

Dynamic artificial wave facility for surfing practice

TECHNICAL FIELD OF THE INVENTION

5 The invention relates to dynamic artificial wave facilities for the practice of surfing.

STATE OF THE ART

 It is known that dynamic artificial waves reproduce natural waves that propagate and must not be confused with static artificial waves which are
10 formed by a layer of water of uniform thickness, for example of the order of 10 cm, projected onto a sloping wall.

 In the present document, it is intended that the references to artificial waves be understood as being directed to dynamic artificial waves and not static artificial waves.

15 There is already known, by French patent application 3 039 421, to which corresponds international application WO 2017/017319, an artificial wave facility for the practice of surfing, comprising:

- a support having an upper surface comprising an edge zone, a wave progression zone and a culminating zone, the wave progression zone
20 extending, in an upward slope, from the edge zone to the culminating zone;
- water situated over said edge zone and said wave progression zone; and
- an artificial wave generator comprising at least one water driving member movable over the edge zone along a predetermined path, said wave
25 generator and said upper surface of the support being configured such that when the wave generator is in use, the movable member is laterally followed by a wave moving in the water towards the wave progression zone in contact with which the generated wave breaks towards the culminating zone;

 Example embodiments of this facility are described below with the
30 aid of Figures 1 to 6 of the accompanying drawings.

 Figure 1 is a view from above of a first embodiment of this facility of which the artificial wave generator is at rest.

Figure 2 is the section view on II-II of Figure 1.

Figure 3 is the section view on III-III of Figure 1.

Figure 4 is a view similar to Figure 1 but with the artificial wave generator in use.

5 Figure 5 is the section view on V-V of Figure 4.

Figure 6 is a similar view to Figure 2 for a second example embodiment of this facility.

The facility 10 illustrated in Figures 1 to 5 comprises a floating platform 11, here with a circular outer contour and an artificial wave generator
10 12 installed on the platform 11.

The platform 11 has an upper surface 14 comprising an edge zone 15, a wave progression zone 16 and a culminating zone 17.

The artificial wave generator 12 comprises four water driving members 20, each movable along a predetermined path 21, which is circular
15 here.

Each mobile member 20 moves over the edge zone 15.

The facility 10 is situated in a body of calm water, with no or very little disturbance such as natural waves. The shore of the body of water is at a distance from the facility 10, which thus forms an island.

20 When the wave generator 12 is at rest, that is to say when the movable members 20 are fixed, the culminating zone 17 is emerged.

In Figures 1 and 4, the limit between the zones that are emerged and immersed when the wave generator is at rest, is represented by a line 18 of mixed dashes.

25 When the wave generator 12 is in use, each mobile member 20 is laterally followed, as can be seen in Figure 4, by a wave 22 moving towards the wave progression zone 16, in contact with which the wave 22 generated breaks towards the culminating zone 17.

30 The platform 11 for example has a diameter of 60 to 80 m or even more and the waves 22 have a height of the order of 2 m for the practice of traditional surfing (surfer standing on a board); while for the practice of surfing lying on an appropriate board (bodyboard), the facility for example has a

diameter of 18 to 22 m or more and the waves 22 have a height of the order of 50 to 60 cm.

Here, the body of water is formed by a sheltered maritime bay or cove.

5 As a variant, the maritime bay or cove is replaced by another body of water in a natural environment, for example a lake or a river if there is not too much current, or in an artificial setting, for example a pond of masonry.

 The aquatic environment 23 (here, the sea) with which cooperate the platform 11 and the wave generator 12 comprises a region 24, called inner
10 aquatic region, situated over the edge zone 15 and the wave progression zone 16.

 In addition to the inner aquatic region 24, the aquatic environment 23 comprises, outside the platform 11 along the edge zone 15, a region 25, called upper outer aquatic region, situated higher than the edge zone 15 and a region
15 26, called deep outer aquatic region, situated lower than the edge zone 15.

 The aquatic environment 23 lastly comprises, below the platform 11, a region 27, called underlying aquatic region.

 The deep outer aquatic region 26 and the upper outer aquatic region 25 are horizontally contiguous.

20 The inner aquatic region 24 and the upper outer aquatic region 25 are vertically contiguous.

 Similarly, the underlying aquatic region 27 and the deep outer aquatic region 26 are vertically contiguous.

25 It is to be clearly understood that the subdivision of the aquatic environment 23 into aquatic regions 24 to 27 is solely based on the location of the regions in question relative to the platform 11, that is to say that the regions 24 to 27 designate locations at which water is to be found and not isolated volumes of water.

30 It will be noted in this connection that there are no liquid-tight walls isolating the different aquatic regions 24 to 27 from each other.

 On the contrary, the water of the aquatic environment 23 (here sea water) flows between the different aquatic regions 24 to 27.

Thus, when the wave generator 12 is at rest, the entire aquatic environment 23 has the same surface level.

In particular, as can be clearly seen in Figures 1 to 3, the surface level of the inner aquatic region 24 is identical to the surface level of the upper outer aquatic region 25.

To protect the surfers against possible marine predators, a grid or net 28 may be provided (shown diagrammatically only on Figures 2, 3 and 5) between the inner aquatic region 24 and the upper outer aquatic region 25. Similarly, a grid or a net (not shown) may be provided around the path 21 to avoid any contact between the movable members 20 and the surfers.

The upper surface 14 of the platform 11 comprises, in addition to the edge zone 15, the wave progression zone 16 and the culminating zone 17, a crest 30 and a depressed zone 31 depressed relative to the crest 30.

The crest 30 is located between the culminating zone 17 and the depressed zone 31. More specifically, the crest 30 is located between the apex of the culminating zone 17 and the apex of the depressed zone 31.

As can be clearly seen in Figures 4 and 5, the culminating zone 17 and the depressed zone 31 are configured such that when the wave generator 12 is in use, the water at the end of travel of the waves 22 gets past the crest 30 and falls into a volume 32 delimited by the depressed zone 31, this volume being called reception volume.

Openings 33 or 39 formed through the platform 11 respectively open into the reception volume 32 and into the underlying aquatic region 27.

The underlying aquatic region 27 provides fluidic communication linking the deep outer aquatic region 26 to the openings 33 or 39, and thus to the reception volume 32.

As can be clearly seen in Figures 2 and 3, this results in the surface level of the reception volume 32 remaining the same for the whole of the aquatic environment 23 when the wave generator 12 is at rest or, as can be clearly seen in Figure 5, the same only for the aquatic environment 23 outside the inner aquatic region 24 when the wave generator 12 is in use.

Thus, when the wave generator 12 is in use, the water at the end of travel of the waves 22 leaves the inner aquatic region 24 by falling into the reception volume 32 from which it is evacuated without passing by the inner aquatic region 24 since the fluidic communication is situated under the platform 11.

The upper outer aquatic region 25 is not disturbed either, or is disturbed very little, since it is the deep outer aquatic region 26 which is in communication with the reception volume 32.

As the inner aquatic region 24, and furthermore the upper outer aquatic region 25, are not therefore disturbed by the backwash, or whatever the case are very little disturbed, it is possible to have a very short time between two successive waves 22.

What is more, the platform 11 is acted on mechanically relatively little by the waves 22 since the water is guided towards the reception volume 32 from which it naturally goes to join the underlying aquatic region 27 which communicates with the deep outer aquatic region 26.

An explanation will now be given of how the platform 11, which is a floating platform as indicated above, is held in place in the aquatic environment 23.

In general terms, the capacity to float of the platform 11 is provided in order for the edge zone 15 to be at a predetermined distance under the surface level of the aquatic environment 23.

This predetermined distance is that which is appropriate for the proper operation of the wave generator 12.

