

FORM 1

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

597491

APPLICATION FOR A STANDARD PATENT

I\We,

NIPPON KOKAN KABUSHIKI KAISHA

of

1-2, 1-CHOME, MARUNOUCHI,
CHIYODA-KU
TOKYO
JAPANhereby apply for the grant of a standard patent for an
invention entitled:

WAVE MAKING APPARATUS

which is described in the accompanying complete specification

Details of basic application(s):

Number of basic application	Name of Convention country in which basic application was filed	Date of basic application
134979/87	JP	01 JUN 87

My/our address for service is care of CLEMENT HACK & CO., Patent Attorneys, 601 St. Kilda Road, Melbourne 3004, Victoria, Australia.

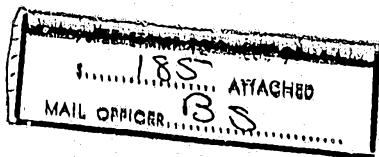
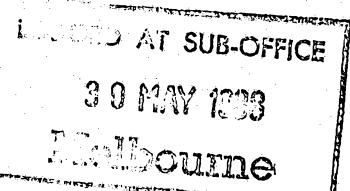
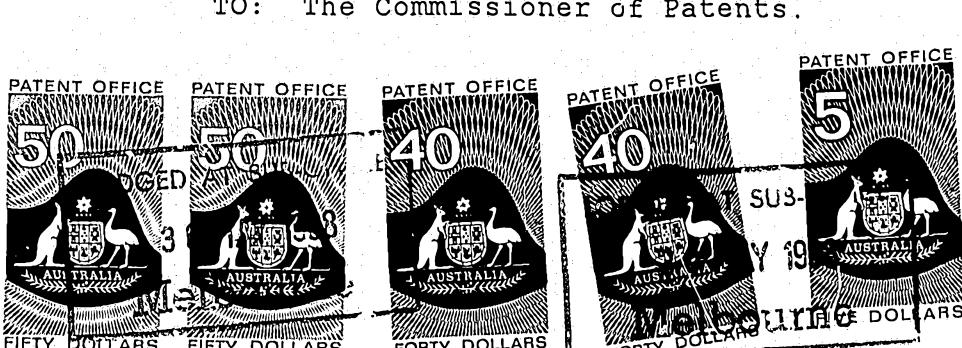
DATED this 30th day of May 1988

NIPPON KOKAN KABUSHIKI KAISHA

CLEMENT HACK & CO.

APPLICATION ACCEPTED AND AMENDMENTS

ALLOWED 10.3.90



Forms 7 and 8

AUSTRALIAPatents Act 1952DECLARATION IN SUPPORT OF A CONVENTION OR NON-CONVENTION
APPLICATION FOR A PATENT OR PATENT OF ADDITIONName(s) of
Applicant(s)In support of the application made by _____
NIPPON KOKAN KABUSHIKI KAISHA

Title

for a patent for an invention entitled _____
WAVE MAKING APPARATUSName(s) and
address(es)
of person(s)
making
declarationI/we, Yu Niimiya, General Manager of Patent & License and
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1-2, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan

do solemnly and sincerely declare as follows:-

- I am/we are the applicant(s) for the patent, or
am/are authorised by the abovementioned applicant
to make this declaration on its behalf.
- The basic application(s) as defined by Section 141
of the Act was/were made in the following country
or countries on the following date(s) by the
following applicant(s) namely:-

Country, filing
date and name
of Applicant(s)
for the or
each basic
applicationin Japan on June 1, 1987
by NIPPON KOKAN KABUSHIKI KAISHA
in _____ on _____ 19 _____
by _____
JP 134979/87

- The said basic application(s) was/were the first
application(s) made in a Convention country in respect
of the invention the subject of the application.

- The actual inventor(s) of the said invention is/are

Norihisa KODAN, c/o Patent & License and Quality Standards
Department, Nippon Kokan Kabushiki Kaisha, 1-2, 1-chome,
Marunouchi, Chiyoda-ku, Tokyo, Japan.

