

SURFING WAVE-MAKING APPARATUS AND SURFING PRACTICE FACILITY EQUIPPED WITH SAME

5 Technical Field

[0001]

The present invention relates to a surfing wave-making apparatus for generating waves used for surfing play, and a surfing play facility provided with a pool to which the surfing wave-making apparatus is
10 equipped. The present invention provides a competition practitioner with practice of surfing tube riding, and a general player with experience and play of surfing tube riding.

Background Art

[0002]

15 Surfing is popular throughout the world. In recent years, there is an increasing number of people who challenge not only a marine leisure but also as a competition. In order to actually enjoy the surfing, it is necessary to go to the seashore in which the natural environment suitable for the surfing condition. The condition of the natural environment
20 suitable for the surfing is that a coastal line that faces the ocean that is likely to reach a large wave and is likely to be a so-called large and isolated wave in which the wave to be struck advances toward the coast. It is necessary for the large and isolated wave to strike advance toward the coast that the coast has a shallow sea bottom terrain such that waves
25 are likely to appear at the same time so that the collapse area of the wave head and the area about to break are continuous. The above-mentioned

large and isolated wave is not a vibration wave that repeats vertical movement at the same point, but is a progressive wave going forward to the coast that has an interval between the waves and in which one wave becomes a large and isolated state.

5 [0003]

In particular, the wave suitable for the surfing is a wave in which the cross section of the wave is formed into a tubular shape by the appearance of a region immediately before the collapse of the wave head of the isolated wave. Surfing player can surf by sliding from the collapse area of
10 the wave front of this tubular winding wave to the area just before the collapse.

The beaches where waves suitable for surfing are formed are limited to places where natural conditions are met, and it is not possible to enjoy surfing anywhere in the world.

15 [0004]

Therefore, in the prior art, an attempt has been made to develop a wave-making apparatus for surfing which can artificially generating an artificial wave for surfing in a pool and enjoy the surfing in the pool.

As a wave-making apparatus for making an artificial wave in a pool, it
20 is known that various methods such as the following are known in the prior art.

[0005]

There is a so-called flap type wave-making apparatus. As shown in FIG. 21, the flap-type wave-making apparatus can generate a wave by
25 reciprocating and swinging a semi-submerged vertical wave-making plate whose lower end is rotatably supported by a hinge as a fulcrum at the

bottom of the water tank.

[0006]

There is also a so-called piston type wave-making apparatus. As shown in FIG. 22, the piston wave-making apparatus can generate a wave by reciprocating a semi-submerged piston attached to a shaft by pushing and pulling along the shaft.

[0007]

There is also an air compression type wave-making apparatus. As shown in FIG. 23, the air compression type wave-making apparatus is provided with a vacuum pump, a blower, or the like in an air storage tank formed on one side of the water tank, and air into the air storage chamber by suction and blow-out atmospheric pressure. The water level fluctuates according to the inflow and outflow of water to generate waves.

[0008]

There is also a tank chamber type wave-making apparatus. As shown in FIG. 24, the tank chamber type wave-making apparatus is provided with a gate at the lower part of the water storage tank formed on one side of the water tank, water is stored to a certain height in the water storage tank by a pump or the like, and then the gate is opened. It opens momentarily and drops water into the water tank to generate waves.

[0009]

In addition, there is a water flow nozzle injection type wave-making apparatus. As shown in FIG. 25, the water flow nozzle injection type wave-making apparatus pressurizes and ejects water from the nozzle into the pool to generate waves.

[0010]

There is also a carry-type wave-making apparatus. As shown in FIG. 26, the carry-type wave-making apparatus starts from the state where the water carrier is submerged in the pool and pulls vigorously with a cable or the like to power the water carrier and pull the inside of the pool almost
5 horizontally. It is a wave-making apparatus that generates waves by ejecting water captured by the water carrier forward by moving it.

[0011]

Patent Document 1: JP H11-224895

Patent Document 2: JP H06-073911

10 Patent Document 3: JP H03-268772

Patent Document 4: JP 2002-257675

Patent Document 5: JP H06-778692

Patent Document 6: WO 2016-129107

Disclosure of the invention

15 The problems to be solved

[0012]

However, the various types of wave-making apparatuses disclosed in the prior art have the following problems in terms of wave-forming apparatuses suitable for surfing.

20 First, the wave formed by the flap-type wave-making apparatus is the so-called vertically fluctuating wave that vertically fluctuates the water in the pool at the same place and is not a progressive wave for going forward in an isolated state. Therefore, it is impossible to generate a so-called tubular wave in which the wave head in a region immediately
25 before the collapse is continuous from the collapse region suitable for the surfing. Therefore, even if the size of the apparatus is increased and the

power is increased, it is not possible to generate a tubular wave suitable for the surfing. If a large wave is generated by the flap-type wave-making apparatus, the flap is enlarged, and the depth of water needs to be increased. However, there is a problem that the mechanism becomes so
5 large and complicated because the amount of water in the pool is so large to move.

[0013]

Next, the wave generated by the piston-type wave-making apparatus becomes a so-called vertically fluctuating wave that vertically pushes the
10 water in the pool in the same manner as the flap type and is not a progressive wave that goes forward in an isolated state. Therefore, it is impossible to generate a so-called tubular wave in which the wave head in a region immediately before the collapse is continuous from the collapse region suitable for the surfing. Therefore, even if the size of the apparatus
15 is increased and the power is increased, a tubular wave suitable for the surfing cannot be generated.

[0014]

Similarly, the air compression type wave-making apparatus is also a so-called vertically fluctuating wave that vertically pushes the water in
20 the pool in the same manner as the piston type and is not a progressive wave that travels in an isolated state. Therefore, it is impossible to generate a so-called tubular wave in which the wave head in a region immediately before the collapse is continuous from the collapse region suitable for the surfing. In addition, since a large vacuum pump is used,
25 energy efficiency is not good to generate a large wave.

[0015]

Although the tank-type wave-making apparatus has a problem in the direction of discharging the stored water, basically, the water is dropped directly under the tank chamber in the pool, so that the wave is transmitted as a so-called vertically fluctuating wave which is largely
5 raised and lowered in the field due to the influence of the weight of the water and does not become a progressive wave which go forward as an isolated state. Therefore, it is impossible to generate a so-called tubular wave in which the wave head in a region immediately before the collapse is continuous from the collapse region suitable for the surfing. In addition,
10 since the water is pumped up by the pump and stored in the tank, the energy efficiency is not good.

[0016]

Next, it is impossible for the water flow nozzle injection type wave-making apparatus to generate a real tubular wave. The generated
15 wave only slides on the curved surface of the apparatus that is made in a mountain shape, and the generated wave does not have a collapse area suitable for surfing. It is not possible to generate a so-called tubular wave in which the wave head in a region immediately before the collapse is continuous from the collapse region suitable for the surfing.

20 [0017]

The carry-type wave-making apparatus is the most excellent wave-making apparatus in the prior art, and the generated wave is a wave suitable for the surfing, and a so-called tube-shaped wave is generated so that the wave head in a region immediately before the collapse can
25 continue from the collapse region.

However, the carry-in type wave-making apparatus according to the

prior art, the water carrier is pulled by a cable or the like to move horizontally in the pool from a state in which the water carrier is sunk under a pool draft waterline. In order to obtain the initial speed in a state where the water is caught in the water carrier in the sunk state, the
5 motor of the driving device should be large.

[0018]

In order to solve the above problem, it is an object of the present invention to provide a wave-making apparatus for surfing to a large scale with a simple structure, which is capable of forming a so-called tubular
10 wave, in which a wave head in a region immediately before collapse is continuous from a collapse region suitable for a surfing. It is difficult to be formed by a conventional wave-making apparatus.

Means for solving the problems

[0019]

15 In order to achieve the above object, a wave-forming apparatus according to the present invention for producing a wave for surfing in a play area of a pool, comprises: a container body having at least a bottom plate and opening capable of at least temporarily capturing water on the bottom plate; a moving track including a slope track for moving the
20 container body in which the container body moves along from a start position above a draft waterline of the pool to a lower position where at least a part of the container body sinks under the draft waterline of the pool; and an in-pool traveling track for moving the container body forward in a state that at least a part of the container body sunk in the pool facing
25 the play area; wherein the container body moves forward on the slope track and the in-pool traveling track in a state where the front surface of

the container body faces the play area, and discharges the water captured by the container body toward the play area ahead.