To hold the platform 11 in relation to the bottom 35 of the aquatic environment 23, links 36 such as chains are provided between the platform 11 and moorings 37 placed on the bottom 35.

A pile 38 is also provided which is fastened to the bottom 35 and engaged in a central opening 39 of the platform 11.

When changes in surface level of the platform occur due to the tide, the platform 11 slides relative to the pile 38 and the links 36 retain the platform 11, in particular to avoid it turning around the pile 38.

As a variant, the platform 11 is held differently in relation to the bottom 35, for example solely with links such as 36 or solely with piles such as 38.

Here, the platform 11 is manufactured from composite materials in the manner of the hull wall of a boat.

As a variant, the composite materials are replaced by other materials used for the manufacture of boat hulls, for example aluminum or wood.

To adjust the capacity to float of the platform 11, chambers (not shown) may be provided, which can be filled to a greater or lesser extent with water.

In normal use, the chambers are filled to adjust the capacity to float as has just been indicated, that is to say in order for the edge zone 15 to be at the desired predetermined distance below the surface level of the aquatic environment.

If it is desired for the platform 11 to emerge more, for example for maintenance operations, the chambers are emptied.

If it is desired for the platform 11 to sink down further, for example to rest on the bottom 35 in case of a storm, the tanks are filled.

As a variant, the platform 11 is not a floating platform but is for example supported by pylons fastened to the bottom 35.

In addition to the platform 11 and the wave generator 12, the facility 10 comprises a groin 40 connected to the platform 11.

The groin 40 projects upward from the wave progression zone 16 while extending through the inner aquatic region 24 from the culminating zone 17 towards the edge zone 15.

The groin 40 has an upper surface 41 comprising a first lateral zone 42, a second lateral zone 43 situated on the opposite side to the first lateral zone 42 and an intermediate zone 44 extending from the first lateral zone 42 to the second lateral zone 43.

Here, the intermediate zone 44 comprises a first crest 45 and a second crest 46, each being emerged when the wave generator 12 is at rest.

The intermediate zone 44 also comprises a depressed zone 47 which is depressed relative to the first crest 45 and the second crest 46, the first crest 45 being located between the first lateral zone 42 and the depressed zone 47, the second crest 46 being located between the second lateral zone 43 and the depressed zone 47.

More specifically, the first crest 45 is located between the apex of the first lateral zone 42 and one of the two apexes of the depressed zone 47; and the second crest 46 is located between the apex of the second lateral zone 43 and the other apex the depressed zone 47.

The first crest 45, the second crest 46 and the depressed zone 47 are configured such that when the wave generator 12 is in use, the water at the end of travel of the waves 22 gets past the first crest 45 or the second crest 46 and falls into a volume 48 delimited by the depressed zone 47, hereinafter called reception volume.

Here, the reception volume 48 of the groin 40 and the reception volume 32 of the platform 11 are vertically contiguous.

More specifically here, as can be clearly seen in Figures 1 to 3, the depressed zone 47 which delimits the reception volume 48 has a U-shaped profile and the depressed zone 31 which delimits the reception volume 32 is of frusto-conical general shape with an interruption at the groin 40. The depressed zones 31 and 47 are connected at the location of the interruption.

The crest 30 of the platform 11 is connected at one end to the first crest 45 of the groin 40 and connects at the other end to the second crest 46 of the groin 40.

On the opposite side to that at which it connects to the reception volume 32, the reception volume 48 is open here at the location of the junction between the wave progression zone 16 and the edge zone 15.

The reception volume 48 is thus in fluidic communication with the upper outer aquatic region 25 via the part of the inner aquatic region 24 which is situated over the edge zone 15.

Openings 49, similar to the openings 33, are formed through the lowest part of the wall which forms the depressed zone 47. The openings 49

respectively open into the reception volume 48 and into the underlying aquatic region 27.

The reception volume 48 is thus in fluidic communication, via the underlying aquatic region 27, with the deep outer aquatic region 26.

5 The water at the end of travel of the waves that has fallen into the reception volume 48 is thus evacuated towards the deep outer aquatic region 26 and/or the upper outer aquatic region 25.

 The reception volume 48, on account of the fact that it joins the reception volume 32, is able to participate in the evacuation of the water that
10 has fallen into the reception volume 32.

 The connection between the platform 11 and the groin 40 is created here due to the platform 11 and the groin 40 being a single part, the platform 11 and the groin 40 being manufactured conjointly from composite materials in the manner of a boat hull wall.

15 As a variant, the composite materials are replaced by other materials used for the manufacture of boat hulls, for example aluminum or wood.

 As a variant, the groin 40 is a part added onto the platform 11.

 The wave generator 12 comprises, as indicated above, four water driving members 20, each movable along the predetermined path 21, which is
20 circular here.

 Each movable member 20 moves over the edge zone 15, in the direction shown by arrows in Figure 4, while driving water towards the wave progression zone 16.

 More specifically, each movable member 20 is laterally followed by a
25 wave 22 moving towards the wave progression zone 16. On contact with the wave progression zone 16, the wave 22 breaks towards the culminating zone 17.

 The movable members 20 are disposed on the path 21 while being angularly equidistant.

30 The artificial wave generator 12 is of a well-known type, for example such as that described by U.S. patent 3,913,332.

It will be noted that it is possible to shape the movable members 20 in order for them also to generate waves by moving in the opposite direction to that illustrated in Figure 4.

The facility 10 thus gives surfers the possibility of traveling on waves breaking towards the right or on waves breaking towards the left, according to the direction of movement of the movable members 20.

The upper surface 14 of the platform 11 here comprises, between the edge zone 15, which is horizontal, and the wave progression zone 16, which is inclined, a shoulder zone 50 which is vertical or substantially vertical.

The shoulder zone 50 creates an obstacle to the propagation of the water which has been made to move by the movable member 20, which promotes the quality, for the practice of surfing, of the wave generated before it breaks on the wave progression zone 16.

The groin 40, which is disposed across the inner aquatic region 24, enables a possible current of water turning around the culminating zone 17 to be interrupted.

It will be noted in particular that the waves 22 are stopped by the groin 40; and that after the mobile member 20 has got past the groin 40 a new wave 22 begins in calm water or in any event water which has not been disturbed by the previous wave 22.

The presence of the upper outer aquatic region 25 also promotes the limitation of currents in the inner aquatic region 24.

As a variant, the groin is employed in a facility in which there is no outer aquatic region.

To avoid backwash as much as possible, the first lateral zone 42 of the groin 40, which is that acted upon most by the waves 22 since the movable members 20 turn in the direction in which they approach that lateral zone, is provided with spits 51.

As explained above, the groin 40 also serves for the evacuation of the water at the end of travel of the waves.

To avoid the movable members 20 causing water to enter the reception volume 48, appropriate measures are employed, for example a

shutter which closes the opening towards the outside of the reception volume 48 when the movable member 20 passes in front, or the path 21 is configured in order for the movable members 20 to pass over the surface of the water at that location.

5 As a variant, the groin 40 does not comprise any reception volume 48, for example by having the intermediate zone 44 of its upper surface 41 replaced by a simple crest.

In another variant not shown, the facility 10 does not comprise a groin such as the groin 40.

10 A description will now be given of Figure 6, with reference to the facility 10.

For convenience, for similar parts, the same numerical references have been kept as for the facility 10 illustrated in Figures 1 to 5.

15 In general terms, the facility 10 illustrated in Figure 6 is similar to the facility 10 illustrated in Figures 1 to 5, apart from the fact that the support which provides the upper surface 14 is not a platform situated over an underlying aquatic region but a substrate 55 forming part of the ground and surrounded by an annular pond 56 of which the bottom surface 54 is much lower than the edge zone 15; and the fact that the water of the aquatic environment 23 is treated
20 water, in this case swimming-pool water.