- The facts upon which the applicant(s) is/are entitled
to make this application are as follows:-
the applicant is the assignee of the actual inventor.

Name(s) and
address(es)
of the or
each actual
inventorSee reverse
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DECLARED at Tokyo this 23rd day of May 1988

Yu Niimiya

Yu Niimiya, General Manager
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(54) Title
WAVE MAKING APPARATUS

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(56) Prior Art Documents
AU 572116 24526/84 A47K 3/10

(57) Claim

1. A wave making apparatus for use in a wave pool comprising:

a wave generating plate having a wave generating face which is inclined toward the center of a wave pool relative to a stationary upper surface of water in said wave pool; and

drive means for driving said wave generating plate along a wall which is upwardly and backwardly inclined relative to the center of the wave pool.

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Form 10

COMPLETE SPECIFICATION

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TO BE COMPLETED BY APPLICANT

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Complete Specification for the invention entitled:
WAVE MAKING APPARATUS

The following statement is a full description of this invention
including the best method of performing it known to me:-

WAVE MAKING APPARATUS

Background of the Invention

Field of the Invention

The present invention relates to a wave making apparatus used in a wave pool for recreation.

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Description of the Prior Art

Most prior art wave making apparatus used in pools for recreation have been of the flap or air type. The wave making apparatus used in experimental tanks are mainly of the flap, plunger or piston type. The flap-type wave making apparatus drives the upper end of a flap, in a horizontal direction, the flap being held with a pin at the lower end in a freely rotatable state, and generates waves by oscillating the flap with a centered pin. The air-type wave making apparatus sends air into an air chamber by means of a blower and fluctuates the level of water by opening and closing a duct set in the air chamber, to thereby generate waves. The plunger-type wave making apparatus moves a wedge-shaped plunger held at the lower end of a shaft up and down along a tank wall standing vertically, to thereby generate waves in the water. The piston-type wave making apparatus moves a flap set vertically relative to the surface of the water on a rod, back and forth along a tank bottom, to thereby generate waves in the water.

The flap-type wave making apparatus, one of the above-mentioned conventional wave making apparatus, produces a larger

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1A.

turbulence near the surface of water and a smaller turbulence under water as it goes deeper, because the flap is held at the lower end with a pin. To generate high waves, therefore, it is necessary to increase the height of the flap greatly. In

5 addition, to absorb the waves generated behind the flap, it is necessary to provide a certain distance between the back of the flap and the tank wall, and a special wave absorbing device or a special wave absorbing construction is required. Although a method wherein air exists instead of water behind the flap is partly put to practical use, this method requires an intricate 10 mechanism.

15 The air-type wave making apparatus has difficulties in that it requires a complicated control of a blower, and a complicated mechanism for controlling the opening and closing of a duct due to the compressibility of air to generate high waves.

20 The plunger-type wave making apparatus produces a smaller turbulence in a deep zone of the water than near the surface of the water because the plunger as a wave generating plate is wedge-shaped. To generate high waves, therefore, it is necessary to increase the stroke of the wave generating plate. This 25 disadvantageously leads to a great size of the wave generating plate.

The piston-type wave making apparatus requires a certain distance to be provided between the back of the wave generating 25 plate and the tank wall, and a special wave absorbing device or a

special wave absorbing construction is required in order to absorb the waves produced behind the wave generating plate.

Summary of the Invention

5 It is an object of the present invention to provide wave making apparatus which is able to easily generate high waves and which requires neither special wave absorbing devices nor a special wave absorbing construction.

10 In accordance with the present invention, a wave generating apparatus comprises a wave generating plate having a wave generating face inclined toward the center of a wave pool relative to the stationary surface of water of the wave pool; and means for driving the wave generating plate along a wall which is inclined backward relative to the center of the wave pool.