[0020]

According to the above configuration, the water captured by the
5 container body of the pool water is pushed out forward as the container
body moves forward, and the kinetic energy of the water discharged
forward is propagated in the forward direction, so that an isolated
progressive wave can be easily formed. Since the water in the vicinity of
the upper part of the water in the pool is caught by the container body
10 and is pushed out so as to be carried forward, this configuration belongs a
"carry-type wave generating apparatus".

Since the amount of water to be extruded is only an amount to be shot
as a progressive wave, most of the kinetic energy of the container body
can be converted into kinetic energy of the progressive wave. The most of
15 energy is given to water to generate wave, and other than the wave
generating can be suppressed, so energy efficiency becomes high.

[0021]

In the above configuration, the movement of the container body in of the
moving track can be a free fall movement on the slope. When the
20 container body is formed of a material having a specific gravity larger
than that of water and the total weight is enough large, the potential
energy becomes large. By obliquely dropping the container body on the
slope down to the draft waterline of the pool, the potential energy is
converted into kinetic energy. If the kinetic energy is sufficient to plunge
25 into the water of the pool, the kinetic energy can be supplied to the pool
water temporarily while catching the water mass caught in the container

body temporarily. That is, the kinetic energy of the container is converted into kinetic energy for discharging the water mass, and the water lump is shot forward. In this way, when the water mass is shot forward, a carry-type wave is generated, and the generated wave becomes a progressive wave suitable for surfing wave. There is no need for a driving device such as a large-sized motor which has a large initial velocity, which is a problem in a conventional carry-type wave-making apparatus.

[0022]

The container body is open forward, has at least a bottom plate, and can capture water at least temporarily on the bottom plate, however, there may be a variety of variations.

For example, there may be a configuration in which only a bottom plate is provided as a container body.

In this case, the bottom plate has a slope bottom in which the front side in the advancing direction is low and the rear side is high. The vertical cross section is triangular, and the sharply pointed tip is forward and enters the draft waterline of the pool from the tip. It is possible to temporarily catch and lift water on the bottom of the conical slope by rushing into the water as if it is hatchet. If the inclination of the bottom of the slope is large, the water does not slip upward and plunge over the rear of the container body, so that the amount of water to be temporarily captured becomes large.

[0023]

Here, in the case where the container body is only the bottom plate, it is preferable to build a lane partition wall along the side of the traveling lane for the container body in the in-pool traveling track. The container

body moving in the traveling lane so as to give kinetic energy to hit the captured water sufficiently forward after the container body enters the water in the pool. With the structure provided with the lane partition wall in the in-pool traveling track, the captured water is surrounded by the
5 container body from the bottom side and the lane partition wall from the side. When the container body advances forward, the water caught on the upper surface of the container body is easily pushed forward.

Further, if the lane partition wall is built in the in-pool traveling track, there is almost no turbulent flow to the side in the in-pool traveling track,
10 and an isolated progressive wave having a small disturbance and good quality can be generated.

[0024]

For example, the container body may be provided with a bottom plate and a back plate.

15 If the back plate is provided, the captured water on the bottom surface of the container body is slid upward up to the rear of the container body, the captured water is held by the back plate so that the captured water is less leaked from the rear because of the back plate. In this structure having the back plate, the bottom surface is preferable as the slope shape
20 to reduce the amount of collision of the water with respect to the back plate. The kinetic energy obtained by the free fall of the container body is smoothly converted into the kinetic energy of the water.

[0025]

For example, the container body may be provided with a bottom plate, a
25 back plate and side plates.

If there is side plates, captured water on the bottom surface of the

container body is prevented from leaking from the side of the container body.

Further, if the side surface plate is built on the side surface of the container body, a turbulent flow hardly occurs on the boundary surface
5 between the side surface plate and the captured water, so that an isolated progressive wave having a small disturbance and good quality can be generated.

In the case where there are side plates in the container body, the lane partition wall in the pool can be omitted. Of course, a structure in which
10 side plates are provided in the container body and a lane partition wall on the in-pool traveling track can be possible.

[0026]

It is preferable that the weight of the container body can be adjusted by providing a detachable weight on a part of the container body.

15 When the weight of the container body is adjusted by the detachable weight, the potential energy of the container body on the slope track and the magnitude of the kinetic energy obtained by converting the potential energy of the container body by dropping the slope track can be adjusted, the kinetic energy given to the water can be adjusted, and the kinetic
20 energy and height of the shot wave can be adjusted.

[0027]

The arrangement structure of the container body in the wave-making apparatus for surfing has the following types.

One arrangement structure of the container body is the one wherein a
25 plurality of container bodies are provided, and the container bodies are arranged in a row in a width direction so as to face the front surfaces of

the respective containers with respect to the play area. Even in this type, one large traveling wave can be generated by moving the plurality of containers in a row and moving forward. In addition, if there is no gap on the joint surface between the container bodies, a turbulent flow is suppressed, and an isolated traveling wave having a small disturbance and good quality can be generated.

[0028]

Another type is that the container body is a singular, but the width of the container corresponds to the width of the wave to be generated. It is preferable that one or plural of inner partition plates are provided so as to be orthogonal to the front surface in the container body. Even in this type, since there is inner partition plates at an appropriate interval, it is possible to suppress the turbulent flow in the lateral direction, and to generate an isolated progressive wave having a small disturbance and good quality.

[0029]

Next, as the movement of the container body in the wave-making apparatus for surfing, only the free fall movement on the slope track of the container body may be performed, but it is possible that the acceleration movement by the catapult or the acceleration movement using the elastic body provided at the position on the slope track can also be combined in addition to the free-falling movement on the slope. When the catapult or the elastic body is arranged, the apparatus configuration becomes complicated, but when the height of the free-falling slope is sufficiently difficult to secure or when the inclination should be made gentle and the length of the slope (the slope moving distance) becomes

large but sufficient length is not easily secured or the like, kinetic energy obtained by free fall is insufficient because of suppressing the height of the slope and the length of the slope, the shortage can be compensated by enhancing the kinetic energy by the catapult or the elastic body.

5 [0030]

As a whole of the moving track, the main portion may include the slope track above the draft waterline of the pool to under the draft waterline of the pool. The slope track may have a slope of a plane or a gentle angle in the starting portion and may have the gentle angle gradually reduced in
10 the terminal direction under the draft waterline of the pool of the slope.

It is also preferable that in the terminal direction under the draft waterline of the pool, the angle gradually decreases in the advancing direction followed by the angle gradually increases in the advancing direction. Because, after the container body is plunged into water to catch
15 the water in the pool and the captured water in the inside of the container is go forward, rapidly decelerating forward of the container facilitates the generation of an isolated wave. If there is a portion in which the moving path gradually becomes smaller in the advancing direction and includes a portion of which the angle gradually increases in the advancing direction,
20 deceleration is easily applied to the container body, and only the water inside the container body is forced forward apart from the container to form an isolated wave.

[0031]

Next, the frictional resistance between the container body and the
25 moving track of the slope track is described.

As described above, the container body falls along the slope of the

moving track, but a frictional resistance may occur between the bottom surface of the container body and the slope. The inclination of the slope, the material of the slope, the bottom surface state of the container body, the weight of the container body, etc. can vary. However, it is preferable
5 that a rail mechanism provided along the track as a rail type moving path and a wheel provided on the bottom surface of the container body are employed, the container body can move smoothly by the rail mechanism. Since impact is applied to the container when the container body enters the water of the pool, it is preferable that the rail structure such that the
10 wheel does not come off from the rail by the impact.
[0032]

Next, a return traction device in the wave-making apparatus for the surfing of the present invention is described. After the container body is dropped along the slope track of the moving track and the surfing wave is
15 formed in the pool, the container body is pulled back to the starting portion again.

The return traction device is provided with a connection line attached to a part of the container body, and a driving force for pulling up the connection line and pulling back the container body to the starting
20 position above the draft waterline of the pool. Since the driving force is used for the movement of pulling back the container body, it is possible to take up the container body at a speed smaller than the speed at which the container body falls and rushes into the water and may not be an excessively large motor or the like.
25 [0033]

Next, the surfing play facility of the present invention will be described.

In the surfing play facility of the present invention, the wave-making device for the surfing of the present invention described above is installed in the pool. Further, the bottom surface of the pool is devised as follows. There is a flat part following the range where the container body moves,
5 and a slope part of an upward gradient is provided in the vicinity of the start position of the play area following the flat part. In this arrangement of the slope portion, an angle is given to a moving direction in which the container body moves.

