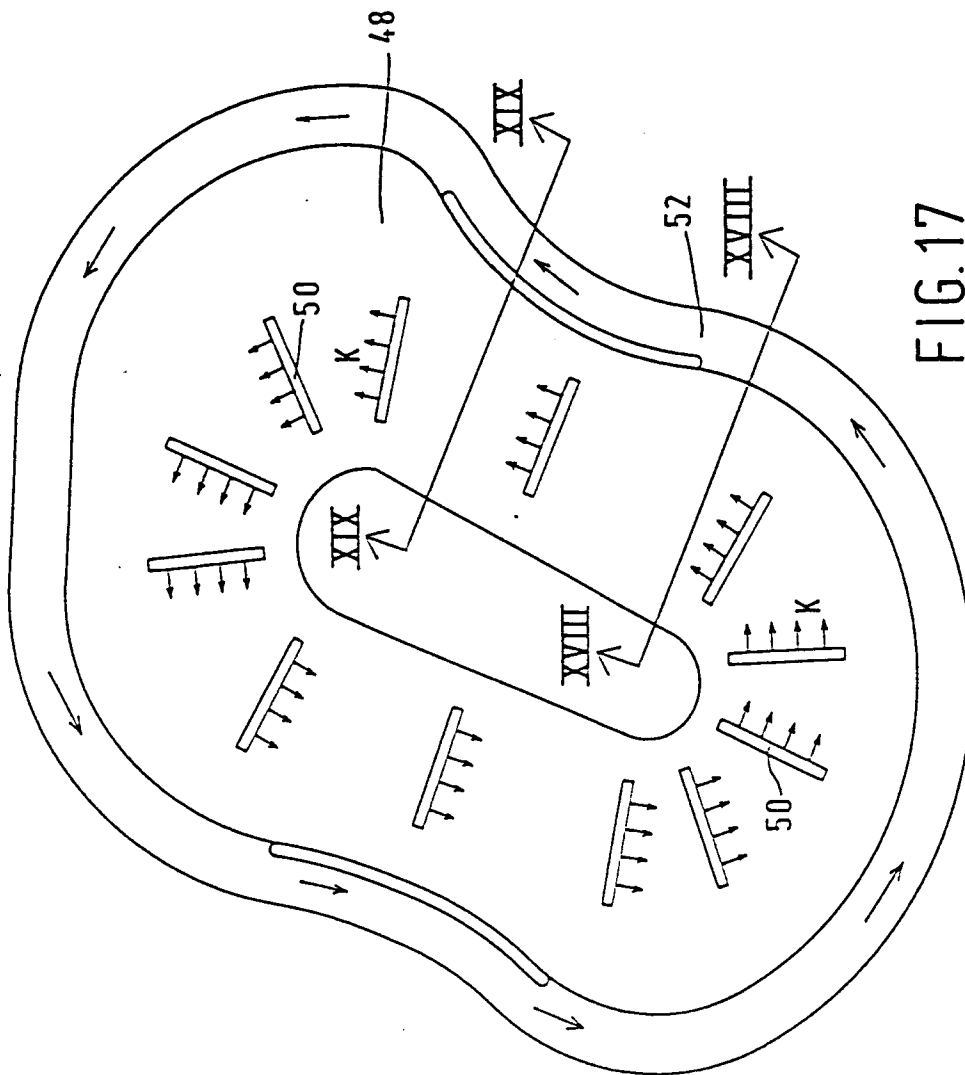


FIG. 18

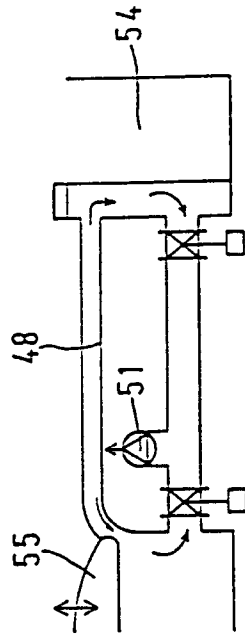


FIG. 19

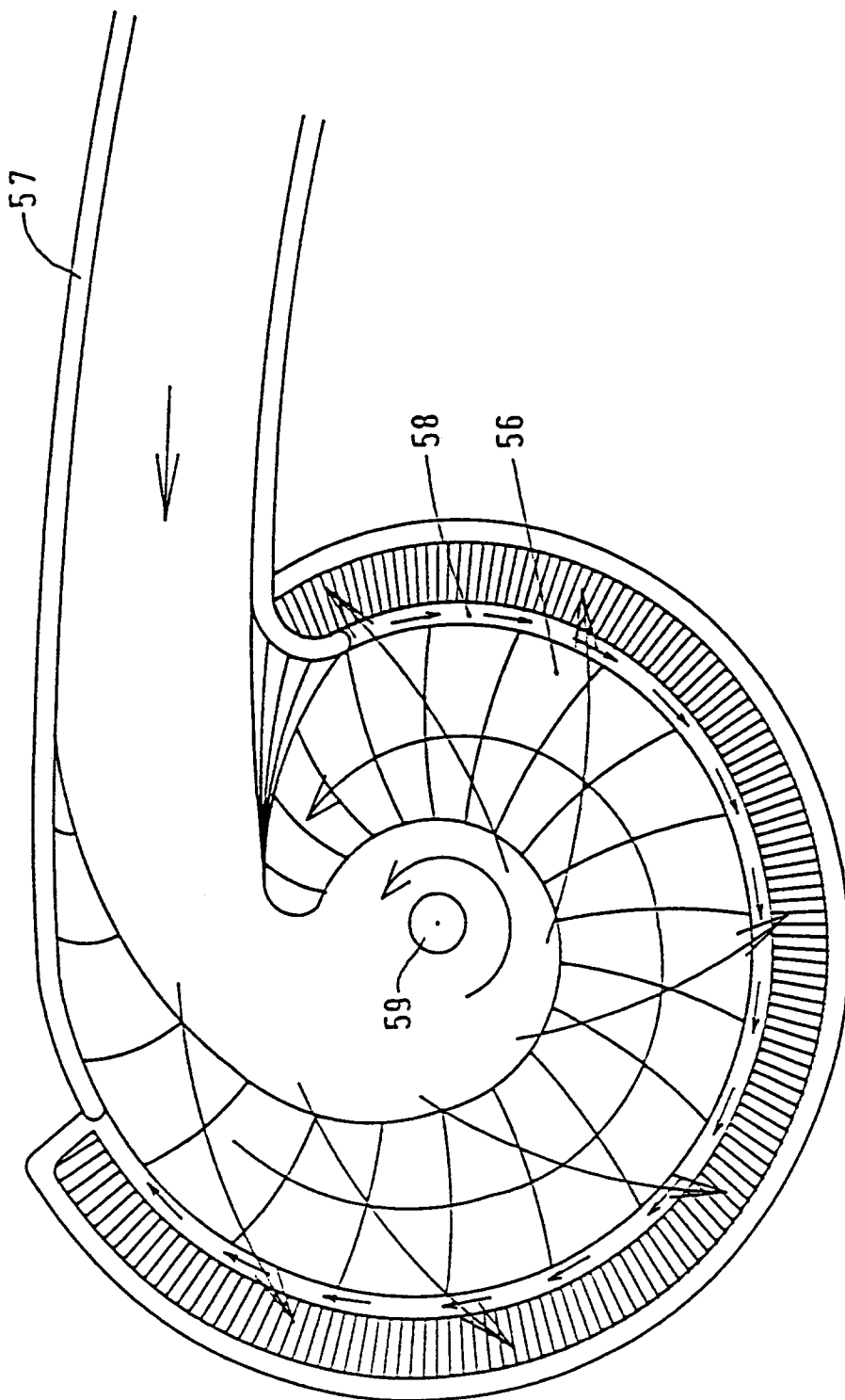


FIG. 20

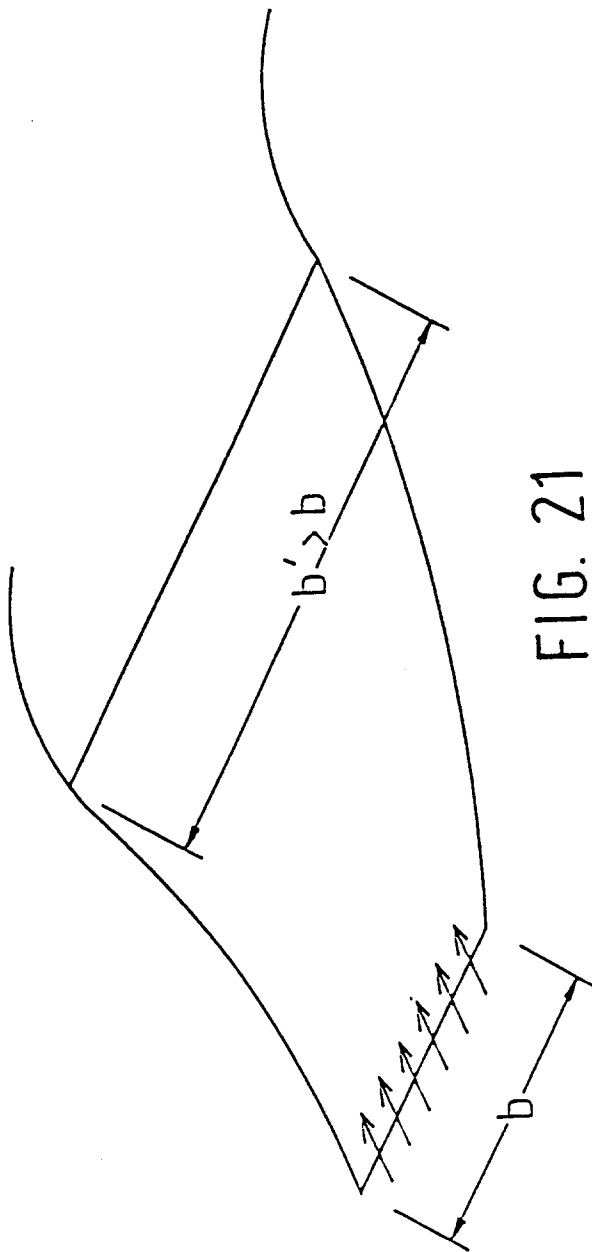


FIG. 21

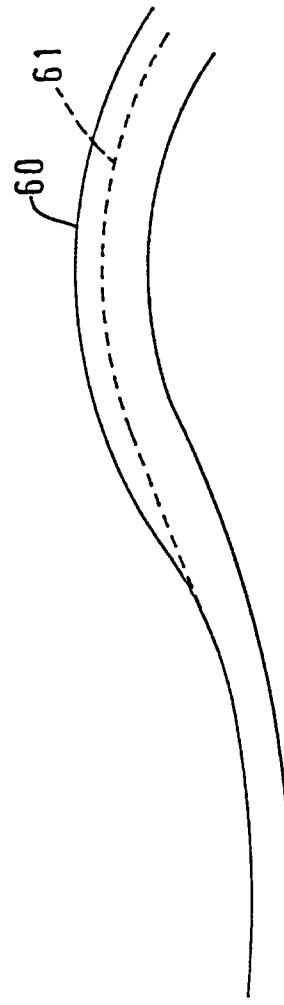