To implement the fluidic communication situated under the upper surface 14 of the support formed by the substrate 55, pipes 57 are formed in the substrate 55. Each pipe 57 opens at one end, by an opening 58, into the reception volume 32 of the substrate 55 and, at the other end, by an opening
25 59, into the deep aquatic region 26.

Here, the substrate 55 and the annular pond 56 are formed by a structure of masonry.

In variants that are not represented:

- the number of mobile members such as 20 of the wave generator
30 such as 12 is different from four, for example only one, two, three or more than four;

- an emerged island is provided in the center of the reception volume such as 32 of the support such as the platform 11 or the substrate 55, for example an island on which are disposed buildings;

- the path such as 21 of the mobile member or members such as 20, and thus the contour of the support such as the platform 11 or the substrate 55 is annular without being circular, for example oval, oblong and/or with undulations; or for instance this path is not annular, but for example straight or curved.

DISCLOSURE OF THE INVENTION

10 The invention is directed to providing an artificial wave facility of the same kind but of which the artificial wave generator provides better performance.

To that end the invention provides an artificial wave facility for the practice of surfing, comprising:

- a support having an upper surface comprising an edge zone, a wave progression zone and a culminating zone, the wave progression zone extending, in an upward slope, from the edge zone to the culminating zone;

- water situated over said edge zone and said wave progression zone;

- an artificial wave generator comprising at least one water driving member movable over the edge zone along a predetermined path, said wave generator and said upper surface of the support being configured such that when the wave generator is in use, the movable member is laterally followed by a wave moving in the water towards the wave progression zone in contact with which the generated wave breaks towards the culminating zone;

25 characterized in that said movable member of the wave generator comprises a body delimiting a water flow chamber open by an inlet opening located at the front and facing forward and by an outlet opening located rearward of the inlet opening and facing the wave progression zone, said body comprising peripheral walls which entirely close said chamber from said inlet opening to said outlet opening except optionally at the side that faces upward.

30 When the wave generator is in use (when the movable member is driven forward along the predetermined path), the only openings of the water

flow chamber by which water passes are the inlet opening and the outlet opening (if there is an opening at the side that faces upward, no water passes through it on account of gravity). Water enters the flow chamber by the inlet opening (since it is at the front and faces forward) and exits the flow chamber by the outlet opening (since it is rearward of the inlet opening). It is thus possible, for example by implementing the advantageous features disclosed below, to form the water ejected by the outlet opening into a jet having homogeneous characteristics, in particular of orientation and velocity value. Given that the outlet opening faces towards the wave progression zone, the water jet ejected by the outlet opening goes towards the wave progression zone, while forming a wave that follows the movable member laterally.

It will be noted that with the generator described in U.S. patent 3,913,332, the water flow is free (there is no peripherally closed chamber for water flow from an inlet opening to an outlet opening) and there cannot therefore be any water jet created with homogeneous characteristics of orientation and velocity, in contrast to the wave generator that the facility according to the invention comprises, which thus provides much better performance in relation to control of the configuration of the waves generated and in relation to energy efficiency.

According to features that are favorable to the performance of the facility according to the invention:

- said peripheral walls of said body delimit, in said water flow chamber, an inlet section extending rearward from said inlet opening and an outlet section extending rearward to said outlet opening, the outlet section being rearward of the inlet section;
- the inlet section is delimited on the side towards the wave progression zone and on the opposite side to the wave progression zone by portions of said peripheral walls which are oriented in the direction of said path, said outlet section being delimited on the opposite side to the wave progression zone and optionally on the side towards the wave progression zone by portions of said peripheral walls which are oriented in an outlet direction forming a predetermined angle of change of direction with said path;

- the inlet section is delimited on the side towards the wave progression zone and on the opposite side to the wave progression zone by portions of said peripheral walls which are oriented in an inclined direction forming an angle of incidence with said path, said inclined direction being oriented rearward and away from the wave progression zone, said outlet section being delimited on the opposite side to the wave progression zone and optionally on the side towards the wave progression zone by portions of said peripheral walls that are oriented in an outlet direction forming a predetermined angle of change of direction with said path.
- said angle of incidence is comprised between 5° and 30° , preferably between 8° and 20° , and more preferably between 10° and 16° ;
- said predetermined change of direction angle is comprised between 20° and 60° , preferably between 25° and 40° , and more preferably between 30° and 35° ;
- the velocity with which said movable member is driven relative to said support is comprised between $\sqrt{gH}$ and $2\sqrt{gH}$, g being the acceleration due to gravity and H being the height of the water over the edge zone;
- the inlet opening is fully immersed whereas the outlet opening is emerged at its vertex;
- said outlet section is only delimited on the opposite side to said wave progression zone, said outlet opening extending in line with said portion of peripheral wall that delimits the inlet section on the side towards the wave progression zone;
- said water flow chamber has a rectangular shape in cross-section;
- said movable member comprises deflection fins disposed in said water flow chamber, each said fin having, in a change of orientation section in which the flow in said water flow chamber passes from the orientation along said path to the orientation in said outlet direction, a general orientation in a direction angularly mid-way between said path and said outlet direction.
- said fins extend for the most part in said change of orientation section;

- said fins extend over a major part of said inlet section, or instead over a major part of said outlet section, or instead over a major part of said inlet section and over a major part of said outlet section;

- said facility comprises an annular drive structure of the movable
5 members that floats;

- said installation comprises thrusters fastened to the annular structure to drive it and/or a fixed driver which turns a roller in contact with the outside surface of the annular structure to drive it; and/or

- at least one said movable member, said annular structure and
10 the fastening between said annular structure and said at least one movable member are configured such that said at least one movable member is retractable into said annular structure.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure of the invention will now be continued with the
15 detailed description of embodiments, given below by way of non-limiting illustration, with reference to the appended drawings.

Figures 1 to 6 illustrate a facility of the state of the art, already described, from which the facility according to the invention differs solely by the arrangement of the movable members of the wave generator.

20 Figure 7 is a view similar to the upper part of Figure 4 but for the facility according to the invention, Figure 7 thus showing in a view from above one of the movable members of the wave generator of the facility according to the invention and the immediate surroundings of that movable member.

Figure 8 is a perspective view of the movable member of Figure 7,
25 viewed from the wave progression zone and from above.

Figure 9 is a similar view to Figure 7 but simplified, in which arrows indicate the respective velocities of the movable member and of the water in its immediate surroundings, relative to the facility support.

Figure 10 is a similar view to Figure 9, except that the velocities are
30 indicated relative to the movable member.

Figure 11 is a diagram showing the relationships between the velocities shown in Figures 9 and 10.

Figure 12 is a view in elevation of the movable member illustrated in Figures 9 and 10, viewed from the wave progression zone, the wave generator being at rest.

Figure 13 is a similar view to Figure 10, but for a variant of the
5 movable member which comprises short deflection fins.

Figure 14 is a view similar to Figure 12 but with the movable member of Figure 13.

Figure 15 is a similar view to Figure 10, but for a variant of the movable member which comprises long deflection fins.

10 Figure 16 is a view similar to Figure 14 but with the movable member of Figure 15.

Figure 17 is a view similar to Figure 12 but for a variant of the movable member which comprises an inlet section delimited by walls portions inclined rearward and upward.

15 Figure 18 is a similar view to Figure 12 but for a variant of the movable member similar to that illustrated in Figure 17 and which further comprises a screen of vanes disposed across its outlet opening, as well as long deflection fins similar to that of the movable member illustrated in Figures 15 and 16.

20 Figure 19 is an elevation view of the movable member illustrated in Figure 18, viewed from the front.

Figure 20 is a similar view to Figure 12 but for a variant of the movable member similar to that illustrated in Figure 18 except that the screen of vanes is arranged differently.

