United States Patent [19]

Le Mehaute

[11] **3,802,697**

[45] **Apr. 9, 1974**

[54] **WAVE GENERATOR FOR SIMULATED SURFRIDING**

[76] Inventor: **Bernard J. Le Mehaute,** 2159 Highland Vista Dr., Arcadia, Calif. 91006

[22] Filed: **Oct. 14, 1971**

[21] Appl. No.: **189,219**

[52] **U.S. Cl.** .... **272/17,** 4/172.16, 35/19 R, 35/29 R, 61/1 R, 73/148, 272/3, 272/32

[51] **Int. Cl.** **A63g 31/16**

[58] **Field of Search** .... 272/1 B, 3, 16, 17, 26; 4/171, 172, 172.16, 178; 35/19 R, 29 R, 29 B; 61/1 R, 21; 73/148

[56] **References Cited**

UNITED STATES PATENTS

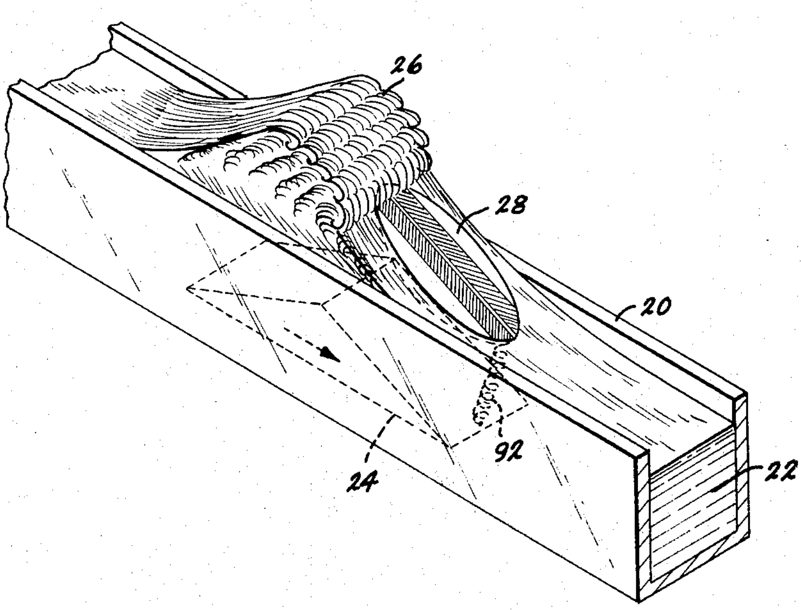
3,473,334	10/1969	Dexter	61/1 R
3,478,444	11/1969	Presnell et al.	35/19 R
1,718,181	6/1929	Province et al.	61/21
2,815,951	10/1957	Baldanza	35/29 R

Primary Examiner—Richard C. Pinkham
Assistant Examiner—R. T. Stouffer
Attorney, Agent, or Firm—Harris, Kern, Wallen & Tinsley

[57] **ABSTRACT**

A wave generator including a water filled channel and a wave forming body positioned in the channel so that water is deflected by the upper surface of the body for simulating to a rider of a boat or surfboard attached to the wave forming body and floating on the top surface of the water the thrill of surfriding while insuring a safe controlled environment. The wave forming body is either movable or stationary as long as movement exists relative to the water; the apparatus may also form part of a surfriding teaching device or boat model testing facility.