FIG. 22

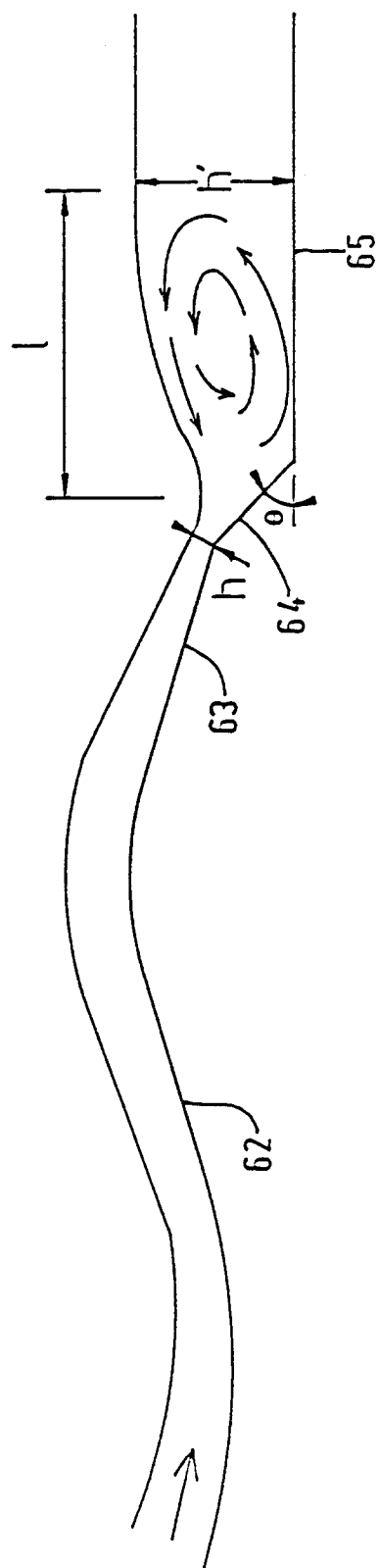


FIG. 23

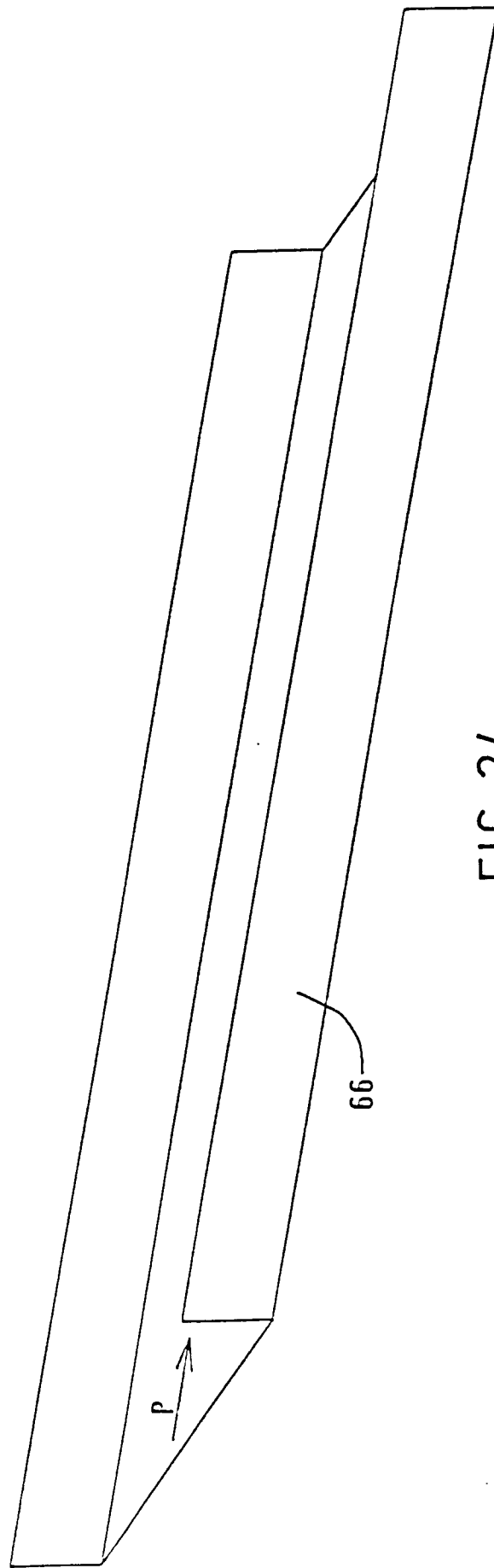


FIG. 24

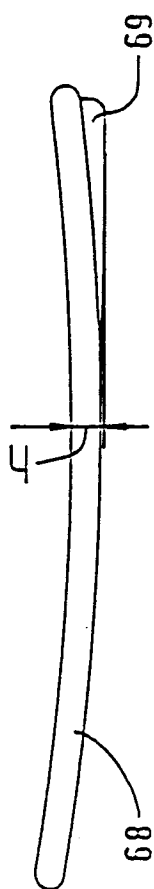


FIG. 26

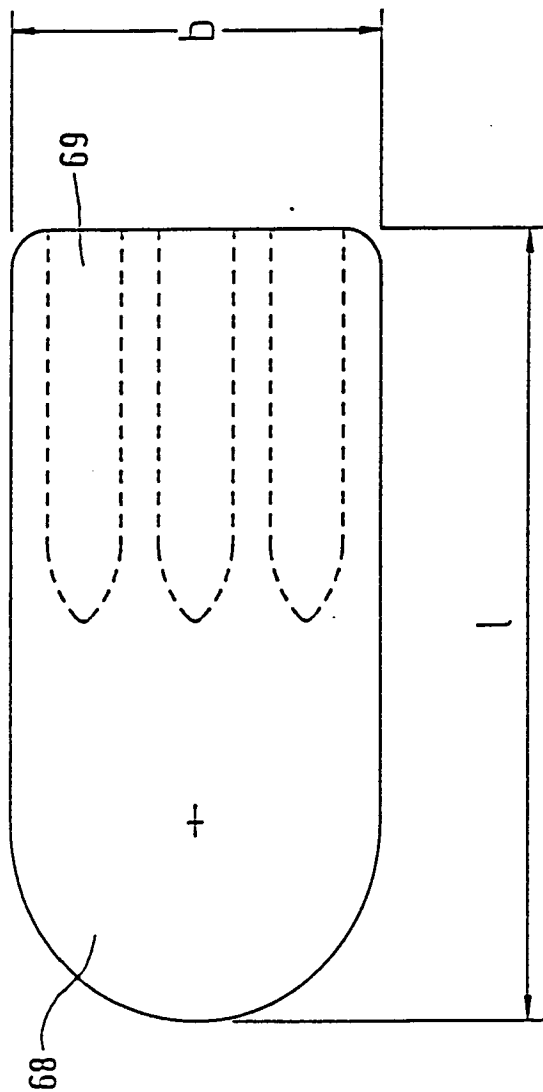


FIG. 25



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 20 3371

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	WO-A-92 03201 (LOCHTEFELD) * page 23, paragraph 1 - page 26, paragraph 1; figures 1C,5F,7A,7B * ---	1-4,12	A63C19/10
A	US-A-3 598 402 (FRENZL) * column 3, paragraph 7 - column 6, paragraph 1; figures 1-7 * ---	1,3,4	
A	US-A-4 954 014 (SAUERBIER ET AL) * figures 9,10 * ---	1	
P,A	WO-A-93 15801 (LIGHT WAVE LTD) ENTIRE DOCUMENT ---	1,10,12, 19,22, 24,25,28	
P,A	WO-A-93 17762 (LIGHT WAVE LTD) ENTIRE DOCUMENT -----	1,10,12, 19,22, 24,25,28	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			A63C A63G
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 7 March 1994	Examiner Steegman, R
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	