25 Figure 21 is a view similar to Figure 10 but with the movable member of Figure 20.

Figure 22 is a perspective view of a variant of the movable member similar to that illustrated in Figures 15 and 16, and which further comprises portions of inclined walls similar to those of the movable member illustrated in
30 Figure 17, as well as spacers disposed in its inlet section, the view being from the wave progression zone, from the front and from above.

Figure 23 is a similar view to Figure 22, some parts of the movable member having been removed.

Figure 24 is a view from above of the movable member illustrated in Figure 22, without a top peripheral wall which the movable member comprises.

5 Figure 25 is the section view on XXV-XXV of Figure 24.

Figure 26 is a similar view to Figure 15, but for a variant of the movable member in which the spacing between two successive deflection fins is variable.

10 Figure 27 is a similar view to Figure 10 but for a variant of the movable member which is similar to that illustrated in Figures 15 and 16 and which further comprises foldable portions.

Figure 28 is a view from above illustrating a variant of the artificial wave generator which comprises an annular rotary structure to which are fastened the movable members.

15 Figure 29 is a cross-section view of a tubular shell which the annular structure comprises.

Figure 30 is a similar view to Figure 26 but for a variant of the movable member of which the inlet section is delimited on the side towards the wave progression zone and on the opposite side to the wave progression zone by portions of peripheral walls which are not oriented along the predetermined path followed by the movable member but are inclined relative to that path.

DETAILED DESCRIPTION

25 As indicated above, the facility 10' (Figures 7 to 12) according to the invention is identical to the facility 10 illustrated in Figures 1 to 6, apart from the fact that the movable members 20 of the wave generator 12 are replaced by movable members 20' arranged differently.

For convenience, with the exception of numerical references 10' and 20', for similar parts, the same numerical references have been kept as for the facility 10 illustrated in Figures 1 to 6.

30 The movable member 20' of the wave generator 12 comprises a body 60 delimiting a water flow chamber 61 (Figures 8 and 12) open by an inlet opening 62 located at the front and facing forward and by an outlet opening 63

located rearward of the inlet opening 62 and facing towards the wave progression zone 16.

The water flow chamber 61 here has a rectangular shape in cross-section.

5 The body 60 comprises peripheral walls which here fully close the chamber 61 from the inlet opening 62 to the outlet opening 63.

In other words, the only openings of the water flow chamber 61 by which the water passes are the inlet opening 62 and the outlet opening 63.

10 The peripheral walls here are an inside wall 64 which delimits the water flow chamber 61 on the side towards the wave progression zone 16, an outside wall 65 which delimits the flow chamber 61 on the opposite side to the wave progression zone 16, a bottom wall 66 which delimits the flow chamber 61 on the side facing downward, and a top wall 67 which delimits the flow chamber 61 on the side facing upward.

15 In the water flow chamber 61 the peripheral walls 64, 65, 66 and 67 delimit an inlet section 68 and an outlet section 69, the outlet section 69 being rearward of the inlet section 68 (Figure 8).

The inlet section 68 extends rearward from the inlet opening 62.

The outlet section 69 extends rearward to the outlet opening 63.

20 The inlet section 68 is delimited on the side towards the wave progression zone 16 and on the opposite side to the wave progression zone 16 by portions of the peripheral walls which are oriented along the path 21.

Here these are a portion 71 of the inside wall 64, as well as a portion 72 of the outside wall 65.

25 The outlet section 69 is delimited on the opposite side to the wave progression zone 16 by a portion 76 of the outside wall 65 which is oriented in an outlet direction 75 which forms a predetermined change of direction angle, denoted α , with the path 21.

30 Here, the outlet section 69 is not delimited on the side towards the wave progression zone 16.

As a variant, the outlet section 69 is delimited on the side towards the wave progression zone 16 by portions of the peripheral walls that are oriented in the outlet direction 75.

Here, the outlet direction 75 is rectilinear.

5 In addition to the inlet section 68 and the outlet section 69, the peripheral walls 64, 65, 66 and 67 delimit, within the water flow chamber 61, a change of direction section 70 connecting the inlet section 68 to the outlet section 69.

10 The change of direction section 70 is delimited on the opposite side to the wave progression zone 16 by a bent portion 78 of the outside wall 65. The concavity of the bent portion 78 is oriented towards the wave progression zone 16. The bent portion 78 here connects the portion 72 to the portion 76.

15 The change of direction section 70 is delimited on the side towards the wave progression zone 16 by a bent portion 77, of which the concavity is oriented towards the wave progression zone 16. The bent portion 77 here connects the portion 71 to the edge of the outlet opening 63.

The top and bottom walls 67 and 66 here are each planar and oriented generally horizontally, as can be seen in Figure 12.

20 Water flows in the chamber 61 first in the inlet section 68 then in the change of direction section 70 then in the outlet section 69.

In the change of direction section 70, the water flow has an orientation which passes from the orientation it has in the inlet section (along the path 21) to the orientation it has in the outlet section 69 (along the outlet direction 75).

25 In the example of Figures 7 and 8, the walls 77 and 78 are curved. As a variant, the change of direction section 70 is delimited differently on the side towards the wave progression zone 16 and on the opposite side to the wave progression zone 16, for example the walls 72 and 76 are attached directly to each other (no curved wall such as 78 is provided between them)
30 while the wall 71 extends to the outlet opening 63 (no curved wall such as 77 is provided), the change of direction section 70 then being entirely open on the side towards the wave progression zone 16 and delimited on the opposite side

to the wave progression zone 16 by the walls 72 and 76 in the vicinity of their attachment.

In the example of Figures 7 and 8, the walls 71 and 72 are curved. As a variant, as illustrated in particular in Figures 9 and 10, the walls 71 and 72 are planar.

The operation of the movable member 20' will now be described in reference to Figures 9 to 12.

To simplify, it has been considered that in this drawings the path 21 is rectilinear.

This assumption moreover corresponds to an approximation which can be implemented if the diameter of the path 21 is sufficiently great, for example at least to 50 m.

Below, unless explicitly stated otherwise, it will thus be considered that the path 21 is rectilinear.

To simplify Figures 9 and 10, the outlet direction 75 has not been shown and the angle α is indicated between the path 21 and the wall 76 (which is oriented in the outlet direction 75).

Figure 9 shows the movable member 20' and its immediate surroundings when the wave generator 12 is in use.

The arrows 79 and 80 respectively indicate the velocity of the movable member 20' and the velocity of the water ejected from the flow chamber 61 by the outlet opening 63, each relative to the support 11 or 55 of the facility 10'.

It will be noted that the arrows 79 and 80 indicate not only the orientation and the direction of the velocity, but that their length furthermore represents the value of the velocity.

When the wave generator 12 is in use, the movable member 20' is driven forward along the predetermined path 21 at a predetermined velocity relative to the support 11 or 55 of the facility 10'.

Water enters the flow chamber 61 by the inlet opening 62 (since it is at the front and faces forward) and exits the flow chamber 61 by the outlet opening 63 (since it is rearward of the inlet opening 62).

The body 60 thus guides the water flow in the manner of a bend in piping.

Here, the body 60 is configured by applying the rules known to the person skilled in the art in relation to dimensioning bends in piping such that the
5 water flows homogenously or approximately so at the outlet opening 63.

The water ejected by the outlet opening 63 is thus formed into a jet having homogenous characteristics, in particular of orientation and velocity value.

Given that the outlet opening 63 faces towards the wave progression
10 zone 16, the water jet ejected by the outlet opening 63 goes towards the wave progression zone 16, while forming a wave 22 (Figure 4) that follows the movable member 20' laterally.

Figure 10 is a similar view to Figure 9, but in which the arrows 81 and 82 respectively indicate the velocity of the water that enters the flow chamber
15 61 by the inlet opening 62 and the velocity of the water which is ejected from the flow chamber 61 by the outlet opening 63, each relative to the movable member 20'.