15 The above objects and other objects and advantages of the present invention will become apparent from the detailed description to follow, taken in connection with the appended drawings.

20 Brief Description of the Drawings

Fig. 1 is an explanatory view illustrating a first embodiment of a wave making apparatus according to the present invention;

25 Fig. 2, is an explanatory view illustrating another embodiment of a wave making apparatus of the present invention;

Fig. 3 is an explanatory view illustrating still another embodiment of a wave making apparatus of the present invention;

Fig. 4 is a plan view illustrating a pool used with the wave making devices of the present invention;

5 Fig. 5 is a cross sectional view of the present invention taken on the plane of line 2-2 of Fig. 4; and

Fig. 6 schematically shows a hydraulic drive for the wave generating plate of the invention.

10 Detailed Description

The wave making apparatus of the present invention comprises a wave generating plate which is driven along a pool wall so that waves can not be generated behind the wave generating plate if high waves are generated. In this case, the pool wall, along 15 which the wave generating plate slides, is inclined so that turbulence can be produced in a deeper zone of water.

Fig. 1 is an explanatory view illustrating one embodiment of a wave making apparatus 10 of the present invention. Wave making apparatus 10 comprises a wave generating plate 12 having a wave generating face 13 (front face of wave generating plate 12) which is inclined forward relative to the stationary upper surface of the water 22 and means for driving wave generating plate 12 along wall 18, wall 18 being inclined backward relative to the center of the wave generating pool. The drive means for plate 12 has a 20 drive shaft 14 coupled to the wave generating plate 12, a mount 16 holding the drive shaft 14, and a drive unit (not shown, but 25

arranged in mount 16) driving wave generating plate 12 along wall 18 through the drive shaft 14. To move wave generating plate 12 along wall 18, drive shaft 14, coupled to the wave generating plate 12, and mount 16 holding the drive shaft 14, are arranged 5 so that drive shaft 14 and mount 16 have the same incline as that of wall 18.

It is preferable to incline wall 18 backward relative to the center of the wave pool at an angle α of 30° to 50° relative to the vertical plane. If the wall 18 is inclined at less than 30° , 10 smaller turbulence is produced in a deeper zone of water. If the wall is inclined at more than 50° , the wave generating plate 12 will be required to be too large.

A minimum clearance between wave generating plate 12 and wall 18 is sufficient to permit moving of the wave generating 15 plate 12. If necessary, a slide guide can be provided between wave generating plate 12 and wall 18 in order to carry the partial weight or buoyancy of wave generating plate 12.

The lower end of wave generating plate 12 is positioned at a height above pool bottom 20 which is equal to about one-half of 20 the stroke or greater than the stroke necessary to generate waves of desired height. The upper end of front face 13 of wave generating plate 12 is positioned at a height such that water does not splash over the top of wave generating plate 12 when waves of desired height are generated. Wave generating face 13 25 of wave generating plate 12 is inclined toward the center of the pool, i.e. inclined forward relative to the stationary upper

surface 22 of the water, to generate a wave 24 moving toward the center of the pool. The wave generating face 13 of the wave generating plate 12 is desired to be inclined toward the center of the pool at an angle β of 10° to 40° relative to the vertical plane. The wave generating face 13 need not be flat; it may be curved, either convex or concave. The bottom face of wave generating plate 12 is parallel to inclined wall 18. The top face of wave generating plate 12 and the surface on which drive shaft 14 is mounted have no restriction on shape or orientation.

5 In the embodiment of Fig. 1, wave generating plate 12 of a block shape having a rectangular section is used, but the wave generating plate 12 is not confined to the above-mentioned shape. It is sufficient that the wave generating plate 12 has a wave generating face 13 which is inclined forward. A wave generating plate 12 comprising a wave generating face, bottom face and an upper face and a wave generating plate of a shape of a thin plate having only a wave generating face can be used.