Physically, by providing a slope part rising from the flat part, the wave
10 speed at which the depth becomes shallow becomes slow. While passing through the slope, the difference in speed in the front-back direction of the wave is accumulated, so that a so-called tubular wound wave is formed so that the back side of the wave covers the front side, and eventually the wave head collapses forward. Here, the slope portion has a
15 skew and has a substantially triangular shape having a vertex so as to face the container body direction, the speed is gradually delayed from the position corresponding to the vertex of the triangle, and the speed is gradually delayed toward the side direction of the triangle. In one traveling wave, a tube-shaped winding wave suitable for the surfing in
20 which the collapse region and the wave head in a region immediately before the collapse are continued is formed by successively collapsing in the lateral direction so as to continue from the collapse region.

The effect of the invention

[0034]

25 According to the wave-forming apparatus for surfing of the present invention, only the water of the pool captured in the container body in the

pool water is pushed forward as the container body moves, and the isolated progressive wave can be easily formed. Further, in the surfing practice play facility of the present invention, if the slope portion of the upward gradient is provided near the start position of the play area of the pool, the speed of the traveling wave is delayed during the passage of the slope, and in one progressive wave, a tubular wave suitable for the surfing in which the wave head in a region immediately before the collapse is continued from the collapse region is generated.

The movement of the moving track of the container body can be mainly made as a free fall movement on the slope, the potential energy is converted into kinetic energy, and when it is sufficient kinetic energy to plunge into the water of the pool, energy can be supplied to the water so that the water mass caught in the container body can be temporarily shot forward.

Brief description of the drawings

[0035]

FIG. 1 is a schematic view for easily showing the principle of a wave forming when a first variation container body 110a is used.

Fig.2 is a schematic view showing from a vertical cross section and a schematic view showing from an upper surface of the surfing wave-making apparatus.

Fig.3 is a schematic view for easily showing the principle of wave making when the second variation container body 110b is used.

Fig.4 is a schematic view showing from a longitudinal section and a schematic view showing from an upper surface of the surfing wave-making apparatus.

Fig.5 is a schematic view showing a variety of container bodies in a simple manner.

Fig.6 is a schematic view showing an example configuration of a conventional flap-type wave-making apparatus

5 Fig.7 is a schematic view showing an example configuration of a conventional piston-type wave-making apparatus

Fig.8 is a schematic view showing an example configuration of a conventional air tank-chamber type wave-making apparatus.

10 Fig.9 is a schematic view showing example configuration of a conventional water tank-chamber type wave-making apparatus.

Fig.10 is a schematic view explaining the turbulent flow generated at the back surface of a moving body moving in water becomes inhibition factor for wave-making.

15 Fig.11 is a schematic view showing a basic structure of a wave-making apparatus for surfing according to the Embodiment 1 of the present invention.

Fig.12 is schematic view showing an example where the container body 110a is a plurality of (n) pieces.

20 Fig.13 is a schematic view showing a state in which an isolated progressive wave 202 of a synthetic wave is formed in a configuration in which four container bodies 110a are parallelized in a row.

Fig.14 is a schematic view showing one stroke of a wave-making for surfing by the wave-making apparatus 100.

25 Fig.15 is a schematic view showing configuration in which a stopper 125 is provided on the in-pool traveling track 123 of the moving track 120.

Fig.16 is a schematic view showing a flow from the wave form of the surfing wave until the container body 110 is returned after the wave is formed in the wave-forming apparatus 100.

Fig.17 is a schematic view showing configuration in which a rail is
5 laid on a contact surface between the moving track 120 and the container body 110a.

Fig.18 is a schematic view for explaining a structure for reducing friction with respect to the container body by installing a wheel between the moving path and the container body.

10 Fig.19 is a schematic view showing the bottom of the pool 200 of the surfing practice facility of the present invention in an easy-to-understand manner.

Fig.20 is a schematic view showing an example in which a shape of the slope 220 is provided so as to run obliquely.

15 Fig.21 is a schematic view showing a conventional flap-type wave-making apparatus in the prior art.

Fig.22 is a schematic view showing a conventional piston wave-making apparatus in the prior art.

20 Fig.23 is a schematic view showing a conventional air compression type wave-making apparatus in the prior art.

Fig.24 is a schematic view showing a conventional tank chamber type wave-making apparatus in the prior art.

Fig.25 is a schematic view showing a conventional water flow nozzle injection type wave-making apparatus in the prior art.

25 Fig.26 is a schematic view showing a conventional carry-type wave-making apparatus in the prior art.

Detailed description of the preferred embodiment

[0036]

Some embodiments of the wave-making apparatus for surfing and the surfing play facility of the present invention will be described below.

5 First, the principle of wave-making by the wave-making apparatus for surfing of the present invention will be described, and an example of a specific apparatus configuration is given as an embodiment. The present invention is not limited to these examples. Needless to add, the claims of the present invention are not limited to the configuration shown in the
10 following embodiments.

[0037]

FIG 1 to FIG. 4 are a drawings for easily explaining the principle of wave-making by the wave-making apparatus for surfing according to the present invention. FIG. 5 is a drawing showing a variety of container
15 bodies in a simple manner.

For comparison explaining, FIG. 6 to FIG. 9 are added which show an example configuration of a conventional flap-type wave-making apparatus, a piston-type wave-making apparatus, and a wave-making apparatus of a tank-chamber type.

20 [0038]

First, the principle of wave making in the case where the first variation container body 110a is used will be described briefly.

The first variation container 110a is a container body formed of a bottom plate (a slope bottom) and a side plate shown in FIG. 5 (a).

25 FIG. 1 is a schematic view easily showing the principle of a wave form when a first variation container body 110a is used. Parts relating to the

description of the principle of the wave making are picked out and other parts are omitted.

FIG. 1 is a perspective view showing the movement of the container body 110 in the five stages of (1), (2), (3), (4), and (5) in time series from the left side to the right side in the figure and the state of shooting the isolated wave for surfing.

In FIG. 1, the front side of FIG. 1 is continued to the play area of the pool 200, but the drawing is omitted.

[0039]

As shown in FIG. 1, there is a moving track 120 including a slope track 121 for moving the container body 110a. The slope 121 is provided from a position above the draft waterline of the water 201 of the pool 200 to a position where at least a part of the container body 110a sinks below the draft waterline of the water 201 in the pool 200.

FIG. 1 shows a state in which the container body 110a slides on the slope 121 of the moving track 120 and enters the water 201 of the pool 200.

The state of FIG. 1 (1) is that the container body 110a is located above the draft waterline of the water 201 of the pool 200 on the moving track 120. In this state, the water 201 of the pool 200 is not yet plunged into the water 201. In the state of FIG. 1 (1), the container is dropped along the slope 121 while accelerating in the moving direction by gravity. The contact structure between the container body 110a and the slope surface and the auxiliary structure using the catapult and the elastic body for enhancing kinetic energy will be described later. In order to simplify the description, it is assumed that the container body 110a slides down by its

own weight along the slope 121.

[0040]

Referring now to FIG.2.

FIG.2 (a) shows a vertical cross section so that the state in water is
5 easy to understand. FIG.2 (b) is a schematic view showing a view from the
upper surface. In each of the figures, the right side (1) shows the initial
state of the container body 110a, the center portion (2) shows the
acceleration state of the container body 110a, and the left side (3) shows
the state immediately after the container body 110 stops. FIG. 2 (1)
10 shows a state in which the container body 110a is located at a position
above the draft waterline of the water 201 of the pool 200 on the moving
track 120, and FIG.2 (a) shows a vertical section and (b) viewed from the
upper surface. FIG.2 shows the state that is different in height of the
container body 110a from FIG. 1 (1), but these are showing the state
15 before entering the water 201 in the pool 200 is common.

[0041]

Next, the state of FIG. 1 (2) is a state in which the container body 110a
starts to enter under the draft waterline of the water 201 of the pool 200
on the moving track 120. From FIG. 1 (1) to FIG. 1 (2), the potential
20 energy possessed by the container body 110a is converted to kinetic energy.
Although the state of the inclined surface 121 under the water 201 of the
pool 200 is not shown in FIG. 1, it is preferable that the inclined surface
121 of the moving track 120 gradually becomes smaller in the advancing
direction such that the container body 110a is smoothly plunged into the
25 water of the pool to easily travel forward.