Prior to the passage of the movable member 20' the water over the support 11 or 55 is immobile relative to the support 11 or 55.

20 Water thus enters the flow chamber 61 with a velocity 81 relative to the movable member 20' of which the value is the same is that of the velocity 79 at which the movable member 20' moves relative to the support 11 or 55.

It is assumed that the flow cross-section remains constant from the inlet opening 62 to the outlet opening 63 and that the flow velocity thus
25 maintains the same value.

The velocity value 81 of the water at the inlet opening 62 is thus the same as the velocity value 82 of the water at the outlet opening 63.

Since the velocity value 81 of the water is the same as the velocity value 79 of the movable member 20' the velocity value 82 of the water is also
30 the same as the velocity value 79 of the movable member 20'.

Since the portions of the peripheral walls that delimit the outlet section 69 are oriented in the outlet direction 75, the velocity of the water that

exits the flow chamber 61 has the same orientation, relative to the movable member 20' as those peripheral walls, that is to say the same orientation as the outlet direction 75.

The velocity 82 is thus oriented in the outlet direction 75.

5 An explanation will now be given using the diagram of Figure 10 of what the velocity 80 of the water jet is through the outlet opening 63 of the movable member 20' according to the velocity 79 of movement of the movable member 20' relative to the support 11 or 55 and of the angle α .

10 According to the law of resultant velocity, the velocity 80 of the water jet relative to the platform 11 is equal to the (vector) sum of the velocity 82 of the water jet relative to the movable member 20' and of the velocity 79 of the movable member 20' relative to the support 11 or 55.

In Figure 11, this sum is represented schematically by the arrangement of the velocities 82, 79 and 80 in a triangle, which is isosceles
15 since the value of the velocity 82 is the same as the value of the velocity 79.

It can be seen that the velocity 80 of the water jet is oriented relative to the support 11 or 55 in a direction forming an angle $\alpha/2$ forward relative to a direction 84 perpendicular to the path 21.

20 It can furthermore be shown that the value of the velocity 80 of the water jet relative to the support 11 or 55 is $2\tan(\alpha/2)$ times that of the velocity 82 of the water relative to the movable member 20'.

However, as indicated above, the value of the velocity 82 is the same as the value of the velocity 79.

25 In other words, the value of the velocity 80 of the water jet relative to the support 11 or 55 has a value of $2\tan(\alpha/2)$ times the value of the velocity 79 of the movable member 20' relative to the support 11 or 55.

For example, if $\alpha = 30^\circ$, the value of the velocity 80 of the water jet relative to the support 11 or 55 is 0.54 times the value of the velocity 79 of the movable member 20'.

30 The angle of in direction change α must therefore be (i) sufficiently great in order for the value of the velocity 80 to enable a wave to be generated having the features required for the practice for surfing; and (ii) sufficiently small

for the direction of the velocity 80 to stay close to the direction 84 perpendicular to the path 21, in order to enable good propagation of the wave 22 towards the wave progression zone 16.

It is shown by the studies carried out by the inventors that it is
 5 advantageous for the angle of direction change α to be comprised between 20° and 60° , preferably between 25° and 40° , and more preferably between 30° and 35° .

Moreover, it is advantageous for the velocity of movement of the
 movable member 20' to be greater than the velocity of propagation of the waves
 10 in the region of the aquatic environment 23 that is located over the edge zone 15, in particular to obtain a wave 22 under good conditions that follows the movable member 20'.

The assumption can be made that the wave 22 is a surface wave of small amplitude propagating in a medium of small depth.

15 The velocity of propagation of these waves is then $c = \sqrt{gH}$, g being the acceleration due to gravity at the surface of the Earth (of which the conventional value is approximately equal to 9.81 m/s^2) and H is the height of the water over the edge zone 15 (distance between the edge zone 15 and the surface of the water, shown in Figure 12).

20 For example, if $H=1.5 \text{ m}$, then $c = \sqrt{9.81 \times 1.5} = 3.84 \text{ m/s}$ i.e. 13.8 km/h or 7.46 knots .

It is thus advantageous for the value of the velocity 79 of the movable member 20' relative to the support 11 or 55 to be at least equal to $\sqrt{gH}$.

It is also advantageous for the value of the velocity 79 of the movable
 25 member 20' relative to the support 11 or 55 to be sufficiently small for the wave 22 to be suitable.

It is shown by the studies conducted by the inventors that it is advantageous for the velocity with which the movable member 20' is driven relative to the support 11 or 55 to be comprised between $\sqrt{gH}$ and $2\sqrt{gH}$, that
 30 is to say between $3.13\sqrt{H}$ and $6.26\sqrt{H}$, and preferably less than $1.5\sqrt{gH}$, that is to say preferably less than $4.70\sqrt{H}$.

It will be noted that if the diameter of the path 21 is not sufficiently great to make the approximation that the path 21 is rectilinear, for example less than 50 m, it is advantageous for the inlet section 68 to be generally curved, as shown in Figures 7 and 8, the center of curvature being the same as that of the path 21. The portions 71 and 72, which delimit the inlet section 68, are thus generally curved, which enables these portions 71 and 72 each to be oriented as well as possible along the path 21 throughout the inlet section 68.

Figures 13 and 14 illustrate a variant of the movable member 20' which is identical to the movable member 20' shown in Figures 7 to 12 except that it further comprises deflection fins 85.

It will be noted that to simplify, the deflection fins 85 have been drawn in solid line in Figure 13, whereas they should have been not dashed line since they are under the top peripheral wall 67.

The deflection fins 85 are disposed in the change of direction section 70 in which the flow inside the chamber 61 passes from the orientation along the path 21 (the orientation which the flow has in the inlet section 68)) to the orientation in the outlet direction 75 (the orientation which the flow has in the outlet section 69).

Each fin 85 is formed by an upright wall extending over the whole height of the chamber 61 (that is to say from the top wall 67 to the bottom wall 66) between a front edge 86 facing towards the inlet opening 62 and a rear edge 87 facing towards the outlet opening 63. Between the front edge 86 and the rear edge 87, the fins 85 have a general orientation in a direction angularly situated between the path 21 and the outlet direction 75, here angularly mid-way (the angular spacing between this direction and the path 21 or the direction 75 is of the order of $\alpha/2$).

Here, the fins 85 are identical and disposed parallel to each other with a regular pitch along a direction angularly mid-way between a direction transverse to the path 21 and a direction transverse to the outlet direction 75 and passing by the point of intersection between the path 21 and the outlet direction 75.

It will be noted that the fins 85 are relatively short here, according to their direction of transverse extension, that is to say in the direction of water flow in the movable member 20'.

In particular, the fins 85 do not extend, or extend little, in the inlet
5 section 68 and do not extend, or extend little, in the outlet section 69.

By virtue of the fins 85, it is as though the flow in the chamber 61 was sub-divided into a plurality of distinct flows, passing respectively between two neighboring fins 85, between the inside peripheral wall 64 and the neighboring fin 85 and between the outside wall 65 and the neighboring fin 85.

10 In the example illustrated in Figures 13 and 14, in which there are seven fins 85, it is as though the flow in the chamber 61 was sub-divided into eight distinct flows.

It is known that a rule for dimensioning bends in piping in order for the water to flow evenly or approximately so is that the sum of the length of the
15 inlet section and of the length of the outlet section may be selected according to the flow cross-section.

The fact that by virtue of the fins 85 it is as though there were eight distinct flows thus makes it possible to considerably reduce the sum of the length of the inlet section and of the length of the outlet section, and thus have a
20 body 60 that is particularly compact.

