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(58) Field of search
A1A
Selected US specifications from IPC sub-class A01K

(54) Tidal aquarium system

(57) A self-contained variable water level Aquarium system is so constructed as to reproduce the effects of variable currents and rise and fall of water found within an open Ocean.

Contained within the compartments 2–5 are water circulation pumps 17,22,26 and filters.

Intermittent currents are formed in display tank 1 by operating pumps 22 or 26 with those currents emanating from compartment 4 preferably being stronger than those from compartment 5. Tidal rise and fall in tank 1 between high water marks 8,9 and low water mark 10 is provided by actuating pump 17.

FIG. 1

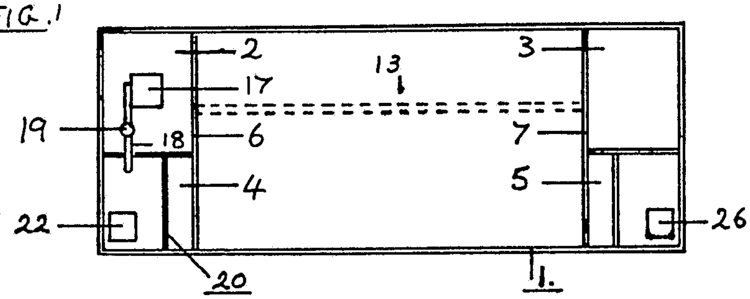
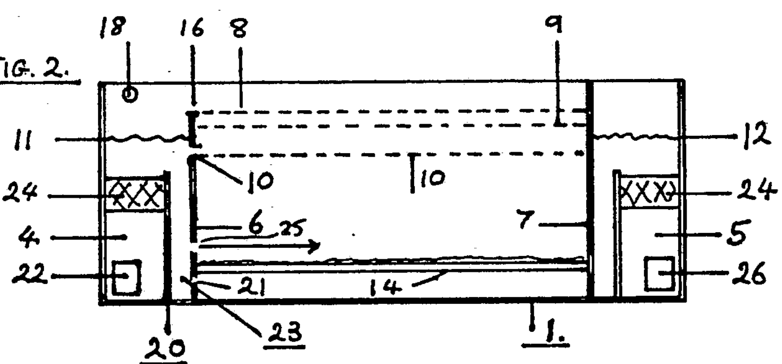


FIG. 2.



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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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DFA

FIG. 1

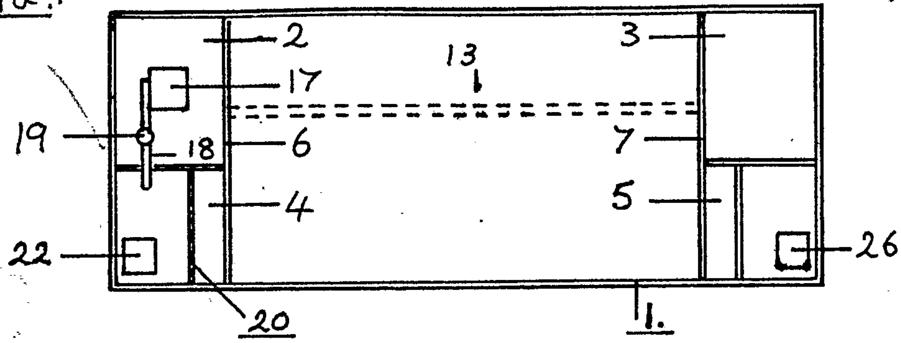


FIG. 3

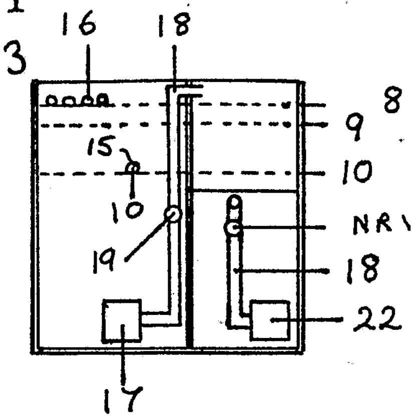


FIG. 2.