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A drive means for the wave generating plate 12 comprises drive shaft 14 connected to wave generating plate 12, mount 16 holding the drive shaft and a drive unit (not shown) for driving the wave generating plate along wall 18 through said drive shaft. The drive unit coupled to drive shaft 14 may be hydraulic, pneumatic or electrical. The chain lines in Fig. 1 show the wave generating plate 12 in different positions, as driven by the 20 25 drive means.

According to the wave making apparatus described above, when the wave generating plate 12 is pushed into the water by being moved half a stroke downward along wall 18 by the drive unit through drive shaft 14, wave generating face 13 of wave generating plate 12 produces turbulence down to the deep zone in the water, thereby generating waves of desired height. Such generation of the waves by means of wave generating plate 12 is carried out each time wave generating plate 12 is pushed into the water by being moved downward after being moved upward. Thus, wave 24 being generated continuously.

Fig. 2 is an explanatory view illustrating another embodiment of a wave making apparatus of the present invention. The wave making apparatus of Fig. 2 comprises a hydraulic actuator which moves drive shaft 14' supported by mount 16'. A pneumatic actuator can be used as a drive unit in place of a hydraulic actuator. In other respects, the embodiment of Fig. 2 is the same as that of Fig. 1. A typical hydraulic drive unit is shown in Fig. 6, and is described below.

Referring to Fig. 6, the wave generating plate is reciprocably mounted on guiding rods 47, which pass through openings or apertures in wave generating plate 12. The guiding rods are fixedly secured to inclined wall 18 by means of respective mounting members 48. Hydraulic actuators 16' actuate respective drive shafts 14', which are connected to the wave generating plate 12, as shown in Fig. 6. Hydraulic actuators 16' are mounted to the upper surface of the pool by means of

respective mounting members 46. The wave generating plate 12 is driven along the guiding rods 47 by means of the hydraulic actuators 16' in a reciprocating manner. The hydraulic actuators 16' are coupled to a source of hydraulic fluid (not shown), and 5 to a control device to control the supply of the hydraulic fluid to operate the actuators to reciprocably drive the wave generating plate 12.

Fig. 3 is an explanatory view illustrating still another embodiment of the wave making apparatus of the present invention. In this embodiment, a drive means comprises a drive shaft 34 connected to the wave generating plate 12, the drive shaft 34 having a rack 26 thereon. The drive means further comprises a pinion gear 28 engaged with the rack 26. A drive motor 35 is coupled to drive pinion gear 28, preferably through a reduction gearing (not shown). Mount 36 supports the drive shaft 34 and the drive motor 35 coupled to turn the pinion gear 28 for driving the wave generating plate 12 along a wall through the rack gear 26 on the drive shaft 34. In other respects, the embodiment of Fig. 3 is similar to that of Fig. 1.

An example of the wave making apparatus arranged in a pool for surfing is shown in Figs. 4 and 5. Fig. 4 is a plan view illustrating the pool used in the surfing pool example of the invention. Fig. 5 is a cross-sectional view taken on the plane of line 2-2 of Fig. 4. The pool of Fig. 5 includes two wave 25 making apparatuses 10a and 10b, which are the wave making apparatus 10 shown in Fig. 1. In Fig. 4, the distance from the

bottom of pool 30 to the top surface of the water is indicated in parentheses. The bottom surface of pool 30 is lowest in the central area and slopes up toward the pool sides. A wave making apparatus of the present invention was arranged at each end of 5 two waterways 32a and 32b which are connected to pool 30. The waves generated by wave making apparatuses 10a and 10b pass through the two respective waterways 32a and 32b and cross each other in pool 30. As a result, high waves appropriate for surfing can be generated easily in pool 30, by means of the wave 10 making apparatuses 10a and 10b. In the case of a wave making pool for surfing, the form of wave 24 need not be sinusoidal. Waves 24 of high steepness ratio, which have peaked crests and flat troughs, are preferable. The drive unit for driving the wave generating plate 12 is not required to have a sophisticated 15 sinusoidal motion control mechanism. A drive cycle range which cover a very limited range of the cycle is sufficient.