For example, by adding the seven fins 85, it is possible to have for the body 60 a width (greatest transverse dimension, here the distance between the walls 64 and 65)) which is 1.20 m and a length (greatest longitudinal dimension, here the longitudinal dimension of the face of the body 60 that faces
25 the wave progression zone 16) which is 3 m.

Here, each fin 85 is curved and shaped as a lift-giving wing with a leading edge formed by its front edge 86, a trailing edge formed by its back edge 87, an intrados face 88 facing towards the wave progression zone 16 and an extrados face 89 facing towards the opposite side to the wave progression
30 zone 16, the extrados face 89 here having a developed length greater than the developed length of the intrados face 88.

As a variant, the fins are shaped differently, for example by being curved with uniform thickness or planar.

Figures 15 and 16 illustrate a variant of the movable member 20' which is similar to the variant of the movable member 20' illustrated in Figures 13 and 14 except that its deflection fins 90 are of constant thickness and extend over the whole length of the water flow chamber 61, that is to say from the inlet opening 62 to the outlet opening 63, such fins 90 being referred to below as long deflection fins.

The portions of the long fins 90 located in the inlet section 68 are oriented along the path 21, while the portions of the long fins 90 located in the outlet section 69 are oriented in the outlet direction 75. The portions of the long fins 90 located in the change of direction section 70 have a general orientation in a direction that is angularly between the path 21 and the outlet direction 75, here angularly mid-way like the short fins 85.

The long fins 90 make it possible to have a body 60 that is particularly compact, for the same reasons as for the short fins 85. The long fins 90 extending over the whole length of the chamber 61 provides homogeneity of flow that is particularly high and thus a water jet ejected by the outlet opening that is particularly homogenous.

As a variant, the fins 90 do not extend over the whole length of the chamber 61 but only over part of the inlet section 68 and/or part of the outlet section 69.

The movable member 20' illustrated in Figures 15 and 16 here comprises four long fins 90.

As a variant, the movable member 20' comprises less than four long fins such as 90, for example one, two or three, or comprises more than four long fins, for example five, six (Figures 22 to 24) or thirteen (Figure 19).

It will be noted that in the examples of the movable member 20' described above, the openings 62 and 63 are at the same level and are furthermore each fully immersed (Figure 12).

Figure 17 illustrates a variant of the movable member 20' which is identical to the movable member 20' illustrated in Figures 7 to 10 and 12,

except that the portions of the top and bottom walls 67, 66 which delimit the inlet section 68 are each oriented in a direction inclined rearward and upward.

The outlet opening 63 is thus positioned higher than the inlet opening 62.

5 Here, the movable member 20' is disposed in the aquatic environment 23 such that the inlet opening 62 is fully immersed whereas the outlet opening 63 is emerged at its apex.

This configuration is favorable for the quality of the wave 22, for the practice of surfing, in particular concerning its power and its form.

10 Figures 18 and 19 illustrate a variant of the movable member 20' which is identical to the variant of the movable member illustrated in Figure 17 except that a screen of vanes 92 is provided, disposed across its outlet opening 63, as well as long deflection fins 90 similar to those of the movable member illustrated in Figures 15 and 16.

15 The screen of vanes 92 comprises a plurality of vanes 93 which are oriented in a lying-down direction, here horizontal. Here, the vanes 93 are inclined towards wave progression zone 16 and downward, so as to direct downwardly the water jet ejected by the outlet opening 63. The vanes 93 are fixed here relative to the movable member 20'.

20 As a variant, the vanes such as 93 are rotatably mounted such that their inclination towards the wave progression zone 16 is adjustable upward or downward.

The screen of vanes 92 is favorable for the quality of the wave 22, for the practice of surfing, in particular concerning its power and its form.

25 The possibility of changing the orientation of the vanes 93 of the screen of vanes 92 enables the configuration of the wave 22 to be adjusted, in particular its thickness.

30 Figures 20 and 21 illustrate a variant of the movable member 20' which is similar to that illustrated in Figures 18 and 19 except that the long deflection fins 90 are fewer and that the vanes 98 are oriented in an upright direction, here vertical.

The vanes 98 are rotatably mounted here, such that their inclination towards the wave progression zone 16 is adjustable forward or rearward, which makes it possible to vary the orientation and velocity of braking of the wave 22 produced by the movable member 20'.

5 Here the vanes 98 are inclined towards the wave progression zone 16 and rearward.

In variants not illustrated, a screen of vanes such as 92, with vanes that are upright or lying-down such as 93 or 98, is provided on a movable member that is configured differently to that illustrated in Figure 17, for example
10 on a movable member such as that illustrated in Figures 7 to 10 and 12, or in Figures 13 and 14, or in Figures 15 and 16, or for instance in Figures 22 to 25 a description of which will now be given.

Figures 22 to 25 illustrate a variant of the movable member 20' which is similar to the movable member 20' illustrated in Figures 7 to 10 and 12,
15 except that it is provided with long deflection fins 90, with an inlet section 68 delimited by inclined walls above and below similar to those of the movable member illustrated in Figure 17, and with spacers 94.

The spacers 94 are formed here by planar walls which are each oriented transversely to the inside peripheral wall 64 and to the outside
20 peripheral wall 65 and which here extend rearward from the inlet opening 62.

As can be seen in Figure 25, the spacers 94 here extend over approximately $\frac{2}{5}$ of the length of the inlet section 68.

As a variant, the spacers 94 extend over a greater length, or possibly over the whole length of the chamber 61. By way of further variant, the spacers
25 94 are disposed differently, for example only in the change of direction section 70, only in the outlet section 69 or at the same time in the outlet section 69 and in the inlet section 68 and/or the change of direction section 70.

Each spacer 94 extends here from the outside peripheral wall 65 to the inside peripheral wall 64 (this wall 64, as well as the deflection fin 90
30 juxtaposed against it, have been removed in Figure 23).

The spacers 94 are mechanically connected to the peripheral walls 64 and 65 as well as to the fins 90 at the location of their intersection. The

spacers 94 thus make it possible to stiffen the movable member 20' and in particular to limit the vibrations of the fins 90 when the water flows within the chamber 61. Here, as explained below, the spacers 94 promote the homogeneity of the flow.

5 The spacers 94 are evenly distributed between the top peripheral wall 67 (this wall 67 has been removed in Figure 23) and the bottom peripheral wall 66, and are each oriented in a respective direction inclined rearward and upward. Here, the spacers 94, as well as the portions of the top and bottom walls 67 and 66 opposite which the spacers 94 are located, are each oriented in
10 the same direction.

 By virtue of the spacers 94, it is as though the flow in the chamber 61 was sub-divided into a plurality of distinct flows, passing respectively between two neighboring spacers 94, between the bottom peripheral wall 66 and the neighboring spacer 94 and between the top peripheral wall 67 and the
15 neighboring spacer 94.

 For reasons similar to those set out above but for the change of orientation between a horizontal direction and a direction inclined rearward and upward, the spacers 94 make it possible simultaneously to have a homogenous flow and an inlet section of the chamber 61 that is particularly compact.

20 It will be noted here that the movable member 20' comprises 6 deflection fins 90.

 The spacers 94 and the deflection fins 90 are arranged here so as to form a grid.

 As clearly visible in Figure 22, the inlet opening 62 and the outlet opening 63 here each have a respective rectangular shape. Here, the inlet opening 62 is elongated in a substantially vertical direction while the outlet opening 63 is elongated in a substantially horizontal direction.
25

 Figure 26 illustrates a variant of the movable member 20' similar to that illustrated in Figures 15 and 16, except that the spacing between two successive deflection fins 90 progresses, here geometrically, increasing from
30 the inside wall 64 towards the outside wall 65.

Figure 27 illustrates a variant of the movable member 20' similar to that illustrated in Figures 15 and 16 except that its outside wall 65 and the long deflection fin 90 closest to it each have a portion 29 foldable into the water flow chamber 61.