8 Claims, 11 Drawing Figures



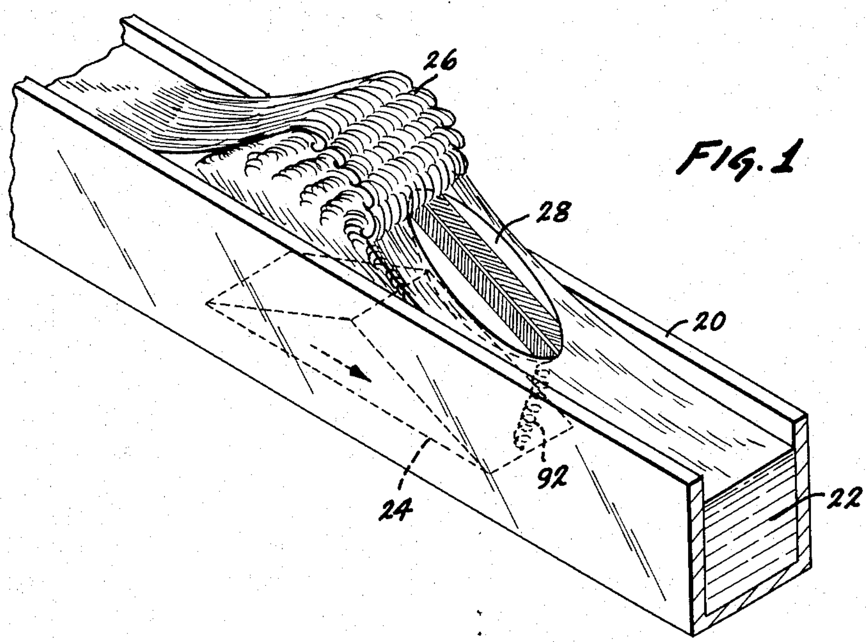


FIG. 1

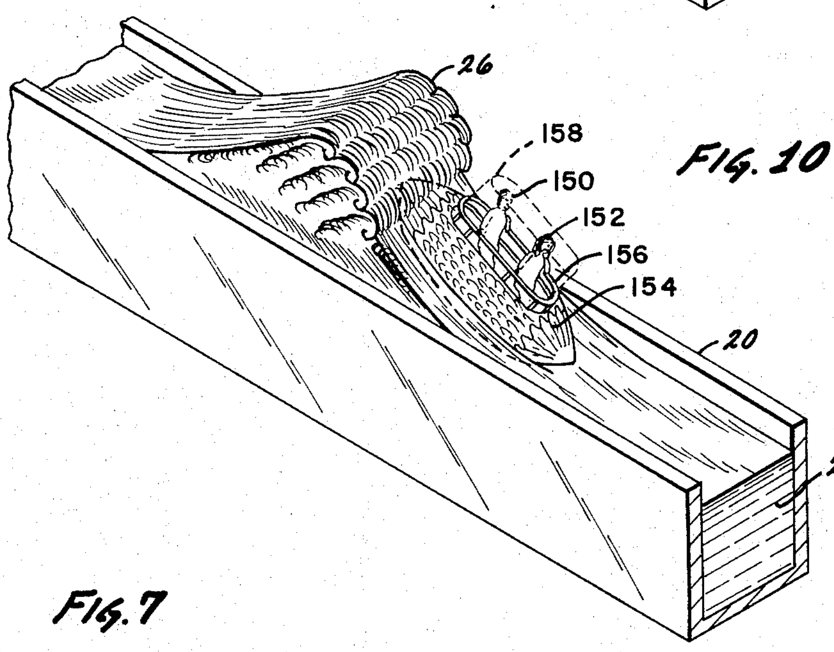


FIG. 10

FIG. 7

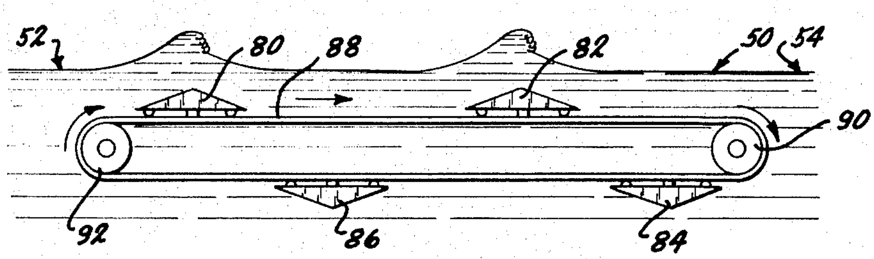


FIG. 2

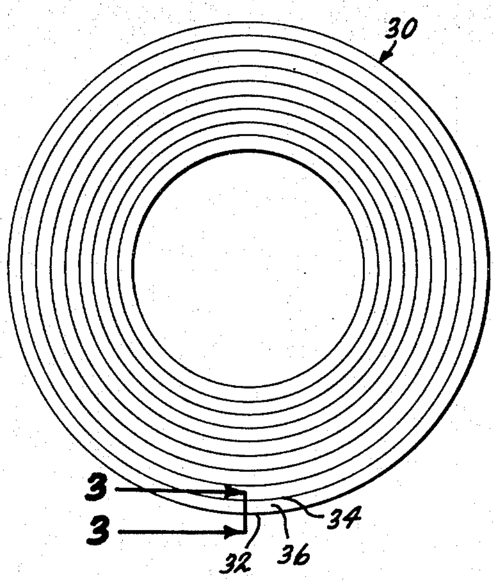


FIG. 4

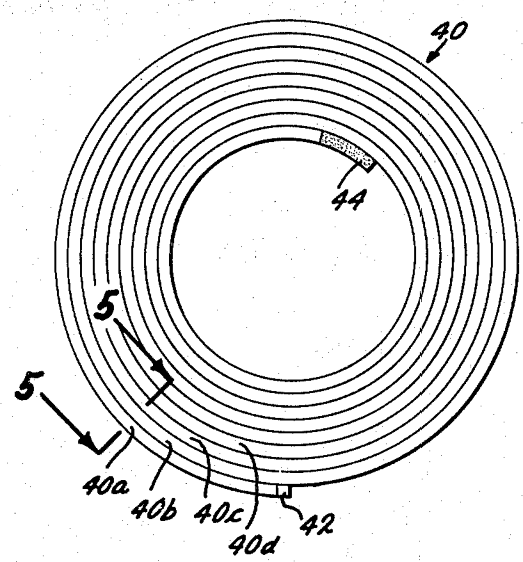


FIG. 3

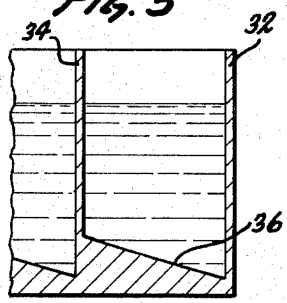


FIG. 5

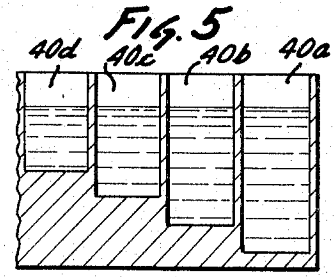


FIG. 6

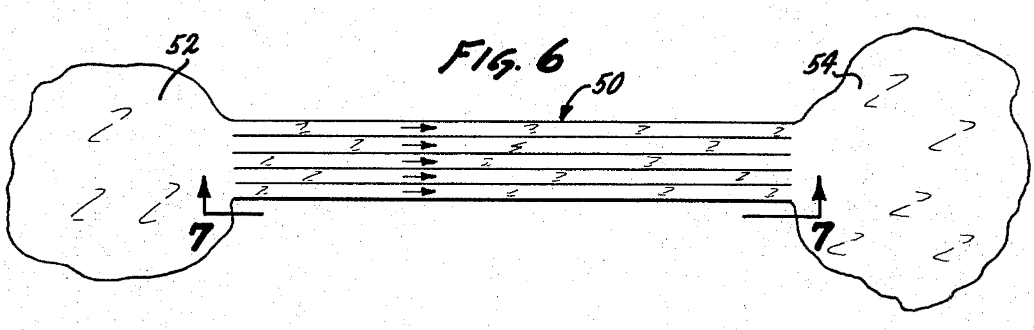


FIG. 8

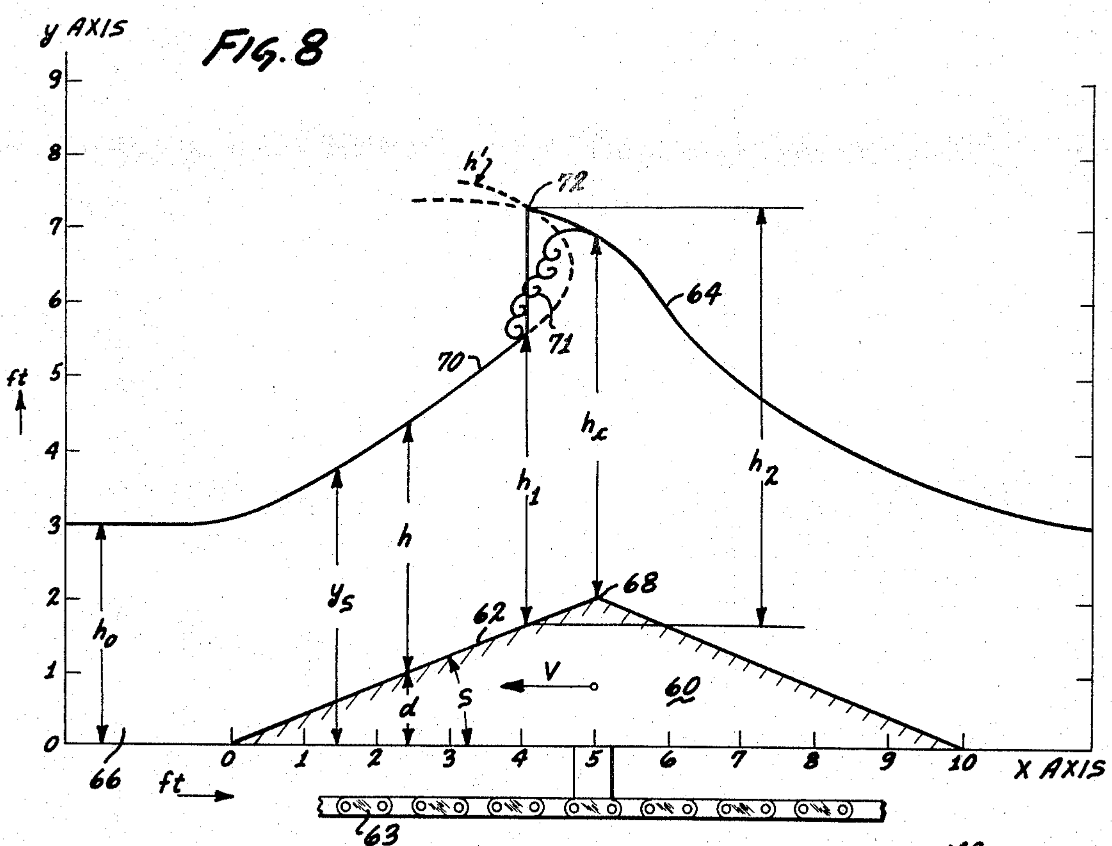


FIG. 11

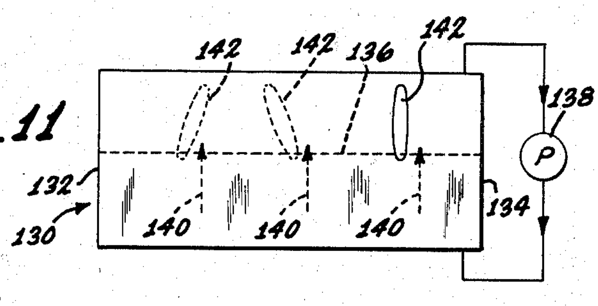
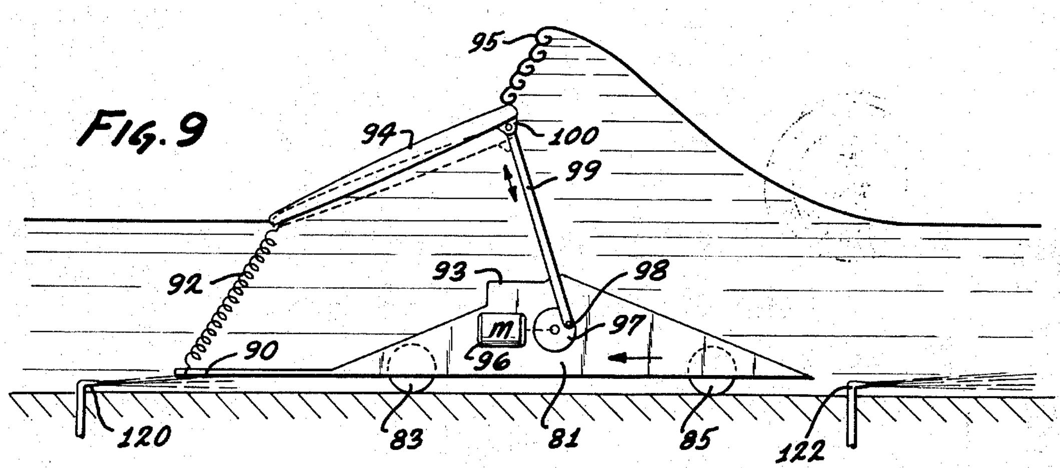


FIG. 9



WAVE GENERATOR FOR SIMULATED SURFRIDING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for simulating surfriding or for model testing and more particularly to an apparatus of the type which may be used in an amusement park where the apparatus creates and controls waves upon which a ride simulating a real surfride may be offered; in an analogous manner different wave forms may be created to test their effects on boat models or other devices subjected to water action.

2. Description of the Prior Art

During the decade of the 1960's, interest in the sport of surfriding has increased at an exceptionally rapid rate among young people especially those living along the West Coast of the United States. The sport may simply be explained as the riding of a relatively flat board slightly ahead of a properly formed wave. The most commonly desired waves are of the more gentle type commonly referred to as spilling breakers; the surfer attempts to locate his surfboard just forward of the wave crest. In this fashion, the wave will push