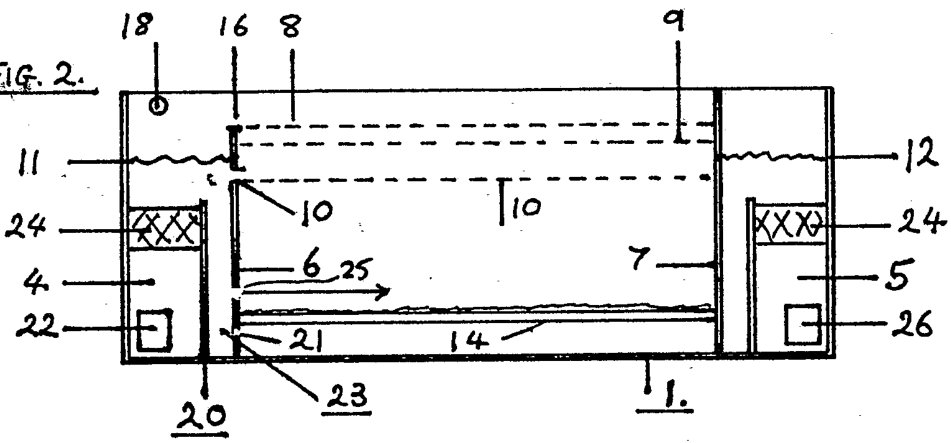


FIG 9

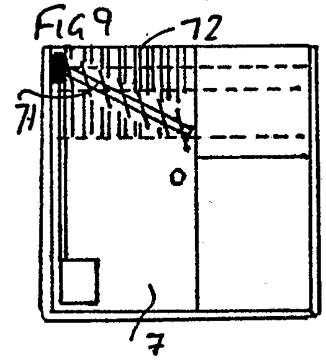


FIG. 7

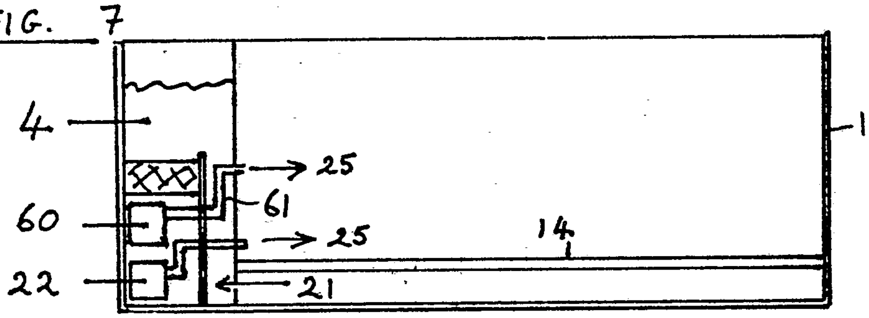


FIG. 8

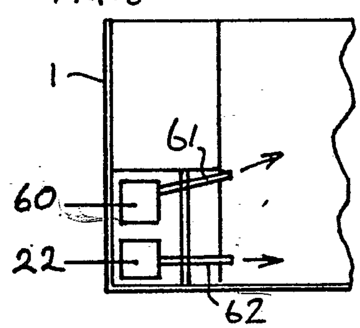


FIG. 11

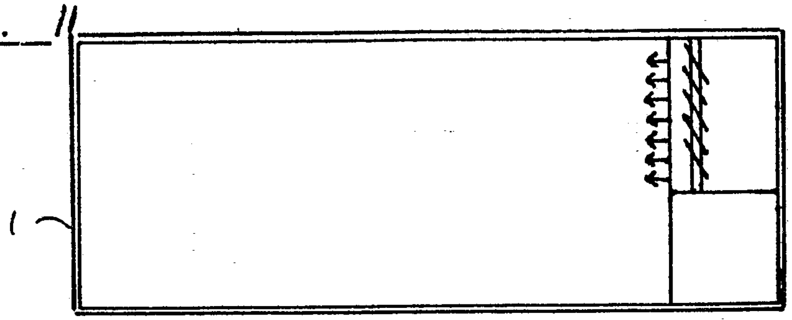
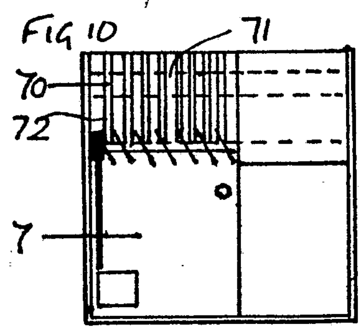