5 Each portion 29 is connected to the rest of the outside wall or the fin 90 by a hinge 95.

Each portion 29 is configured to have a position folded into the chamber 61, in which its distal end (the opposite end to the hinge 95) comes into contact with the fin 90 located immediately after it in the direction towards
10 the inside wall 64, so as to (i) interrupt the fluidic communication between the inlet section 68 and the outlet section 69 in the portions of the chamber 61 that are delimited by the outside wall 65 and the fin 90 closest to it, and (ii) enable fluidic communication between the inlet section 68 and the openings 99
15 29 are folded. The water that has entered the compartment of the chamber 60 located between the wall 65 and the closest fin 90 as well as in the compartment located between that fin 90 and the neighboring fin is thus ejected rearward from the body 60.

Therefore, when the portions 29 are folded, the water jet ejected by
20 the outlet opening 63 has a lower throughput.

It is thus possible to selectively modify the configuration of the wave 22, by folding the two portions 29, a single portion 29 or no portion 29.

In particular, it is thus possible to selectively modify the thickness of the wave 22 (distance between its front face and its back face).

25 As a variant, only the outside wall such as 65 comprises a foldable portion such as 29. As a further variant, several deflection fins such as 90 comprise a foldable portion such as 29.

The driving of the movable member 20' along the path 21 is carried out as described in U.S. patent 3,913,332.

30 As a variant, as shown in Figure 22, the movable member 20' has at its top a mounting lug 96 fastened to the body 60 and projecting from the top

wall 67. The mounting lug 96 is connected to a drive structure (not illustrated) arranged in the manner of a merry-go-round.

As a variant, the lug 96 is positioned differently, for example the lug 96 projects from the outside peripheral wall 65, or for instance the movable
5 member comprises several mounting lugs such as 96.

The lug 96 is an elongate member of rectangular cross-section here.

As a variant, the lug has a cross-section of a different shape, in particular to be more hydrodynamic, for example in the form of a wing of which the opposite extrados and intrados faces are symmetrical.

10 Figures 28 and 29 illustrate a variant in which the drive structure arranged in the manner of a merry-go-round (to which the movable member 20' connects) is replaced by an annular structure 100.

To the annular structure 100 there are fastened thrusters 101 configured to rotate it while maintaining the same centering as the path 21, so
15 driving the movable members 20' along the path 21.

The annular structure 100 floats here.

For this, the annular structure 100 comprises a tubular shell 102 the internal space 103 of which is filled with air here (Figure 29).

As a variant, the internal space 103 is at least partly filled with a
20 material of low density, for example foam.

The annular structure 100 has a diameter of approximately 100 m here.

The support 11 or 55 to use with this generator 12 of course has a diameter adapted accordingly.

25 The tubular shell here has a diameter of approximately 1.0 m.

As a variant, the diameter of the tubular shell is different, for example comprised between 1.0 and 1.5 meters, or optionally more.

The thrusters 101, which are four in number here, are disposed along the annular structure 100 while being angularly equidistant. The thrusters 101
30 are configured here to cooperate with the aquatic environment and are thus immersed. The thrusters comprise propellers here, which may or may not be faired.

The thrusters 101 are for example arranged in the manner of a thruster for a jet ski.

Batteries or fuel tanks, for example of hydrogen to supply a fuel cell itself supplying the electric motors of the thrusters, may be carried on the
5 annular structure 100.

As a variant, the energy is provided to the motors from the exterior, for example by virtue of catenaries carried by poles 104 disposed externally to the annular structure 100.

As a variant, rollers are provided on poles such as 104 to guide the
10 annular structure 100.

To limit the resistance to advancement of the annular structure, hydrofoils may be provided in order to lift the structure 100 when it moves at its cruising speed.

These hydrofoils may be orientable in order to vary the position
15 height-wise of the structure 100 when it is at cruising speed, and thus vary the configuration of wave 22.

It is also possible to provide rudders and/or stabilizer fins to promote the holding of the annular structure 100 to its path.

The thrusters may of course be associated with the hydrofoils,
20 rudders and/or stabilizer fins.

The annular structure 100 and the thrusters 101 are configured here to turn clockwise.

As a variant, at least one thruster such as 101 is configured to cooperate with the medium of the air and is thus emerged, such a thruster for
25 example comprising a turbine, a sail, or a rotary cylindrical structure configured to use the Magnus effect.

As a variant, the number of thrusters is less than four, for example one, two or three thrusters, or greater than four, for example five or six.

As a variant, the thrusters are configured to turn the annular structure
30 anticlockwise, the movable members being configured accordingly.

As a variant, the thrusters carried by the annular structure 100 are replaced by a fixed driver and by a transmission, for example a geared motor

which turns a roller in contact with the outside surface of the annular structure 100 or else a pump which produces a jet of water directed onto blades present on the outside surface of the annular structure 100.

As a variant, the movable member or members 20', the annular structure 100 and the fasteners between the annular structure 100 and the movable member or members 20' are configured in order for the movable member or members 20' to be able to be retracted into the annular structure 100. It is thus possible to operate the facility with zero, one or several waves following the number of movable members implemented outside the annular installation 100.

As a variant, the movable member or members 20', the annular structure 100 and the fasteners between the annular structure 100 and the movable member or members 20' are configured in order for the movable member or members 20' not to project inside the annular structure 100. The safety of users is thus improved simply and conveniently.

As a variant, in the same way as for the platform 11, box structures (not shown) that can be filled with water are provided for the annular structure 100 to rest the annular structure 100 on the bottom in case of a storm.

Of course, in other variants, the features of the variants disclosed above are combined.

It will be noted that the annular structure 100 is also suitable as a drive structure for the movable members of a wave generator different from the movable members 20', for example such as described by U.S. patent 3,913,332.

Figure 30 illustrates a variant of the movable member 20' similar to that illustrated in Figure 26, except that the inlet section 68 is delimited on the side towards the wave progression zone and on the opposite side to the wave progression zone by portions 71 and 72 of peripheral walls which are not oriented along the predetermined path 21 followed by the movable member 20' but in an inclined direction 105 forming a predetermined angle of incidence, denoted i , with the path 21.

More specifically, the inclined direction 105 is oriented rearward and away from the wave progression zone 16.

Although surprising, it is shown by the studies carried out by the inventors that such an inclination facilitates the entry of water into the water flow chamber 61, and thus promotes the quality of the wave obtained and the energy efficiency of the facility.

It appears that the entry of water into the chamber 61 is thus facilitated because when the wave generator is in use, bypassing of the movable member by the surrounding water occurs as shown in Figure 30 by the arrow lines 106, in particular because of the obstacle constituted to the surrounding water by the water jet exiting the flow chamber 61.

This bypassing already occurs upstream of the movable member 20' which induces an orientation of the water in the inclined direction 105.

It is shown by the studies carried out by the inventors that it is advantageous for the angle of incidence i to be comprised between 5° and 30° , preferably between 8° and 20° , and more preferably between 10° and 16° .

It will be noted that in the variant illustrated in Figure 30, the number of deflection fins 90 is three whereas it is four for the variant illustrated in Figure 26. In variants not illustrated, the number of fins 90 is different from three or four, for example two or five.

The fact that the inlet section 68 is delimited on the side towards the wave progression zone and on the opposite side to the wave progression zone by portions 71 and 72 of peripheral walls which are not oriented along the predetermined path 21 followed by the movable member 10' but in an inclined direction 105 forming a predetermined angle of incidence with the path 21, generally applies to all the embodiments of the movable member 20'.