the surfer toward shore at the same velocity as the traveling wave or at a greater velocity if the surfer proceeds at an angle to the wave. A fair degree of skill is involved as well as timing and balance so as to restrict the sport to physically well fit people.

As is often done, most daring and exciting sports are simulated in one fashion or another such as in the form of toys or amusement type devices. For example, automobile racing has been simulated to a high degree by self-powered toy vehicles; mountain aerial tram rides have been simulated by amusement park aerial trams. Nevertheless, it is often difficult to simulate certain types of sports or activities due to their very nature. This is true of the sport of surfriding.

It is to be understood that not only must an apparatus be devised which will closely simulate the desired activity but the apparatus must be economical the he standpoint of the manufacturer and the operator if commercial success is to be achieved. Further, if the apparatus is to be of the amusement park variety, the apparatus must have a high level of inherent safety.

A system for testing boat models or other structures subjected to sea action must have close simulation to actual conditions as well as fine control so as to limit test variables. Once again economics is always a practical limitation. In the past, simulation was accomplished by wave generation. In turn, wave generation was developed by use of a paddle or a sudden surge of water in specially designed channels. For example, a channel having a tapered width may be made to form a spilling breaker at a particular location; or a spilling breaker may be formed intially and retained by a channel having a continually decreasing depth. However, a breaking wave can not be retained in a channel of generally constant cross section along its length with such a system.

SUMMARY OF THE INVENTION

The present invention fulfills all of the above-mentioned requirements by providing in one variation an amusement park apparatus for simulating the sport of surfriding comprising a liquid carrying channel of generally constant depth; a liquid disposed in the channel to a predetermined level; and means, including an upper surface, moveable relative to the liquid for creating when the liquid is deflected by the surface a wave suitable for surfriding. Included with the above-mentioned elements may be a carrier for simulating a surfboard or boat flexibly connected to the wave creating means and positioned to float on the formed wave. In a somewhat broader sense, the present invention also includes the subcombination of a wave generator apparatus comprising a liquid carrying channel; a liquid disposed in the channel to a predetermined level; and means in the channel moveable relative to the liquid for creating a wave.

It is a general aim of the present invention to provide a wave generator apparatus which will closely reproduce and control a wave for surfriding, the apparatus being available at reasonably low cost.

Another aspect of the present invention is to provide a wave generator apparatus which will cause a buoyant carrier such as a simulated cutout log or surfboard to be moved thereby simulating surfriding to a rider positioned on the carrier.