FIG 10



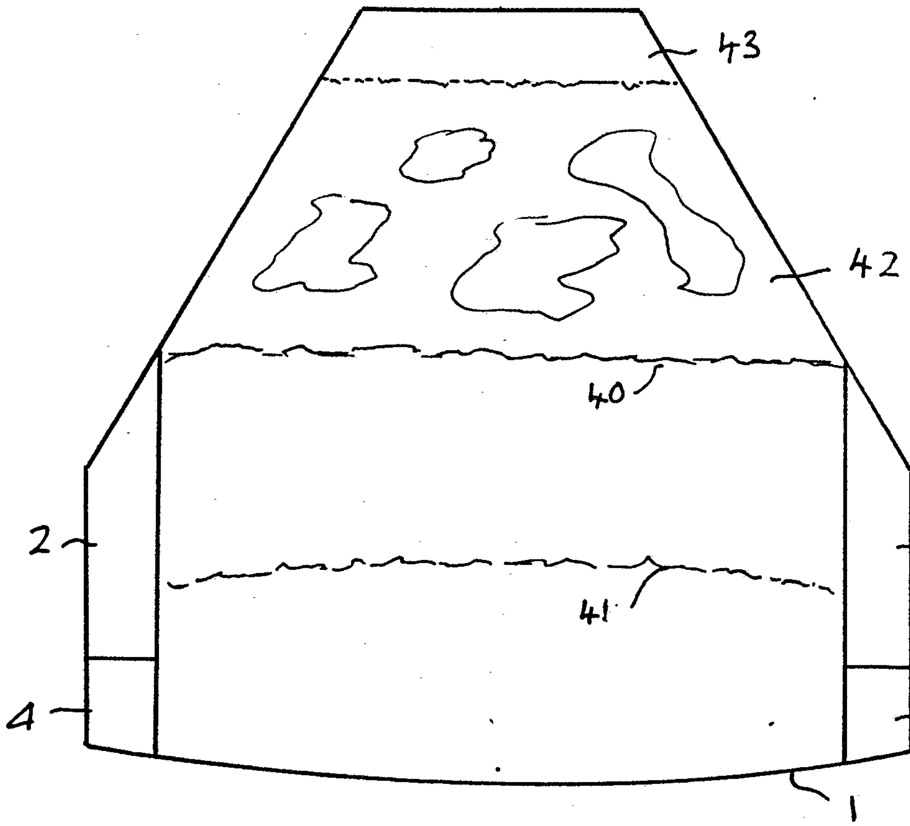


FIG. 5

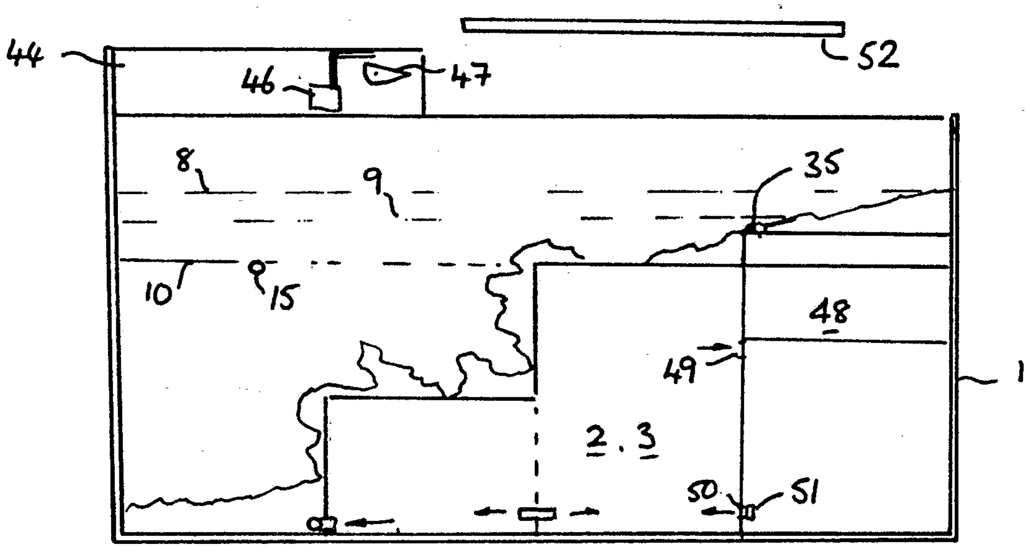


FIG 6

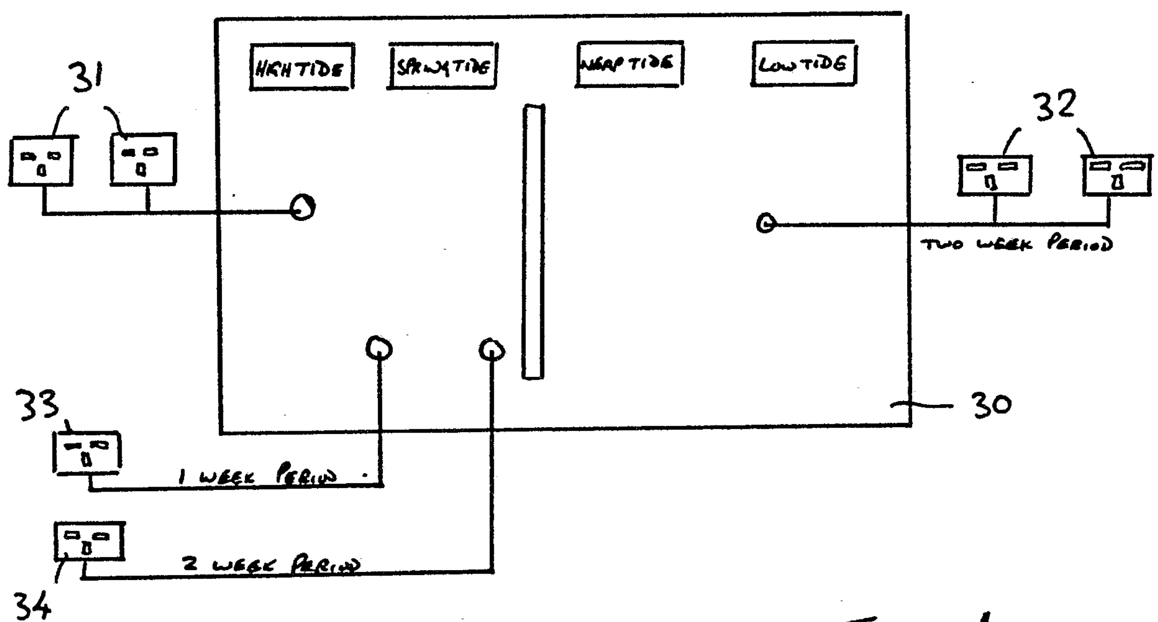

HIGH TIDE
SPRING TIDE
NEAP TIDE
LOW TIDE
31
32
TWO WEEK PERIOD
33
1 WEEK PERIOD
2 WEEK PERIOD
34
30

FIG 4.

SPECIFICATION

Aquaria and control and water treatment equipment for use therewith

This invention relates to aquaria and to control and water treatment equipment for use therewith. By an "aquarium" is meant an artificial tank for displaying, keeping, holding and transporting live aquatic plants and animals such as fish and crustaceans; and for simulating, to a greater or lesser degree, aquatic conditions and phenomena which occur in nature.

Numerous systems and devices are known for cleansing and treating the water content of aquaria. These devices include filters for collecting debris and waste material, and pumps through which air can continuously or intermittently be introduced into the water to increase its oxygen content. Such oxygenation systems include those commonly known as the undergravel and reverse flow cleansing systems.

Few of these treatment systems are capable of simulating such natural phenomena as the generation of surface waves, variations in subsurface currents and tidal conditions.

In nature, fish and invertebrates grow and thrive in environments in which the depth of water, the direction of currents and the force of these currents vary depending upon the prevailing tidal conditions. The currents generated during ebb and flow tidal conditions provide various food sources necessary for continued life and invertebrates and living corals in particular are accustomed to being subjected to strong currents flowing in two different directions. Furthermore, on coral reefs and shore areas which are sequentially covered and uncovered at high and low tides, many species of invertibrates and corals are to be found which depend upon the prevailing tidal conditions for survival.