In a test example, the backward angle of inclination α of the wall 18 was at 45° , and the angle of inclination β of the wave generating face 13 of the wave generating plate 12 was set at 30° . The reciprocating cycle of operation of the wave 20 generating plate was between 2 and 6 seconds. The design criteria for the stroke of the wave generating plate (distance of movement) for a given depth of water is as follows:

$$\text{Wave Height} \doteq (0.5 - 0.7) \times \text{Depth of Water}$$

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$$\text{Stroke} \doteq 1.4 \times \text{Wave Height}$$

$$\text{Consequently, Stroke} \doteq (0.7 - 1.0) \times \text{Depth of Water}$$

The improved effects of the present invention are as follows:

(a) The wave making apparatus of the present invention can produce turbulence in a deep zone of water in comparison with prior art wave making apparatus. Therefore, high waves can be easily generated.

(b) Any special wave absorbing work is not required because there is no surface of water behind the wave generating plate. Accordingly, the space around the wave making apparatus which is necessary for arranging said apparatus is reduced and, therefore, maneuverability for arranging the wave making apparatus increases.

While the invention has been described above with respect to specific apparatus, it should be clear that various modifications and alterations can be made within the scope of the invention as defined in the appended claims. For example, the drive means for driving the wave generating plates can be freely chosen, to drive the wave generating plate 12, forward and backward (that is, "to and fro", substantially parallel to the surface of the rearwardly inclined surface 18 of the pool.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A wave making apparatus for use in a wave pool comprising:

a wave generating plate having a wave generating face which is inclined toward the center of a wave pool relative to a 5 stationary upper surface of water in said wave pool; and drive means for driving said wave generating plate along a wall which is upwardly and backwardly inclined relative to the center of the wave pool.

2. The wave making apparatus of claim 1, wherein said drive means drives said wave generating plate in parallel to said upwardly and backwardly inclined wall of said wave pool.

3. The wave making apparatus of claim 1, wherein said drive means comprises:

a drive shaft coupled to said wave generating plate; mount means for supporting said drive shaft relative to 5 said upwardly and backwardly inclined wall; and drive unit means for driving said wave generating plate along said upwardly and backwardly inclined wall through said drive shaft.

4. The wave making apparatus of claim 3, wherein said drive unit means includes a hydraulic drive unit.

5. The wave making apparatus of claim 3, wherein said
drive unit means includes a pneumatic drive unit.

6. The wave making apparatus of claim 3, wherein said drive
unit means includes an electric motor drive unit.

7. The wave making apparatus of claim 1, wherein said
drive means comprises:

a drive shaft coupled to said wave generating plate and
having a rack gear thereon;

mount means for supporting said drive shaft relative to
said upwardly and backwardly inclined wall; and

drive unit means including a pinion gear engaged with
said rack gear for moving said wave generating plate along said
upwardly and backwardly inclined wall through said pinion gear
and said drive shaft.

8. The wave making apparatus of claim 1, wherein said wave
generating plate comprises a wave generating face which is
inclined toward the center of the wave pool at an angle of 10° to
40° relative to a vertical plane.

9. The wave making apparatus of claim 8, wherein said
upwardly and backwardly inclined wall is inclined backward
relative to the center of the wave pool, at an angle of 30° to
50° relative to a vertical plane.

10. The wave making apparatus of claim 1, wherein said upwardly and backwardly inclined wall is inclined backward relative to the center of the wave pool, at an angle of 30° to 50° relative to a vertical plane.

11. The wave making apparatus of claim 1, wherein said wave generating plate comprises a wave generating face which is inclined toward the center of the wave pool at an angle of about 30°.

12. The wave making apparatus of claim 8, wherein said upwardly and backwardly inclined wall is inclined backward relative to the center of the wave pool, at an angle of about 45°.

13. The wave making apparatus of claim 1, wherein said upwardly and backwardly inclined wall is inclined backward relative to the center of the wave pool, at an angle of about 45°.