Another object of the present invention is to provide a wave generator apparatus which is simply constructed, easy to operate, easy to use and reliable.

It is a further aim of the present invention to provide an amusement apparatus which will closely simulate surfriding in a safe, controlled environment.

Yet a further aspect of the present invention is to provide an amusement apparatus which is inexpensively manufactured and capable of efficient operation.

A correlary object of the present invention is to provide an amusement apparatus which will give a rider an exciting experience and where the apparatus involved is simply constructed and reliable in operation.

Still a further aim of the present invention is to provide an apparatus which may be used to teach the skills necessary for surfriding without exposing the student to any dangers; a complementary object is to provide an apparatus for testing boat models subjected to ocean conditions.

Yet another aim of the present invention is to provide an apparatus which will create a spilling breaking wave in a controlled situation.

Another object of the present invention is to simulate the thrill of surfriding with a commercially feasible apparatus having a low power requirement.

A further major aspect of the invention is the recognition of the application of certain hydraulic theories to the design of a practical amusement park system.

Other objects and advantages of the invention will appear from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the present invention illustrating a channel, a moving underwater wave forming element shown in dotted line and a surfboard.

FIG. **2** is a plan view of a series of concentric channels as designed for an amusement park.

FIG. **3** is an enlarged elevational sectional view taken along **3—3** of FIG. **2.**

FIG. **4** is a plan view of a spiral channel.

FIG. **5** is an enlarged elevational sectional view taken along **5—5** of FIG. **4.**

FIG. 6 is a plan view illustrating a series of linear channels between two pools of water.

FIG. 7 is an elevational view of a plurality of wave forming elements mounted so as to move in a continuous manner taken along lines 7—7 of FIG. 6.

FIG. 8 is a diagrammatic elevational view illustrating a wave forming element creating a spilling breaking wave.

FIG. 9 is a diagrammatic elevational view similar to that shown in FIG. 8 and including a carrier mounted to the wave forming element.

FIG. 10 is a perspective view illustrating riders seated upon a simulated log boat.

FIG. 11 is a plan view of a surfriding training device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

While the present invention is susceptible of various modifications and alternative constructions, illustrative embodiments are shown in the drawing and will herein be described in detail. It should be understood, however, that it is not the intention to limit the invention to the particular forms disclosed; but, on the contrary, the intention is to cover all modifications, equivalents and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring now to FIG. **1**, the invention comprising in a simplified embodiment a channel **20** having a quantity of water **22** through which a wave forming element **24** (shown in dotted line) moves so as to create a wave **26**. Pushed just ahead of the wave's crest is a simulated surfboard **28**.

From hydraulic theory, it is known that liquid flowing along an "open" channel, i.e., having a free surface, at a speed greater than $\sqrt{gh_o}$, where g is the acceleration of gravity and h_o is depth, may experience a "hydraulic jump" or a sudden increase in depth if the bottom of the channel is altered suddenly or if an obstruction is placed in the channel. For example, such an obstruction may be accomplished by a sill. Practical applications of hydraulic jumps are found primarily where dissipation of energy is desired. Using this hydraulic jump theory, it has been determined that a wave can be generated by having a wave forming body or element traveling along a channel at a velocity so that a unit of measure called the "Froude number" is unity or greater. Simplistically, the Froude number may be thought of as the ratio of inertia force to gravity force acting upon a unit of liquid as it moves along the channel. The Froude number is defined as a function of velocity, of the water depth and of the acceleration due to gravity. The power required to operate the wave forming element is that equal to the rate of energy dissipation (turbulence) caused by the moving wave forming element plus the mechanical and hydrodynamical friction (plus the power required to start a wave from an initial at rest condition). By having a properly designed wave forming element and knowing the dimensions of the channel and the desired type of wave, a system can be designed which will simulate a spilling breaking wave which is so desirable for surfriding, for example. Other types of waves may also be generated. Additionally, since the system may be completely controlled, such as by adjusting the speed of a counter current (as will be explained herein below), the velocity with which the wave travels along the channel may be slowed so as to provide a safe environment in which simulated surfriding may be accomplished.

An important aspect of the present invention is to use the above described theory and develop a commercially feasible system. This is done, as illustrated in FIG. **1** where the wave forming element **24** and the water **22** are relatively moveable. Relative movement may be accomplished in any one of three ways, moving the wave forming element while keeping the water stationary, keeping the wave forming element stationary while moving the water, or moving the wave forming element while the water is moved in a counter direction.

A correlary object of the present invention to provide a wave generator apparatus which will closely reproduce a surfing wave. Once the wave is generated, surfriding may be simulated at a reasonably low cost with a simply constructed and reliable apparatus having few moving or complicated parts. Referring now to FIGS. **2** and **3**, there is shown a series of channels which may be used as part of an amusement park apparatus. The channels **30** are formed as concentric rings and may be made of any suitable material. The channels have a generally U-shaped cross-section including an outer wall **32**, an inner wall **34** and a bottom wall **36**. As illustrated in FIG. **3**, the bottom wall **36** may be sloped so as to have an increasing depth when moving from the inner wall **34** to the outer wall **32**. Thus, the bottom wall intersects the inner wall to form an obtuse angle while the bottom wall intersects the outer wall to form an acute angle. As can be appreciated, the required relative velocity for the wave forming element is a function of depth so that a liquid directed in a circular path would require a greater depth along the outer portion of the channel than the inner portion if the wave formation is to be retained perpendicular to the direction of movement.