In this example, the container body 110a has a box shape with a front

portion opened and a bottom portion and a side face plate and is a container capable of capturing water in a portion of the internal space. In this example, the bottom of the slope is provided in the container body 110a, so that the water inside the container body 110a rises up the bottom of the slope, and the water 201 of the pool 200 is temporarily held above the draft waterline of the pool in the container body 110a temporarily. It should be noted that the presence or absence of the bottom of the slope and the angle of the bottom of the slope are not limited.

[0042]

10 The state of FIG. 1 (3) is that a part of the container body 110a travels under the draft waterline of the water 201 of the pool 200 on the moving track 120. From FIG. 1 (2) to FIG. 1 (3), kinetic energy possessed by the container body 110a is converted to kinetic energy of water in the pool captured in the container body 110a. In this example, since a part of the pool water is raised above the draft waterline of the water 201 in the pool 200. A part of the kinetic energy possessed by the container body 110 is converted to the potential energy of the caught water 201.

[0043]

Referring now with FIG. 2.

20 FIG. 2 (2) shows a state in which a part of the container body 110a travels under the draft waterline of the water 201 of the pool 200 on the moving track 120, and FIG. 2 (A) shows a vertical section and (B) viewed from the upper surface. In this figure, although the container body 110a is substantially horizontally traveling, it is not always limited to the horizontal state because the slope 121 of the moving track 120 changes gradually in the advancing direction as in the slide.

As shown in FIG. 2 (2), since the water 201 of the pool 200 is caught inside the container body 110a in order to travel in a state in which a part of the container body 110a is under the draft waterline of the water 201 in the pool 200, the water 201 in the pool 200 runs up the bottom of the slope, and the water 201 travels while being lifted on the draft waterline as shown in FIG. 2 (2).

[0044]

Next, in the state of FIG. 1 (4), the container body 110a continues to travel in the in-pool track, and the water 201 captured in the container body 110a in FIG. 1 (3) moves forward integrally with the container body 110a. Between FIG. 1 (3) and FIG. 1 (4), kinetic energy of water captured in the container body 110A is arranged forward.

In the case where there is a slope bottom in the container body 110a, a transition period from FIG. 1 (3) to FIG. 1 (4) is present, but the state in which the water 201 in the container body 110a and the container body 110a are integrated, this integration period may vary depending on the condition of traveling of the container body 110a, but this integration period may be extremely short.

Next, the state of FIG. 1 (5) shows that the container body 110a is decelerated on the moving track 120, while the water 201 of the pool 200 is not decelerated in speed, so that the caught water 201 is driven forward from the container body 110a as the progressive wave 202 suitable for the surfing.

The kinetic energy of the water shot forward from the container 110a is propagated as an isolated progressive wave 202 as it is.

[0045]

Referring now to FIG.2.

FIG. 2 (3) shows a state in which the container body 110a is decelerated on the moving track 120 and the inner water 201 of the container body 110a is driven forward as a traveling wave 202 for the surfing, and FIG. 2
5 (3) (a) shows a vertical section and (b) viewed from the upper surface.

The water 201 captured inside the container body 110 maintains the speed by the kinetic energy obtained shown as FIG. 2 (2). However, since the container body 110a is decelerated or stopped, only the inner water 201 captured inside the container body 110a continues to move forward
10 and is driven as an isolated traveling wave 202.

[0046]

In particular, the wave suitable for the surfing is a wave in which the cross section of the wave is formed into a so-called tubular shape by the appearance of a region immediately before the collapse of the wave head
15 of the isolated wave. This is formed by gradually decreasing the speed of the isolated traveling wave, and the isolated traveling wave is necessary for wave-forming of the tubular wound wave. According to the wave-making principle of the wave-making apparatus of the present invention, an isolated traveling wave 202 is necessary for making a
20 suitable wave for a surfing, and the surfing can be performed by sliding from the collapse region of the wave head toward a region immediately before the collapse.

In the wave-forming apparatus of the present invention, since the amount of water to be extruded forward is almost all the amount of water
25 to be shot as an isolated traveling wave, so most of the position energy of the container body 110a can be converted into kinetic energy with respect

to the traveling wave, so that energy applied to water other than the wave traveling on the water surface can be suppressed and energy efficiency becomes high.

[0047]

5 Next, other principle of wave making applied in the wave-making apparatus 100 in the case of using other type of a container different from FIG.1 will be described below.

Here, other principle of the wave making in the case where the second variation container body 110b is used will be described briefly.

10 The second variation container body 110b is a container body 110b formed only by the bottom plate (slope bottom) shown in FIG. 5 (b). The container body shown in FIG.5 (b) differs from the container body 110a of FIG. 5 (a) in that there is no side face plate. The longitudinal section has a substantially triangular shape and has a shape such that the tip is
15 pointed toward the rear end like an ax.

FIG. 3 is a drawing for easily explaining the principle of wave making when the second variation container body 110b is used. Parts relating to the description of the principle of the wave making are taken out and other parts are omitted.

20 FIG. 3 is a perspective view showing the movement of the container body 110b in the five stages of (1), (2), (3), (4), and (5) from the left side to the right side in FIG. 3 and the state of shooting the isolated wave for surfing. In FIG. 3, the front side of FIG. 3 is continued to the game area of the pool 200, but the drawing is omitted.

25 [0048]

The same as in the first embodiment, there is a moving track 120

including a slope 121 for moving the container body 110b as shown in FIG. 3, and a slope 121 is provided from a position above the draft water line of the pool 200 to a position where at least a part of the container body 110B sinks under the draft water line of the pool 200.

5 The difference between FIG.1 is that there is provided a lane partition wall 124 for partitioning the running track in the pool. The lane partition wall 124 is disposed on the side of the container body 110b running on the running track in the pool and surrounds the traveling container body 110b so as to prevent the water 201 running on the surface of the slope of the
10 traveling container body 110b from escaping sideways. The container body 110a shown in FIG.1 is provided with a side face plate 110a, but the container body 110b shown in FIG.3 has a simple shape without a side face plate, but a lane partition wall 124 for partitioning the traveling track in the pool is positioned on the side of the container body 110b,
15 whereby water can be surrounded by the container body 110b and the lane partition wall 124.

[0049]

The principle of wave making when the container body 110b is used will be described.

20 FIG. 3 shows a state in which the container body 110b slides on the slope 121 of the moving track 120 and enters the water in the pool 200.

The state of FIG.3 (1) is that the container body 110b is in a position above the draft water line of the water 201 of the pool 200 on the movement path 120. In the state of FIG. 3 (1), the container body 110b is
25 dropped along the slope 121 and is free to fall while accelerating along the slope in the moving direction by gravity.

[0050]

Referring now to FIG. 4.

In FIG.4, FIG.4 (a) shows a longitudinal section so that the state in water is easy to understand. FIG.4 (b) is a view showing a view from the upper surface. In each of the figures, the right side shows the initial state of the container body 110b, the center thereof being in the acceleration state of the container body 110b, and the left side of the container body 110b immediately after the stop of the container body 110b.

FIG.4 (1) shows a state in which the container body 110 is located at a position above the draft waterline of the water 201 of the pool 200 on the moving track 120, and FIG.4 (a) shows a vertical section and (b) viewed from the upper surface. Although the height of the container body 110b differs from the state of FIG.3 (1), the state before entering the water 201 of the pool 200 is common.

[0051]

Next, the state of FIG.3 (2) is a state in which the container body 110b starts to enter under the draft waterline of the water 201 of the pool 200 on the moving track 120. From FIG.3 (1) to FIG.3 (2), the position energy possessed by the container body 110b is converted to kinetic energy.

As shown in FIG.3, the lane partition wall 124 is provided so as to partition the traveling track in the pool, and the side of the traveling container body 110b is surrounded, so that the water 201 running on the slope surface of the traveling container body 110b does not escape sideways. Although the height of the lane partition wall 124 is not limited, it is preferable to be higher than the container body 110b.

[0052]

The state of FIG.3 (3) is that a part of the container body 110b travels under the draft waterline of the water 201 of the pool 200 on the moving track 120. From FIG.3 (2) to FIG.3 (3), kinetic energy possessed by the container body 110 is converted to kinetic energy of water in the pool
5 captured in the container body 110b.

As shown in FIG.3, the side of the traveling container body 110b is surrounded by the lane partition wall 124, so that the water 201 of the pool effectively running up the surface of the slope.