DATED THIS 30TH DAY OF MAY 1988

NIPPON KOKAN KABUSHIKI KAISHA

By its Patent Attorneys:

CLEMENT HACK & CO.

Fellows Institute of Patent
Attorneys of Australia.

16761/88

FIG.1

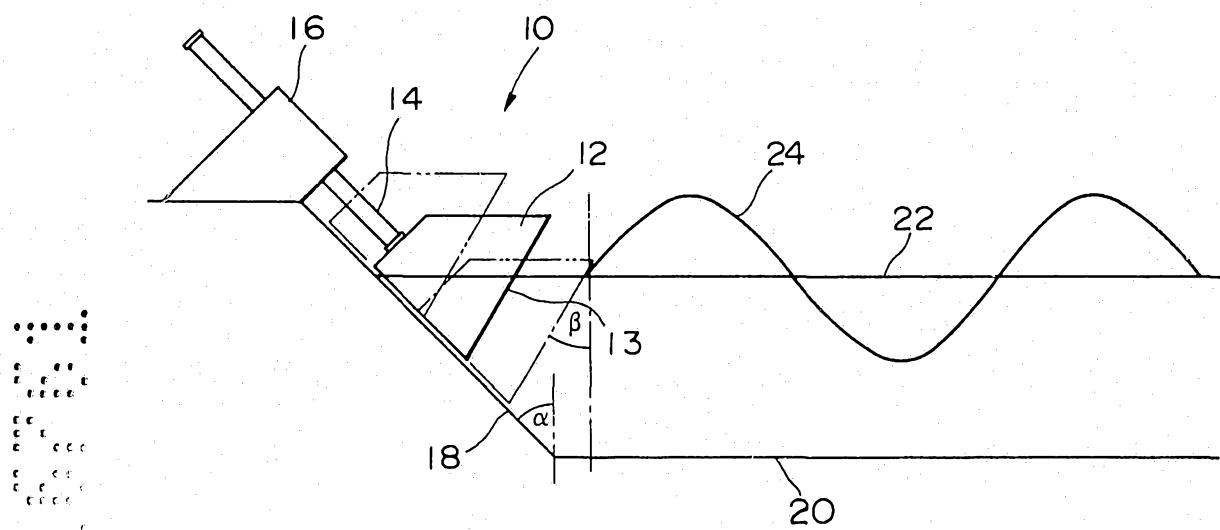


FIG.2

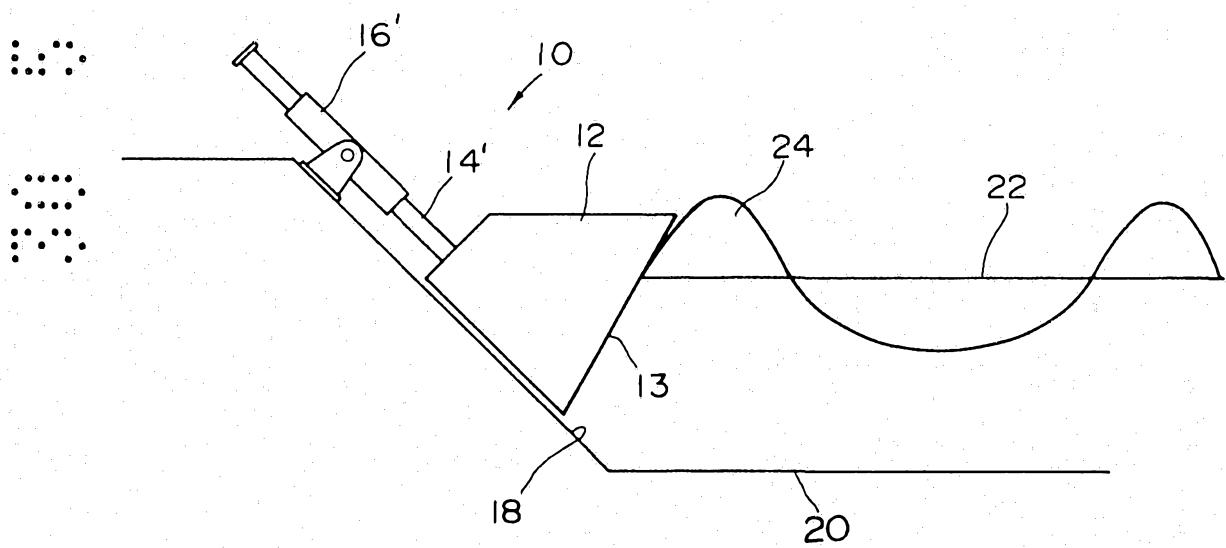


FIG. 3

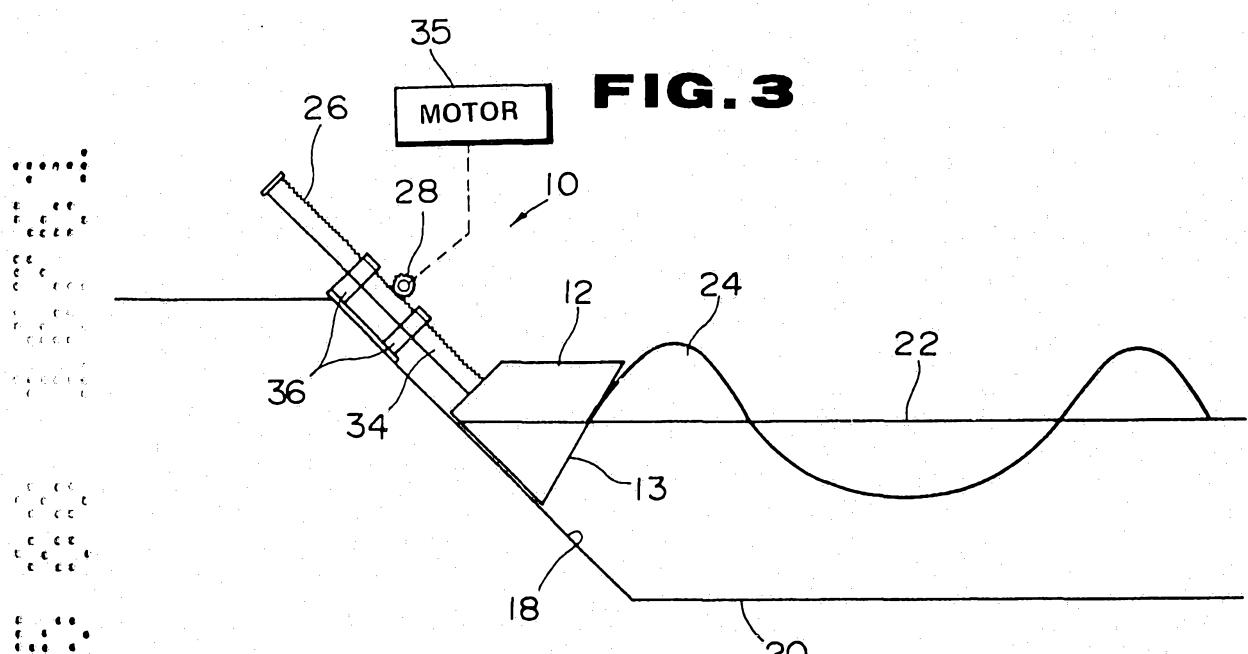