Referring now to FIGS. **4** and **5**, there is illustrated a channel **40** having a spiral shape where a wave may be generated by a plunger or by the sudden release of water at an outer end **42**. A wave absorber is located at an inner end **44** of the spiral. Since such a generated wave would continually decrease in height, it is necessary to continually decrease the channel depth in order to retain a breaking wave. This is graphically shown in FIG. **5** by a channel which decreases in depth such as illustrated with sections **40***a*, **40***b*, **40***c* and **40***d*. The profile shown in FIG. **5** may also be used for the FIG. **2** embodiment with or without a sloping bottom wall since a smaller diameter channel would have to have a lesser depth than a larger diameter channel if the formed waves in each of the channels are to move abreast one another. It is to be understood that when using a circular or curvaceous channel, the width of the channel is sufficiently narrow, the diameter or radius of curvature of the channel is sufficiently large, and the wave length sufficiently long so that the wave moves around the curved channel without being reflected from the side walls. It is to be understood that any curvaceous shape (in plan view) may be used depending upon the setting into which the apparatus is to be placed.

Referring now to FIG. **6**, a linear channel system **50** is illustrated between two pools **52, 54** of water. In the FIG. **6** embodiment, it is contemplated that a wave may be generated at one end of the system such as immediately adjacent one of the pools **52** and propagated toward the other pool **54.** Once again the depth dimension and the width dimension of the channel are closely controlled as as to allow generation of a wave form of predetermined characteristics. Once again the actual shape (in plan view) of the system may be altered since the channel may be designed to meet whatever course requirements are imposed.

Referring now to FIG. **8,** there is illustrated a wave forming element **60** having a wave forming upper surface **62.** The wave forming element is attached to a chain **63,** so as to allow its movement relative a liquid such as water **66.** As explained above when the velocity difference between the wave forming element and the water is sufficient, a proper wave is developed. The obliquely disposed surface **62** will form a "spilling breaker" wave as illustrated having a small degree of turbulence in a region designated **71.** This wave is generally considered to be gentle as compared to a "plunging breaker" which is more violent or a "surging breaker" which is more violent still. A more detailed discussion of the kinds of breaking waves which can be formed may be found in the March 20, 1970 issue of JOURNAL OF GEOPHYSICAL RESEARCH, Volume 75, No. 9, entitled "BREAKING WAVES ON GENTLE SLOPES." A description of different kinds of breaking waves may be found in OCEANOGRAPHICAL ENGINEERING, by R. WIEGEL, published by the Academic Press.

An optimum wave forming upper surface can best be determined from scale model experimentation. However, it is to be understood that should it be desired, a complicated mathematical procedure could also be used to develop the surface profile. Using the scale model approach, a fairly close profile may be roughly calculated initially, after which experimentation may be used for refinement, if desired. It is to be understood that either a projecting type of wave forming element, such as shown in FIG. **8,** or a depression type wave forming element may be used though only the projecting type element will be fully described. Those skilled in the art will be familiar with the depression type element.

For purposes of the calculation, friction between the wave forming element and the water flowing immediately adjacent the element is neglected as will the path curvature effect occuring beneath the crest of the formed wave; the pressure distribution along a vertical is considered to be hydrostatic, i.e., equal to ρgz where z is the distance from the free surface and ρg is the specific gravity. Consider the wave forming element **60,** FIG. **8** moving at a velocity V in still water and a Cartesian system of coordinates x–y moving at the same velocity V. The water motion will be analyzed by a Galilean transformation, i.e., with respect to a moving coordinate system. Since the relative velocity of the water with respect to the wave forming element is V_o, we have

$$V_o^2/2_g + y_s = K \text{ (a constant)},$$

where $y = y_s$ is the free surface elevation of the water above a base line defined by $y = o$. Inserting $q = V_o h_o = Vh$ where q is the quantity of water moving through a reference plane disposed perpendicular to the plane of the drawing of FIG. **8,** $y_s = h_o$ at infinity (away from the wave forming element), and $d = Sx$ where S is the slope of the wave forming surface **62,** and d is the height of the surface of the wave forming element from the x − axis, the equation $V_o^2/2_g + y_s = K$ may be written $q^2/2\,gh^2 + h + d = K$ or $K - Sx = (q^2/2gh^2) + h$. If the wave forming element is to be 10 feet high, the slope $S = \pm 0.4$. If $V = 20$ feet per second and $h_o = 3$ feet, $K = 9.2$ feet. A curve, $K - Sx$ may be defined as a function of h which will allow a free surface water elevation **64** to be determined on the upstream side of the wave forming element. Similar calculations can be accomplished on the downstream side of the wave forming element. At the zenith **68** of the wave forming element, the water depth, h_c, is such that