[0053]

10 Referring now to FIG. 4.

FIG.4 (2) shows a state in which a part of the container body 110b is traveling under the draft waterline of the water 201 of the pool 200 on the moving track 120, and FIG.4 (a) shows a vertical section and (b) viewed from the upper surface.

15 As shown in FIG.4 (2), since the water 201 of the pool 200 is caught inside the container body 110b, and in this example, the water 201 of the pool 200 runs on the surface of the slope, and the water 201 travels with the container 110b above the draft waterline as shown in FIG. 2 (2).

[0054]

20 Next, in the state of FIG.3 (4), the container body 110b continues to travel in the in-pool traveling track, and the water 201 captured in the container body 110b in FIG.3 (3) moves forward together with the container body 110b. Between FIG.1 (3) and FIG.1 (4), kinetic energy of water captured in the container body 110b is arranged forward.

25 As shown in FIG.3, since the lane partition wall 124 is provided so as to partition the traveling track in the pool, both sides of the traveling

container body 110b is surrounded, and the water 201 running on the slope surface of the traveling container body 110b does not escape to the side and is efficiently converted into the forward movement energy.

[0055]

5 Next, the state of FIG.3 (5) indicates that the container body 110b is decelerated on the moving track 120, while the water 201 of the pool 200 is not decelerated at the speed, so that the water 201 of the pool 200 is driven shot forward from the container body 110b as the traveling wave 202 for the surfing.

10 In this case, as shown in FIG.3, since the lane partition wall 124 is provided so as to partition the traveling track in the pool, the lane partition wall 124 let the inner water go forward from the container body 110b and shot the inner water as the traveling wave 202 for the surfing and the energy is efficiently converted into kinetic energy toward the
15 front without any escape to the side.

 The kinetic energy of the water driven forward from the container body 110b is propagated as an isolated traveling wave 202 as it is.

[0056]

 Referring again to FIG. 4.

20 FIG.4 (3) shows the state in which the container body 110b is decelerated on the moving track 120 and the inner water 201 of the container body 110 is shot forward as the traveling wave 202 for the surfing, and FIG.4 (a) shows a vertical section and (b) viewed from the upper surface.

25 The water 201 captured in the container body 110b maintains the speed by the kinetic energy obtained in FIG.2 (2). However, since the container

body 110b is decelerated or stopped, only the water 201 captured in the container body 110b continues to move forward and is driven as an isolated traveling wave 202.

[0057]

5 Next, the variation of the other container body 110 is also easily indicated.

FIG.5 is a drawing showing an example of various variations of the container body 110.

FIG.5 (a) shows a container body 110a of a first variation and is a
10 container body 110a formed of a bottom plate (a slope bottom) and a side plate. The principle of the wave making has described above.

FIG.5 (b) shows a container body 110b of a second variation and is a container body 110b formed only of a bottom plate (inclined bottom). The principle of the wave making has described above and it makes waves by a
15 combination with a lane partition wall 124.

FIG.5 (c) shows a third variation container 110c, which is a container 110c formed of a bottom plate (slope bottom) and a back plate. The principle of the wave-making is the same as the principle of the wave-making of the second variation container body 110b but makes
20 waves by a combination with the lane partition wall 124. Since the back plate is present, the water 201 running up to the end of slope and over the backward of the slope is dammed, and the water 201 is kept forward by the back plate. That is, the water 201 is surrounded by the slope surface, the back plate, and the lane partition wall 124 and is efficiently driven
25 forward.

FIG. 5 (d) shows a fourth variation container 110d, which is a container

body 110d formed of a bottom plate, side plates and a back plate. The principle of the wave-making is the same as the principle of the wave-making of the first variation container body 110a, and the lane partition wall 124 is not particularly required because the side plates are present. The lane partition wall 124 also serves as a partition of the traveling lane even though the fourth variation container 110d has side plates.

In these variations, the material is not limited, but it is necessary to have a structural strength which can withstand the splash into water, and a specific gravity larger than that of water is required, and therefore, a metal made of a metal is preferable. There may be a resin material or the like in a part thereof. Also, a part of the inside can also be made hollow. By making a portion of the interior hollow, the weight can be placed in the space to adjust the total weight. It is also possible to provide a mounting member for attaching a weight to the back surface or the like. If it is the back surface, the weight can be easily replaced.

When a game is performed at night or the like, a sufficient amount of illumination is required around the periphery, but a fluorescent paint or a light is attached to a part of the container body 110, so that the timing at which the container body falls can be easily visually recognized by the player.

[0058]

The above is a principle of the wave making of the wave-making apparatus 100 for the surfing of the present invention.

In the following, the wave-making principle of the conventional wave-making apparatus of the prior art is viewed to compare with the

present invention.

First prior wave-making example so-called “flaps type wave-making apparatus” as shown in FIG.6, it is understood that the back-and-forth movement of the flaps installed in the pool water propagates vibrations to the entire water of the pool. Since kinetic energy is dispersed throughout the water of the pool, it is a vibration wave vibrating vertically, so that it is not an isolated traveling wave.

[0059]

Second prior wave-making example so-called “piston type wave-making apparatus” as shown in FIG.7. it is pushing and pulling the pressing plate along the axis against the water surface of the pool, and it is understood that the vibration source is present in a portion of the water surface of the pool, and the vibration propagates around the water surface, water, or the like. Since the kinetic energy is dispersed throughout the water surface of the pool, it is a vibration wave vibrating vertically, so that it is not an isolated traveling wave.

[0060]

The prior wave-making example so-called “air compression type wave making apparatus” according to the prior art as shown in FIG. 8 is to form a wave by making the air compression tank facing the water surface of the pool and discharging the compressed air into the water at once, and it is understood that the vibration source is present in a part of the water surface of the pool, and the vibration propagates around the water surface, water, or the like. Since the kinetic energy is dispersed throughout the water surface of the pool, it is a vibration wave vibrating vertically, so that it is not an isolated traveling wave.

[0061]

The prior wave-making example so-called “water tank chamber type wave making apparatus” as shown in FIG. 9, a large amount of water is dropped to a pool water surface beneath the tank chamber. Therefore, the position energy of the water is converted into the vibration energy of the surrounding water and the kinetic energy propagates, so the kinetic energy is dispersed throughout the water of the pool, it is not an isolated traveling wave.

[0062]

10 The comparison of FIG. 6 to FIG. 9 with the present invention, it will be understood that the surfing apparatus 100 of the present invention is an advantageous scheme for forming an isolated progressive wave suitable for surfing. In the wave-making apparatus 100 for surfing of the present invention, the forward movement distance of the container body 110 can
15 be designed to make an isolated traveling wave according to the amount of water to be captured by the container body 110 and the width of the play area.

[0063]

Next, consider turbulence influence.

20 The influence of the turbulent flow cannot be ignored, and it may become a major factor of disturbing the shape of the progressive wave. FIG.10 is a drawing easily explaining the turbulent flow generated at the back surface of a moving body moving in water becomes inhibition factor for wave-making. As shown in FIG.10, if an object moving in water at a
25 high speed is a plate body having a large facing area, the water surface on the front surface increases the rising pressure, while the water surface on

the back surface is instantaneously lowered and the pressure decreases. The pressure difference between the front and back of the plate acts to prevent the plate from advancing. In addition, water tries to flow into the dent in the rear from the rising water surface in the front and the surrounding water surface. The flowing water wraps around the back of the plate. The plate body must be moved forward with peeling off the water which goes around the back surface and the water acts as a kind of resistance to the forward movement. Thus, large energy is required when the object such as a plate having a large facing area moves in water at a high speed.

Further, the wave suitable for the surfing needs continuity such that the wave head is substantially equally delayed in the lateral direction while the wave head is aligned, and the turbulence flow disturbs the rhythm of making wave for surfing. Therefore, when a turbulent flow occurs, the formation of a so-called “tubular wound wave in which the wave head in a region immediately before the collapse is continued from the collapse region” is disturbed.

For the reasons described above, it is necessary to suppress the occurrence of turbulent flow.

[0064]

As shown in FIG.1 and 2, since the side surface of the container body has the side plate, it is understood that the occurrence of turbulence is suppressed at the boundary surface between the side plate and the water surface outside the side plate. That is, it is possible to form an isolated traveling wave having a good quality with a small disturbance.

[0065]

On the other hand, as shown in FIG.6 (b), it can be seen that a turbulent flow occurs around the edge of the flap by the reciprocating motion of the plate-like flap installed in the pool water, and the turbulent flow propagates to the surroundings. This turbulent flow may be one of the causes of turbulence of the wave.