It is well accepted by aquarists that captive specimens are generally healthier and more active in conditions which closely simulate those which occur in nature. The present invention sets out more accurately to simulate these conditions, and in tidal and variable current flow conditions.

According to the present invention in one aspect, there is provided an aquarium in which the level of water present in a display tank of the aquarium can be varied selectively by causing water sequentially to be removed from and returned to the display tank to simulate tidal conditions.

According to the present invention in another aspect, there is provided an aquarium including a display tank and a reservoir connected to receive and retain water discharged from the display tank, and means operable selectively to return water retained in the reservoir to the display tank whereby the level of water in the display tank can fall and rise.

According to the present invention in a further aspect, there is provided an aquarium comprising a tank partitioned to define a display tank and a reservoir, the partition being formed with an aperture through which water can flow from the display tank to the reservoir, and at least one pump operable to return water present within the reservoir to the display tank such that the water present within the reservoir to the display tank such that the water level thereof rises.

The or each pump operable to return water present within the reservoir to the display tank is preferably sited within the reservoir. Water passing between the reservoir and the display tank may be subjected to one or more cleansing and/or treatment stages to remove waste products therefrom and to increase the oxygen content of the returned water.

The aquarium may also include a compartment separated from the reservoir by a dividing wall and including one or more water treatment stations. The treatment stations may include ones for increasing the oxygen content of the water and for removing debris and waste products from the water. In this arrangement, water leaving the reservoir enters and flows through the treatment compartment before being re-admitted to the display tank.

One or more pumps may be positioned in the water treatment compartment so that the returning water enters the display tank with sufficient force to create currents within the water present in the display tank. The rate at which the water is returned to the tank may be controlled to simulate water currents generated in nature in both ebb and flow tidal conditions.

Two such treatment compartments, may be provided, one located on each side of the tank of the aquarium. In this arrangement, water may be returned selectively from one or other treatment compartment such that the direction of induced currents can be varied.

The force with which the water is re-admitted from the respective chambers may differ so that different currents generated during tidal flow conditions can be simulated.

The or each treatment compartment may operate continuously or intermittently to draw water from the display tank and to return such water to the display tank after treatment. In this arrangement, the flow rate of water readmitted to the display tank increases as the head of water within one or other compartment is increased by the admission of water from the reservoir to simulate the stronger currents generated in nature during "flow tidal" conditions; that is to say during periods of time when the level of water in the display tank is rising.

According to the present invention in a further aspect, there is provided an aquarium including a display tank partitioned to define a compartment in which are housed water treatment apparatus and at least two pumps operable selectively to withdraw water from the display tank, circulate such water through the water treatment apparatus and to return the treated water to the display tank, the arrangement being such that water discharged by one selected pump or group of pumps enters the display bank with greater force than water discharged by the other selected pump or group of pumps to simulate variable current flows within the water content of the aquarium. Water discharged by one selected pump or group of pumps preferably enters the display tank in a direction different to that in which water discharged by the other selected pump or group of pumps enters the display tank.

The pumps may be operated selectively through a timing circuit or manually. The outlets through which water is discharged into the display tank may each be provided with a non-return valve to prevent water re-entering the compartment through any one such outlet when the respective pump is inoperative. The outlet of each pump is provided with a non-return valve to prevent water entering compartment 4 through any such outlet when the respective pump or pumps are inoperative.

The invention will now be described by way of example only with reference to the accompanying diagrammatic drawings in which:—

Figure 1 is a plan view from above of a aquarium in accordance with the invention;

Figures 2 and 3 are respectively front and side views partially in section of the aquarium illustrated in Fig. 1;

Figure 4 is a block diagram of an electrical control system for use with the aquarium illustrated in Figs. 1 to 3;

Figure 5 and 6 are respectively plan and side elevational views of an alternative aquarium in accordance with the invention;

Figures 7 and 8 are respectively front and side views of a further alternative aquarium in accordance with the invention; and

Figures 9, 10 and 11 are respectively plan and end views of apparatus for simulating the presence of surface waves in aquaria in accordance with the invention.