$$V = (gh_c)^{1/2}$$

or

$$h_c = (q^2/g)^{1/3};\ h_c = 4.8 \text{ feet.}$$

The momentum flux of the water is defined by

$$F = q^2/gh + h^2/2.$$

A curve F as a function of h may also be defined. The location of the moving breaking wave (hydraulic jump) is characterized by a loss of energy; however, if the gravity effect is neglected, the momentum of the system is constant. Therefore, the breaking wave is located at a point where the free surface elevation **64** from downstream crosses a line of "conjugated" depth **70** as defined by the equation: $F = (q^2/gh_1) + (h_1^2/2) = (q^2/gh_2) + h_2/2$. This location is designated **72** in the drawing. The location is $x = 4$ ft. as illustrated in FIG. **8.**

Referring now to FIG. **7,** four wave forming elements **80, 82, 84** and **86** are shown mounted to a chain **88** which revolves around two sprockets **90** and **92.** When placed in a system such as that described for FIG. **6,** a series of properly formed waves may be generated. It is to be understood that although a chain drive is illustrated a wave forming element may be attached to a continuous belt or cable or may be mounted to rollers or wheels to provide mobility. Any suitable moving mechanism may be used without detracting from the invention herein.

It is another important aspect of the present invention to provide a commercially feasible amusement park apparatus which is simply constructed, reliable in operation and yet provides a thrilling simulation of surfriding. Additionally, the simulation is provided in a safe environment. Referring now to FIG. **9,** there is illustrated a wave forming element **81** on rollers **83** and **85.** The element **81** is very similar in shape to the wave forming element **60** of FIG. **8.** The wave forming element **81** has a forward portion **90** to which is mounted one end of a spring **92.** The other end is connected to a buoyant carrier **94** such as a simulated surfboard (or perhaps a boat). It is to be noted that the placement of the carrier is just beneath the white water breaking region **95** which would be the proper placement of a surfboard during actual surfriding. A projection **93** in the upper surface **91** insures the "stability" of the moving hydraulic jump. Normally the position of the generated hydraulic jump (wave) would be unstable in that its position would vary somewhat with time. By using the projection **92,** a discontinuity on the surface **91,** the hydraulic jump will stabilize in the position as shown. Spring mounting the surfboard adds flexibility to more closely simulate the "feel" of a surfboard. To further simulate a surfboard and the various forces acting upon it, a locomotion mechanism is provided having a motor **96** operatively connected to a rotatable disk **97** to which is rotatably pinned one end **98** of a link **99.** The other end **100** of the link is pivotally connected to the carrier **94.** The motor may provide a periodic motion to the carrier or the motor may be programmed to provide a more random motion. It is to be noted that total control of the surfboard carrier is maintained. The surfboard cannot "break away" as a real surfboard often does. Additionally, the surfboard carrier never leaves its optimum portion vis a vis the wave thereby enhancing the apparatus as a teaching device.

It is to be understood that while a surfboard is provided as an example of a carrier, a more traditional boat or simulated cutout log, for example, may be used as a passenger carrier as shown in FIG. **10.**

As mentioned earlier, proper wave generation is a function of the velocity of the wave forming element. However, as also mentioned, this velocity is a relative one between the wave forming element and the liquid through which it is traveling. If the velocity of the wave forming element is decreased, proper wave generation may still be accomplished by moving the liquid in a direction opposite that of the wave forming element. Movement of the liquid may be accomplished by the use of a plurality of small liquid carrying conduits or jets such as the jets **120** and **122** of FIG. **9.** Other water moving apparatus such as a propeller may also be used instead of the jets.

In a closed system constant movement of the wave forming element will impart a momentum flux to the water; for example, in a system with circular channels the wave forming elements will cause the water to be stirred; the water's velocity will increase to that of the wave forming element so that the relative velocity between the element and the water would tend toward zero with time. The jets will prevent this by insuring a zero velocity for the water or by creating a counter current to the movement of the element. By having a counter current the same wave effect is achieved with a lower wave forming element velocity. The element's velocity can even be reduced to zero with the water velocity being sufficient to form a wave. A more slowly moving element will help ensure the safety and pleasure for any riders.

A desired absolute velocity of the wave forming element has been calculated to be about 20 feet per second when the liquid is moved in an opposite direction at about 12 feet per second.

The dimensions of an amusement system channel may be varied as desired or as determined by other factors such as the width of the boat to be used. It is contemplated that the width may vary from 2 to 5 feet or more while the depth may be 3 to 7 feet or less as, for example, for a kiddie ride. If a FIG. **2** system is desired, a width of 3 feet and a diameter of 300 feet for the outer channel is recommended. The buoyant carrier may be 4 feet long and, depending upon its width, may be designed to support one, two or three people. Once again, scaling up or down may be accomplished or the system may be distorted from that described without deviating from the invention herein. The power needed to operate such a system is a function of inertial forces of the various parts, the kinetic and potential energy built into the wave, the energy dissipated by the breaker and the drag force. The power requirement is determined by the maximum power required to start the system. Where the predetermined water depth is 3 feet, assumed start up time 15 seconds, and $V = 20$ ft. per second, the horsepower calculates to be 3 per foot of width. Thus, if the channel is 3 feet wide and 10 surfboards or boats are moved, a total of about 90 H.P. is required. Operation of the jets require about 10 H.P. so that for a system as described, a total of about 100 H.P. is needed. The power requirement may be scaled approximately by the formula $\lambda^{7/2}$ where λ is the scale for dimension (ratio for wave height or water depth).