[0066]

Also, as shown in FIG.7 (b), it is understood that a turbulent flow occurs around the edge of the push plate by the reciprocating motion of the plate-like push plate which is pushed against the water surface of the pool as shown in FIG.7 (b), and the turbulent flow propagates to the surroundings. This turbulent flow is one of the causes of disturbance of the wave.

[0067]

Also, as shown in FIG.8 (b), it is understood that the kinetic energy of the air is converted to the vibration energy of the surrounding water, various turbulent flows are generated at once, and the turbulent flow propagates to the surroundings. This turbulent flow is one of the causes of disturbance of the wave.

[0068]

Also, as shown in FIG. 9 (b), since the position energy of the water is converted to the vibration energy of the surrounding water at once, various turbulent flows are generated at once, and the turbulent flow propagates to the surroundings. This turbulent flow is one of the causes of disturbance of the wave.

[0069]

Thus, even from the view point of the generation of turbulent flow, it

will be understood that the excellent superiority of the wave-forming apparatus 100 for surfing of the present invention will be understood.

An embodiment of a wave-making apparatus for surfing according to the present invention will be described below.

5 **Embodiment 1**

[0070]

The configuration of the surfing apparatus and the surfing practice facility according to the present invention will be described below with reference to the drawings.

10 FIG.11 is a drawing showing a basic structure of a wave-making apparatus for surfing according to the Embodiment 1 of the present invention. In the example of FIG.11, the moving track 120 is an example in which a rail or the like is not provided. In FIG.11, the left side of FIG.11 continues to the play area of the pool 200 but is not shown.

15 FIG. 11 (a) is a view showing the overall structure from the side surface and shows the basic configuration in an easy-to-understand manner, and the accompanying structure obtained by the actual apparatus is not shown. The attachment structure for dropping the container body 110 along the slope track of the moving track 120, the reinforcing wall surface
20 and the column structure, etc. are not shown in the drawings in such a manner that the internal structure is easy to understand.

As the container body 110, any container body 110 of the first to fourth variations shown in FIG.5 may be used, but a first variation container body 110a is typically shown.

25 [0071]

As shown in FIG.11, the wave-making apparatus 100 for surfing has a

structure including a container body 110a, a moving track 120, and a delivery traction device 130. It should be noted that FIG. 11 illustrates a basic structure of a set of container bodies 110a, a moving track 120, and a delivery traction device 130, but these basic set of the structure can be provided in parallel in a plurality of set width directions, as will be described later.

[0072]

FIG.11 (b) shows the container body 110. The left side is a plan view, and the right side is a side view, and is partially transmitted so that the internal structure is easy to understand. Here, the first variation container body 110a is typically shown.

Since the container body 110 falls into the pool water 201 by dropping along the slope track 121 of the moving track 120, the weight and mechanical structural strength necessary for obtaining sufficient kinetic energy are required.

[0073]

For the width of the container body 110a, it is necessary to determine the width of the wave to be generated in the play area. Since the wave emitted from the wave-making apparatus 100 of the present invention is an isolated traveling wave advancing forward, the width of the wave is not spread and advances forward in the width as it is. Therefore, it is necessary to determine the number of the container bodies 110a and the respective widths in consideration of the width of the waves reaching the play area. The total width of all the container bodies 110a may be designed to be the width of the wave reaching the play area.

[0074]

Several examples of the number and width of the container body 110a are given below.

FIG.12 (a) is a case where the container body 110a is a plurality of (n) pieces. The front surfaces of the respective container bodies 110-1 to 110-n are arranged in a row in the width direction so as to face each other with respect to the play area. Each width is W-1 to W-n. In this arrangement, if the container bodies 110-1 to 110-n are simultaneously pushed forward while being arranged in one row, the width W of the shot waves becomes the following

$$W = W-1 + W-2 + \dots + W-n$$

This W may be designed to be the width W0 of the wave to be reached in the play area.

[0075]

FIG.12 (b) is a case in which the container body 110a is a single case. In this case, when the width of the wave to be reached in the play area is W0, the width W of the container body 110a may be designed to be $W = W0$. As shown in FIG.12 (B), one or a plurality of partition plates 111 are preferably provided inside the container body 110a as shown in FIG.12 (B). If there is a partition plate 111 installed at an appropriate interval, the advancing direction of each part of the wide wave can be adjusted, and the generation and propagation of the turbulent flow in the side direction can be suppressed, and the isolated traveling wave of good quality with small disturbance can be formed.

FIG.13 is a drawing showing a state in which an isolated progressive wave 202 of a synthetic wave is formed in a configuration in which four container bodies 110a are parallelized in a row. In FIG.13, the front side

of FIG.13 is continued to the play area of the pool 200, but the drawing is omitted.

In the same flow as in FIG.1, the four container bodies 110a are simultaneously run in parallel, and the isolated traveling wave 202 is almost simultaneously driven from the container body 110a, and the isolated traveling wave 202 becomes one large, isolated traveling wave 202 as a synthetic wave.

[0076]

Next, the moving track 120 will be described.

The moving track 120 is a moving path including a slope for moving the container body 110, and includes a slope orbit 121 moving on the slope from a position on the draft waterline of the pool to a position where at least a part of the container body 110 sinks under the draft waterline of the water 201 of the pool 200, and an in-pool traveling track 123 where at least a part of the container body travels while sinking under the draft waterline of the water 201 in the pool 200. In this example, an upper surface 122 is also provided above the draft waterline installed as a starting end.

In this example, the movement path 120 also serves as a support structure for supporting the entire object such as the container body 110 and the delivery traction device 130. The width and length of the moving track 120 may be determined by appropriately designing the width of the container body 110a and the moving length of the container body 110a.

Although the inclination of the slope track 121 is not particularly limited, it may be too long to accelerate the container 110a at too small angles. In addition, the acceleration of the container 110a becomes too

large at an angle that is too large, and the impact at the time of plunging into the water of the pool may be excessive. Therefore, the inclination may be designed in consideration of the weight of the container body 110a, the acceleration required for the container body 110a, the friction coefficient
5 between the slope track and the container body 110a. For example, an angle between 15 degrees and 35 degrees may be considered but is not limited.

[0077]

The friction coefficient between the slope track 121 of the moving track
10 120 and the container body 110, and between the slope track 121 of the moving track 120 in the in-pool traveling track 123 and the container body 110 may be designed in consideration of various conditions such as the presence of a structure such as a rail on the surface material of the moving track 120, and whether or not a wheel is installed between the
15 moving track 120 and the container body 110a.

In the example of FIG.11, the moving track 120 is an example in which a rail or the like is not provided. In this case, since the container body 110a slides down the plane of the moving track 120, a structure capable of withstanding the friction and the weight of the container body 110a is
20 required. The moving track 120 needs to be designed so that the required mechanical structural strength can be obtained because the heavy container body 110a is accelerated and traveled.

In the moving track 120, it is also possible to provide a side wall which is installed over a side surface of the entire moving range in which the
25 container body 110 moves. In FIG.11 and other figures, the side wall is omitted so that the internal structure is better understood.

[0078]

Next, a device for enhancing the initial speed of the container body 110a in the moving track 120 will be described.

The basic configuration is such that no special external force is applied
5 to the container body 110a, and the container body 110a is accelerated
only by the position energy of the container body 110a to obtain kinetic
energy. That is, the movement of the moving track 120 of the container
body 110a is a free fall movement on the slope. In this case, since the
container body 110a is hardly dropped in a state where the container body
10 110a is placed on the upper surface 122, the container body 110a is pulled
up to a predetermined position of the slope track 121 by a delivery
traction device 130, which will be described later, so that the container
body 110a is freely dropped and moved on the slope of the moving track
120.

15 [0079]

In the second configuration of the acceleration device, the movement of
the moving track 120 of the container body 110a assists the acceleration
movement by the catapult in addition to the free fall movement of the
slope track 121. Catapults are accelerators used in machines such as jet
20 aircraft and roller coasters that require rapid acceleration at the start.
On the principle of a stone thrower, a heavier object may be dropped, and
its kinetic energy may be applied to the container body 110a via a
connecting line 131, or an electromagnetic catapult may be used for
electromagnetic acceleration.

25 [0080]

The third type of acceleration device is such that the movement of the

moving track 120 of the container body 110a assists the acceleration movement received from the elastic body in addition to the free fall movement of the slope track 121. By the so-called sling shot principle, the container 110a is fixed while being hung on the back plate of the
5 container 110a in a state where tension is generated in an elastic body such as rubber, and the fixing of the container 110 is released to release the rubber. There may be one that applies the elastic force of the elastic body such as the above to the container body 110a.