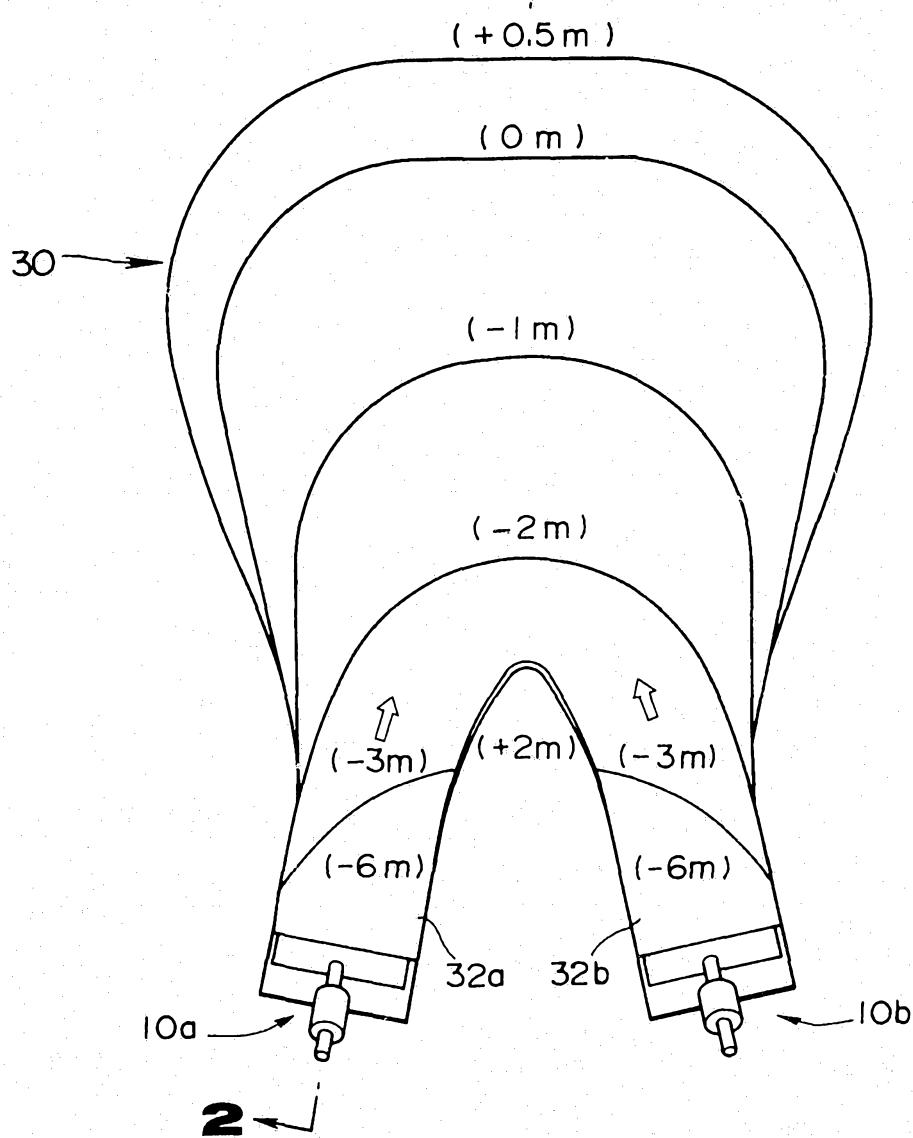
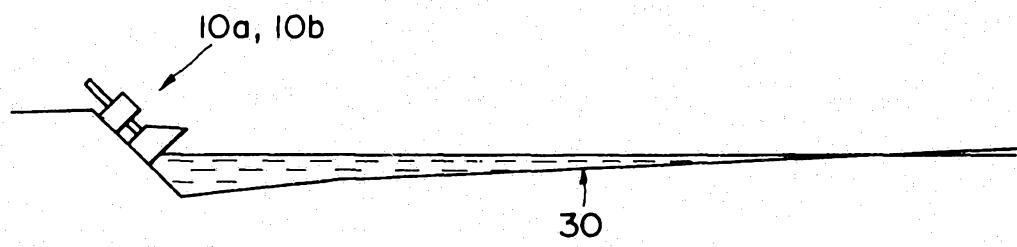


FIG. 4**2****FIG. 5**

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FIG. 6