Referring now to FIG. **10,** there is illustrated two riders **150, 152** seated within a "log" boat **154.** About the riders is a protective railing **156.** Further protection may be accomplished with a plastic shield illustrated diagrammatically by a dotted line **158.** FIG. **10** illustrates a preferred form the invention may take as an amusement apparatus. Loading of the boat may be accomplished from a platform (not shown) which is lowered from above the boat and which travels at the same speed as the boat. Or, more conventional loading techniques may be used including the stopping of the installation.

Another embodiment may include a channel, a wave forming element and a carrier as part of a larger system. For example, such a system may include a conventional boat ride having a slide shoot moving the boat to a lower level so as to require something to lift the boat to its original level. To accomplish this, a channel may be placed at a slight incline (such as 1 inch or 2 inches from a horizontal plane) and have the wave forming element move upwardly along the channel so that during this upward movement riders would have a simulated surf ride experience. In such an arrangement a gravity motivated counter current may be easily developed so that the upward movement could proceed relatively slowly and yet still develop the desired breaking wave.

It is to be further understood that the wave forming element may be moveable as described or stationary. For model testing, a stationary wave forming element or flow disturbing means may be more convenient for a researcher. As a surfriding training device, a stationary wave forming element may be more suitable. Referring now to FIG. **11,** a tank **130** forms a channel between lateral walls **132, 134.** A wave forming element such as already described or which may be a depression in the floor of the tank is represented by a dotted line **136.** A water current (depicted by dotted arrows **140**) is established by a pump **138** causing the water to pass the wave forming element. A surfboard **142** is tethered in position relative the wave forming element. As depicted in phantom line the surfboard may be moved laterally about the tank by a student by shifting his weight and angling the surfboard relative the direction of water flow. This will be more easily accomplished as a student increases his surfing skills.

I claim:

1. An amusement apparatus for simulating the sport of surfriding comprising:

a liquid carrying channel having two oppositely disposed parallel side walls and a floor, said floor intersecting one of said walls to form an obtuse angle and the other of said walls to form an acute angle;

a liquid disposed in said channel; and means, including an upper surface, movable relative to said liquid for forming when said liquid is deflected by said surface a wave generally stationary relative to said wave forming means and of generally constant height when said relative movement between said liquid and said wave forming means is constant, said wave being suitable for surf riding; and wherein

said channel has a constant depth dimension in a direction parallel to the relative movement of said liquid and said wave forming means.

2. An amusement apparatus for simulating the sport of surfriding comprising:

a liquid carrying channel;

a liquid disposed in said channel;

means, including an upper surface, movable relative to said liquid for forming when said liquid is deflected by said surface a wave generally stationary relative to said wave forming means and of generally constant height when said relative movement between said liquid and said wave forming means is constant; and

a carrier connected to said wave forming means and positioned to float upon said formed wave.

3. An apparatus as claimed in claim **2** including means connected to said wave forming means for imparting motion to said carrier.

4. An amusement apparatus for simulating the sport of surfriding comprising:

a liquid carrying channel having a constant width dimension;

a liquid disposed in said channel;

a plurality of liquid carrying conduits spaced along said channel for moving said liquid along said channel;

means, including an upper surface, movable relative to said liquid for forming when said liquid is deflected by said surface a wave generally stationary relative to said wave forming means and of generally constant height when said relative movement between said liquid and said wave forming means is constant; and

a carrier connected to said wave forming means and positioned to float upon said formed wave; wherein

said channel has a constant depth dimension in a direction parallel to relative movement of said liquid and said wave forming means.

5. A wave generator apparatus for allowing simulated surfriding comprising:

a channel having a substantially constant width dimension and having a circular form in plan view and including a smaller radius portion and a larger radius portion, the depth at the smaller radius portion of said channel being less than the depth at said larger radius portion of said channel;

a liquid disposed in said channel to a predetermined level;

means in said channel for forming a breaking wave generally stationary relative to said wave forming means and of generally constant height when the relative velocity between said liquid and said wave forming means is constant; and

means cooperating with said channel for imparting a relative movement between said liquid and said wave forming means.

6. An amusement apparatus as claimed in claim **2** including

a projection in said upper surface of said wave forming means for stabilizing the formed wave.

7. An amusement apparatus as claimed in claim **2** wherein

said wave includes a turbulent portion; and

said carrier is positioned slightly upstream of said turbulent portion.

8. An amusement apparatus as claimed in claim **2** wherein

said wave formed is a breaking wave having a white water breaking region;

said wave forming means includes a portion having a maximum height; and

said white water breaking region is maintained slightly upstream of said portion of maximum height.

* * * * *