[0081]

10 Next, the delivery traction device 130 will be described.

The delivery traction device 130 is a device for pulling up the container body 110a which travels along the track and rushes into the pool 200 along the moving track 120 again.

Here, the delivery traction device 130 includes a connection line 131
15 attached to a part of the container body 110a, and a power device 132. When the container body 110a travels, the connection line 131 is delivered to allow the container body 110a to drop. When the container body 110a is pulled back to the start position again, the connection line 131 is pulled up by the power device 132, and the container body 110a is pulled back to
20 the starting position above the draft waterline of the pool.

[0082]

The connection line 131 is not particularly limited, but may be a strong steel wire, a chain, a string, or the like. Although the number and mounting positions of the connection lines are not limited, the container
25 body 110a may be designed to be stably pulled up.

[0083]

The power unit 130 may be capable of pulling up the container body 110a via the connection line 131. Since the pull-up speed is required to some extent, for example, there is a mechanical driving means such as an electric drive means such as a motor capable of obtaining sufficient torque,
5 an engine, and a winch device.

[0084]

Next, the procedure from making wave for surfing by the wave-making apparatus 100 for surfing up to recovering of the container body 110a will be described.

10 FIG.11 shows a wave-making procedure of the surfing wave by the wave-making apparatus 100 of the present invention. In FIG.11, the left side of FIG.11 continues to the play area of the pool 200 but is not shown.

FIG.11 (a) shows a state in which the container body 110a is located above the slope track 121. In this state, the container body 110a is
15 supported by the connection line 131 of the delivery traction device 130.

When the connection line 131 of the delivery traction device 130 is delivered from the state of FIG.11 (a), the container body 110a starts free fall movement along the slope track 121. The movement path 120 is a flat surface, and receives frictional resistance, but the container body 110a
20 starts free fall movement along the slope track 121.

[0085]

FIG.11 (b) shows a state in which the container body 110a slides down the slope track 121 and travels on the running track in the pool. The lower part of the container body 110a travels beneath the waterline of the
25 pool 200. The state of FIG.11 (b) is similar to that of FIG.2 (2).

Thereafter, as shown in FIG.2 (3), the isolated traveling wave 202 is

shot.

When the traveling speed of the container body 110a is rapidly decreased, the water 201 inside the container body 110a becomes easy to be shot as the isolated traveling wave 202 by the relative speed
5 difference.

Therefore, as an option, it is possible to include a portion (rising portion) or a stopper gradually increasing in angle in the advancing direction on the in-pool traveling track 123 of the moving track 120.

FIG.15 is a configuration in which a stopper 125 is provided on the
10 in-pool traveling track 123 of the moving track 120. As shown in FIG.15, the container body 110 is forcibly stopped by the stopper 125 on the running track in the pool, and water inside the container body 110a is easily driven forward as the isolated traveling wave 202.

Since the container body 110a is decelerated by the resistance of water
15 when the container body 110a enters the pool 200, the stopper 125 is not essential. In the case where the container body 110 is forcibly stopped by the stopper 125, the impact applied to the container body 110a at the time of stopping should be considered.

[0086]

20 Referring now to FIG.16, in the wave-making apparatus 100 for surfing of the present invention, a procedure flow is shown until the container body 110a is returned to its initial state after wave-making of the surfing wave. In FIG.16, the left side of FIG.16 is continued to the play area of the pool 200, but the drawing is omitted.

25 In FIG.16 (a), the power unit 132 of the delivery traction device 130 is operated, the connection line 131 is pulled back, and as a result, the

container body 110a to which the connection line 131 is attached is pulled up.

The state of FIG.16 (A) is a state in which the container body 110a is pulled back along the in-pool traveling track 123 in the pool in the reverse
5 direction.

The state of FIG.16 (B) is a state in which the container body 110a is pulled back along the slope track 121 in the reverse direction.

The state of FIG.16 (B), the container body 110a is returned to the initial state shown in FIG.14 (A).

10 Thus, according to FIG.14 and Fig.16, one stroke of a wave-making for surfing by the wave-making apparatus 100 for surfing of the present invention is completed. Thereafter, the stroke of FIG.14 and FIG. 16 can be repeated to repeat the wave-making of the surfing wave.

Embodiment 2

15 [0087]

Example 2 is a configuration in which a rail is laid on a contact surface between a moving track 120 and a container body 110 to reduce friction with respect to the container body 110.

FIG.17 shows a configuration in which a rail is laid on a contact surface
20 between the moving track 120 and the container body 110a.

As shown in FIG.17 (a), the moving track 120a is a rail type moving path and includes a rail mechanism 126 provided along the track.

As the container body 110, any container body 110 of the first to fourth variations shown in FIG. 5 may be used, but a first variation container
25 body 110a is typically shown.

The laying place of the rail mechanism 126 may be a range in which the

container body 110A travels. The slope track 121, the in-pool traveling track 123, or the like may be laid down to the upper surface 122. In FIG.17 (a), a part of the rail mechanism 126 is taken out and shown.

Although the material of the rail mechanism 126 is not limited, a metal rail such as steel or titanium steel is preferable because the container body 110a which is a heavy object moves on.

[0088]

FIG.17 (b) is a drawing showing a rail mechanism 126 laid on the moving track 120. In this example, the rail mechanism 126 is laid over the upper surface of the moving track 120. In FIG.17 (b), the left side of FIG.17 (b) continues to the play area of the pool 200 but is not shown.

As shown in FIG.17 (b), the container body 110a slides and falls on the slope track 121 while being placed on the rail mechanism 126. The contact area between the container body 110a and the moving path becomes only the contact surface with the rail mechanism 126, the friction coefficient becomes small, the container body 110 is easily accelerated by the slope track 121, and the device scale can be relatively suppressed.

[0089]

By designing the apparatus such as the container body 110a and the moving track 120a in consideration of the coefficient of friction in contact with the rail mechanism 126, it is possible to design the rush speed of the container body 110a into the water in the pool 200, the formation of the isolated traveling wave 202, and the like.

Embodiment 3

[0090]

Example 3 is a configuration in which a wheel is installed between the

moving path and the container body to reduce friction with respect to the container body.

FIG.18 is a view for explaining a structure for reducing friction with respect to the container body by installing a wheel between the moving
5 path and the container body.

An example of FIG.18 (a) is a drawing showing a configuration in which a wheel is installed into the container body side. An example of FIG.18 (b) is a drawing showing a configuration in which a wheel is installed into a moving road side.

10 As the container body, any container body 110 of the first to fourth variations shown in FIG. 5 may be used. A wheel 115 is typically attached to the first variation container body 110a.

[0091]

First, while referring to FIG.18 (a), a configuration example in which a
15 wheel is installed to a container body side is described.

As shown in FIG.18 (a), a wheel 115 is installed in the lower portion of the container 110e. A shaft is attached to a portion of the container body 110e, and a wheel is rotatably attached to the shaft. The number of the shaft and the wheel 115 is not limited, but it may be determined in
20 consideration of the weight, balance, and the like of the container 110e which is a heavy object. In this example, four rows of wheels 115 are provided.

The rotation of the wheel 115 reduces the resistance for the container body 110e to travel along the movement path 120. Therefore, the
25 container body 110e can be easily accelerated by the slope track 121, and the device scale can be relatively suppressed.

By designing a device such as the container body 110e and the moving track 120 in consideration of the reduce of the resistance on the moving track 120 due to the wheel, it is preferable that a rush speed to the water in the pool 200, the formation of the isolated traveling wave 202, and the like can be obtained.

[0092]

Referring now to FIG.18 (b), a configuration example in which wheels are installed to the moving track 120 will be described.

As shown in FIG.18 (b), a wheel is not provided at the lower part of the container body 110a, but a wheel 125 is installed on the moving side. In this example, the rail mechanism 126c described in Example 2 is provided, a shaft is mounted in the rail mechanism 126c, and a wheel 125 is rotatably attached to the shaft. The attachment range of the shaft and the wheel 125 is not limited but may be in the range of all or a part of the slope track 121 requiring acceleration when the container body 110 travels. In this example, only a portion of the rail mechanism 126c is shown, and four rows of wheels 125 are shown, but may be provided in front and rear along the slope track 121.