It will be noted that in the illustrated examples, except in Figures 7 and 8, the outlet section 69 is delimited only on the opposite side to the wave progression zone 16, the outlet opening 63 extending in line with the portion 64 of peripheral wall that delimits the inlet section 68 on the side towards the wave progression zone 16.

Thus, the body 60 does not have any projection on the side towards the wave progression zone, which is favorable to its hydrodynamic qualities.

In a variant not illustrated, spacers such as the spacers 94 are mechanically connected to the short deflection fins such as 85.

5 In another variant not illustrated, the facility 10' comprises a screen of vanes similar to the screen of vanes 92 described above except that it is not fastened to the movable member 20' but to the support 11 or 55; such as screen of vanes projecting upward from the edge zone 15 and being positioned so as to be passed along on its side that faces away from the wave progression zone by the movable member 20' when the wave generator 12 is in use; such a
10 screen of vanes being disposed along at least one portion of the path 21, along several portions of the path 21, or along the whole path 21.

 In another variant not illustrated, the artificial wave facility such as 10' comprises another support, similar to the support such as 11 or 55 but of which
15 the upper surface is arranged as a mirror image of the upper surface of the support such as 11 or 55; and the artificial wave generator such as 12 comprises another movable member, similar to the movable member such as 20' but of which the arrangement is a mirror image of the movable member such as 20'; and with the water located over the edge zone and the wave
20 progression zone of that other support; such that when the wave generator is in use, the other movable member is followed laterally by another wave, similar to the wave such as 22 but of which the movement in the water and the breaking are the mirror image of the movement and of the breaking of the wave such as 22. Advantageously, that other movable member and the movable member
25 such as 20' are disposed side by side and are fastened to each other.

 It will be noted that in all the embodiments described above, the movable member 20' and more specifically its body 60, is configured in order for the flow of water in the chamber 61 to be entirely passive, that is to say taking place simply on account of the fact that movable member 20' is driven along
30 the path 21. In variants not illustrated, the movable member 20' is configured in order for the water flow in the chamber 61 to be at least partly passive, that is to say that part of the flow is due to an active member such as an integrated

pump; and preferably is configured such that the water flow in the chamber 61 is for the most part active.

In other variants not illustrated:

- the water flow chamber may be open on the side that faces upward, that is to say that the peripheral walls only optionally close the water flow chamber on the side that faces upward, for example if the movable member has no top peripheral wall;
- the outlet section such as 69 is not straight but generally curved, the portions of the peripheral walls delimiting it, such as the portion 76, being curved;
- the cross-section of the flow chamber may be different from rectangular, for example oval, circular or triangular; and/or
- in the facility 10, turbines are provided to recover energy from the water exiting the reception volume 32 or 48, for example at the location of the openings 33, 39, 49 or 58; these turbines for example being Kaplan turbines.

More generally, the invention is not limited to the examples described and illustrated.

CLAIMS

1. Artificial wave facility for the practice of surfing, comprising:
 - a support (11 ; 55) having an upper surface (14) comprising an edge zone (15), a wave progression zone (16) and a culminating zone (17), the wave progression zone (16) extending, in an upward slope, from the edge zone (15) to the culminating zone (17);
 - water situated over said edge zone (15) and said wave progression zone (16);
 - an artificial wave generator (12), comprising at least one water driving member movable over the edge zone (15) along a predetermined path (21), said wave generator (12) and said upper surface (14) of the support (11 ; 55) being configured such that when the wave generator (12) is in use, the movable member is laterally followed by a wave (22) moving in the water towards the wave progression zone (16) in contact with which the generated wave (22) breaks towards the culminating zone (17);

characterized in that said movable member (20') of the wave generator (12) comprises a body (60) delimiting a water flow chamber (61) open by an inlet opening (62) located at the front and facing forward and by an outlet opening (63) located rearward of the inlet opening (62) and facing the wave progression zone (16), said body (60) comprising peripheral walls (64, 65, 66, 67) which entirely close said chamber (61) from said inlet opening (62) to said outlet opening (63) except optionally at the side that faces upward.
2. Facility according to claim 1, characterized in that said peripheral walls (64, 65, 66, 67) of said body (60) delimit, in said water flow chamber (61), an inlet section (68) extending rearward from said inlet opening (62) and an outlet section (69) extending rearward to said outlet opening (63), the outlet section (69) being rearward of the inlet section (68).
3. Facility according to claim 2, characterized in that the inlet section (68) is delimited on the side towards the wave progression zone (16) and on the opposite side to the wave progression zone (16) by portions (71, 72) of said peripheral walls (64, 65, 66, 67) which are oriented in the direction of said path (21), said outlet section (69) being delimited on the opposite side to

the wave progression zone (16) and optionally on the side towards the wave progression zone (16) by portions (76) of said peripheral walls which are oriented in an outlet direction (75) forming a predetermined angle (α) of change of direction with said path.

5 4. Facility according to claim 2, characterized in that the inlet section (68) is delimited on the side towards the wave progression zone (16) and on the opposite side to the wave progression zone (16) by portions (71, 72) of said peripheral walls (64, 65, 66, 67) which are oriented in an inclined direction (105) forming an angle of incidence (i), with said path (21), said
10 inclined direction (105) being oriented rearward and away from the wave progression zone (16), said outlet section (69) being delimited on the opposite side to the wave progression zone (16) and optionally on the side towards the wave progression zone (16) by portions (76) of said peripheral walls that are oriented in an outlet direction (75) forming a predetermined angle (α) of change
15 of direction with said path.

5. Facility according to claim 4, characterized in that said angle of incidence (i) is comprised between 5° and 30° , preferably between 8° and 20° , and more preferably between 10° and 16° .

6. Facility according to any one of claims 3 to 5, characterized in
20 that said predetermined change of direction angle (α) is comprised between 20° and 60° , preferably between 25° and 40° , and more preferably between 30° and 35° .

7. Facility according to any one of claims 1 to 6, characterized in that the velocity (79) with which said movable member (20') is driven relative to
25 said support (11 ; 55) is comprised between $\sqrt{gH}$ and $2\sqrt{gH}$, g being the acceleration due to gravity and H being the height of the water over the edge zone (15).

8. Facility according to any one of claims 1 to 7, characterized in that said outlet section (69) is only delimited on the opposite side to said wave
30 progression zone (16), said outlet opening (63) extending in line with said portion (71) of peripheral wall (64) that delimits the inlet section (68) on the side towards the wave progression zone (16).

9. Facility according to any one of claims 1 to 8, characterized in that said water flow chamber (61) has a rectangular shape in cross-section.

10. Facility according to any one of claims 1 to 9, characterized in that said movable member (20') comprises deflection fins (85, 90) disposed in
5 said water flow chamber (61), each said fin (85, 90) having, in a change of orientation section (70) in which the flow in said water flow chamber (61) passes from the orientation along said path (21) to the orientation in said outlet direction (75), a general orientation in a direction angularly mid-way between said path (21) and said outlet direction (75).

10 11. Facility according to claim 10, characterized in that said fins (85) extend for the most part in said change of orientation section (70).

12. Facility according to claim 10, characterized in that said fins (90) extend over a major part of said inlet section (68), or instead over a major part of said outlet section (69), or instead over a major part of said inlet section (68)
15 and over a major part of said outlet section (69).

13. Facility according to any one of claims 1 to 12, characterized in that it comprises an annular drive structure (100) of the movable members (20') that floats.

14. A facility according to claim 13, characterized in that it comprises
20 thrusters (101) fastened to the annular structure (100) to drive it and/or a fixed driver which turns a roller in contact with the outside surface of the annular structure (100) to drive it.

15. Facility according to any one of claims 13 or 14, characterized in that at least one said movable member (20'), said annular structure (100) and
25 the fastening between said annular structure (100) and said at least one movable member (20') are configured such that said at least one movable member (20') is retractable into said annular structure (100).