Since the wheel 125 in the slope track 121 is rotated, the container body 110 passing thereon smoothly travels through the rail mechanism 126c of the moving track 120c, so that the resistance becomes small. Therefore, the container body 110 is easily accelerated by the slope track 121, and the device scale can be relatively suppressed.

[0093]

By designing a device such as the container body 110a and the moving track 120c in consideration of the resistance on the moving track 120c due

to the traveling of the wheel, it is possible to obtain the rush speed to the water in the pool 200, the formation of the isolated traveling wave 202, and the like.

[0094]

5 Next, a device on the pool 200 side of the surfing practice facility of the present invention will be described.

The bottom of the pool is devised so that an isolated traveling wave is formed by the above-mentioned wave-making apparatus for surfing and reaches the play area of the pool. The formed wave has a region
10 immediately before the collapse appears from the collapse area of the wave-head in the wave, and the cross-section of the wave is likely to be formed into a tubular shape.

[0095]

FIG.19 is a drawing showing the bottom of the pool 200 of the surfing
15 practice facility of the present invention in an easy-to-understand manner. FIG.19 is a plan view.

As shown in FIG.19, the bottom surface of the pool 200 includes a flat portion 210, a slope portion 220, and a base portion 230. In the center of the pool 200, there is a play area 240.

20 [0096]

The flat portion 210 is a flat portion following the range of movement of the container body 110. The front of the wave-making apparatus for surfing is spread. In the flat portion 210, the depth of the pool is relatively deep.

25 [0097]

The slope 220 is a slope of the upward gradient provided near the start

position of the play area 240 following the flat portion 210. The water depth of the pool gradually becomes shallow by passing through the slope.

[0098]

Here, the slope 220 is not provided parallel to the direction of the traveling wave but has skew.

That is, the slope portion 220 has a skew with respect to the moving direction in which the container body 110 moves. In the example of FIG.19, the slope 220 is substantially triangular. As a result of the skewed arrangement of the slope portion 220, the wave reaching the area of the slope portion 220 at the shortest time when the traveling wave progresses, starts to become shallow, and passes through the slope portion 220. The adjacent waves then begin to enter and pass the slope 220 area. In this way, the change in the water depth of the traveling wave gradually occurs from one side to the other.

[0099]

The base portion 230 is a base portion having a shallow bottom after through the slope portion 220. The base portion has a play area 240. Since the back side of the base part 230 approaches the end part of the pool, the play area 240 is not set at the back side.

The reason why a tubular wound wave is easily formed can be explained as follows.

[0100]

The speed of the wave is affected by the water depth of the pool.

Physically, it is known that the deeper the water depth, the faster the wave velocity, and the shallower the water depth, the slower the velocity of the wave. Therefore, by providing the slope part 220 rising from the

flat part 210, the speed of the wave becomes slow according to the depth of the pool. During the passage of the slope 220, a so-called tube-shaped winding is formed so that a velocity difference in the longitudinal direction of the wave is accumulated, so that the back side of the wave is covered with the front side, and eventually the wave head is collapsed forward.

[0101]

Since the slope 220 has a substantially triangular shape having a vertex, the speed becomes slow from the position corresponding to the vertex of the triangle, and the speed is gradually delayed toward the side of the triangle. In one traveling wave, a portion corresponding to the vertex in which the collapse region occurs at the earliest time becomes the earliest collapse portion and the adjacent area sequentially in the lateral direction so as to be continuous from the collapse region, and a tube-shaped wound wave suitable for a surfing such that the wave head in the collapsed region and the collapsed region is continuous is formed. In this case, a pair of right and left tubular winding waves which are divided right and left with the vertex of the triangle as a boundary are formed.

[0102]

The shape of the slope 220 may be skewed relative to the traveling wave and may be of various shapes. The example of FIG.20 is an example in which the shape of the slope 220 is provided so as to run obliquely. In this example, one tube-shaped winding is formed from one of the pools toward the other.

[0103]

In order to enjoy the surfing, it is necessary that the width of the play

area is wide to some extent, and the length of the tube-shaped wound wave to be formed is longer than a certain degree. As shown in FIG.13, a configuration in which a plurality of sets of wave-making apparatuses 100 for surfing are arranged in a row is preferable.

5 [0104]

While the preferred embodiment of the configuration of the wave-making apparatus for surfing of the present invention has been shown and described, it will be understood that various changes may be made without departing from the scope of the invention.

10 **Industrial applicability**

[0105]

The wave-making apparatus for surfing of the present invention can be widely applied to a wave-making apparatus for an artificial surfing or the like installed indoors or outdoors.

15 **Description of the reference numerals**

[0106]

100 Wave-making apparatus for surfing

110 Container body

111 Partition plate

20 112 Wheel

120 Moving path

121 Slope track

122 Upper surface

123 In-pool traveling track

25 124 Lane partition wall

125 Stopper

	126 Rail mechanism
	127 Wheel
	130 Delivery traction device
	131 Connecting line
5	132 Power device
	200 Pool
	201 Water
	210 Flat part
	220 Slope part
10	230 Base portion
	240 Play AREA

The Claims

What we claimed is

1. A wave-forming apparatus for producing a wave for surfing in a play
5 area of a pool, comprises:

a container body having at least a bottom plate capable of at least temporarily capturing water on the bottom plate;

a moving track including a slope track for moving the container body in which the container body moves along from a start position above a draft
10 waterline of the pool to a lower position where at least a part of the container body sinks under the draft waterline of the pool; and an in-pool traveling track for moving the container body forward in a state that at least a part of the container body sunk in the pool facing the play area;

wherein the container body moves forward on the slope track and the
15 in-pool traveling track in a state where the front surface of the container body faces the play area, and discharges the water captured by the container body toward the play area ahead.

2. A wave-forming apparatus according to claim 1, wherein the movement
20 of the container body in the moving track is a free fall movement on the slope.

3. A wave-forming apparatus according to claim 1 or 2, wherein the container body comprise only a bottom plate, which bottom plate has a
25 slope bottom that the front side in the advancing direction is low and the rear side is high.

4. A wave-forming apparatus according to claim 1 or 2, wherein the container body comprises a bottom plate and a back plate.
- 5 5. A wave-forming apparatus according to claim 3 or 4 wherein the container body comprises side plates additionally.
6. A wave-forming apparatus according to any one of claims 3 to 5, wherein the container body comprises a detachable weight, the weight of
10 the container body can be adjusted by providing the detachable weight on a part of the container body.
7. A wave-forming apparatus according to any one of claims 1 to 6, further comprising a lane partition wall built along the side of the traveling lane
15 for the container body in the in-pool traveling track.
8. A wave-forming apparatus according to any one of claims 1 to 7, wherein the movement of the container body in the moving track adds an acceleration movement by a catapult or an acceleration movement using
20 an elastic body provided at the position on the slope track can also be combined in addition to the free-falling movement on the slope.
9. A wave-forming apparatus according to any one of claims 1 to 8, wherein a plurality of container bodies are provided, and the container
25 bodies are arranged in a row in a width direction so as to face the front surfaces of the respective containers with respect to the play area.

10. A wave-forming apparatus according to any one of claims 1 to 8,
wherein the container body is a singular, but the width of the container
corresponds to the width of the wave to be generated, and further
5 comprising one or plural of inner partition plates provided so as to be
orthogonal to the front surface in the container body.

11. A wave-forming apparatus according to any one of claims 1 to 10,
further comprise a return traction device for pulling back the container
10 body to a starting position again after being dropped along the slope track
of the moving track,

wherein the return traction device is provided with a connection line
attached to a part of the container body, and a driving force for pulling up
the connection line and pulling back the container body to the starting
15 position above the draft waterline of the pool.

12. A wave-forming apparatus according to any one of claims 1 to 11,
wherein the moving track employs a rail mechanism along the track as a
rail type moving track.

20

13. A wave-forming apparatus according to any one of claims 1 to 11,
wherein a wheel provided between the bottom surface of the container
body and the moving track.

25 14. A surfing play facility comprising:
a pool;

a wave-forming apparatus according to any one of claims 1 to 13
installed in the pool;

wherein the bottom surface of the pool is devised as including:

a flat part following the range where the container body moves, and

5 a slope part of an upward gradient is provided in the vicinity of the
start position of a play area following the flat part,

wherein the slope part has angle given to a moving direction in which
the container body moves.

10 15. A surfing play facility according to claim 14, wherein the slope portion
has a skew and has a substantially triangular shape having a vertex so as
to face the container body direction.