The aquarium illustrated in Figs. 1 to 3 comprises a generally rectangular display tank 1 for fresh water or salt water fish and/or aquatic plants separated from holding reservoirs 2, 3 and water treatment compartments 4, 5 by means of partition walls 6, 7. The display tank may be constructed of glass or a plastics material and the partition walls 6, 7 may also be constructed of glass or plastics or may comprise fibre-glass panels. In use, the level of water in the display tank varies between one of two high water marks 8, 9 and a low water mark 10. The partition walls 6, 7 extend to a common height which lies above the highest of the two high water levels of the display tank. The water level of the compartment 4 is indicated by reference numeral 11 and that for compartment 5 by reference number 12. The two reservoirs 2, 3 are linked by a pipe 13 which lies below an apertured plastics sheet or glass fibre mat 14 on which is supported a layer of coral gravel or sand. Alternatively, the reservoirs 2, 3 may communicate one with the other through a chamber defined between the base of the display tank and a substantially horizontal partition spaced above the chamber base. The partition, therefore, defines a false floor to the display tank.

The display tank is placed in communication with the reservoirs by means of one or more apertures 15 formed within one or both partition walls 6, 7 at a height equivalent to the low water level 10 of the tank and by means of additional apertures 16 positioned in one or both partion wallls at the high water level 8. One or more pumps 17 (only one of which is shown) are located within the reservoir 2 and operate to cause water to flow to the compartment 4 via a pipe 18 whose outlet is positioned above the water level 11. The pipe 18 includes a bleed valve 19 which can be adjusted to vary the flow rate of water passing therethrough. Water in excess of that permitted to flow through the bleed valve 19 is returned directly to the reservoir 2.

As will be seen from Fig. 2, the compartment 4 is divided by means of a wall 20 of a height less than that of the partition wall 6 and less than the water level of the compartment 4. The display tank 1 is placed in communication with the compartment 4 by one or more apertures 21 located towards the base of the partition wall 5 and below the layer of coral gravel or sand supported on the apertured plastics sheet or glass-fibre mat 14. In an alternative construction, the aperture or apertures 21 are positioned above the layer of coral gravel or sand. Coral gravel is preferred in order to alleviate the problem of finer sand particles blocking the apertures of the sheet or mat. Where a glass-fibre mat is used, a mesh size of approximately 1/16in is preferred. Such a mat ensures complete filtration of the water content of the tank.

Water is drawn into the compartment 4 by means of one or more pumps 22 (only one of which is shown) located in the compartment 4. Thus, water drawn by the pumps 22 from the display tank 1 through the apertures 21 flows upwardly through the channel 23 defined between the partition 6 and wall 20, over the top of the wall 20 and thence passes through a filter 24 before being returned by the pumps 22 to the display tank through one or more apertures 25. The filter medium used in filter 24 may comprise nylon wool. This medium can readily be removed for rinsing in either fresh water or water routinely removed from the aquarium. In a closed circuit salt or fresh water aquarium, approximately

10% by volume of the water content of the aquarium is changed monthly to help retard any slow build-up of dissolved organic materials and toxins which, if left, would eventually be potentially harmful to the aquarium specimens.

The force with which water is ejected from the compartment 4 through the apertures 25 is sufficient to produce intermittent or constant flow currents within the water content of the display tank to simulate currents which occur in nature. The height of the apertures 25 is below the low water mark 10 and is selected to create the required effects. Food may be introduced into the water passing through the apertures 25 to simulate natural feeding conditions.

Intermittent current flows are achieved by either varying the power input to the pump or pumps 22 or by a system of pulse timing, that is to say, sequentially switching the pump or pumps off and on for selected time intervals, e.g. one to two seconds. Where intermittent currents are achieved through controlled varitation of power input, the pump or pumps sequentially slow down and speed up.

The compartment 5 is of similar construction to compartment 4 except that the pumps 26 located in this compartment are either less in number or power than those present in compartment 4 so that the currents produced by the water emitted from compartment 5 are of less strength than those produced by water emitted from compartment 4. In a preferred arrangement, the water currents emitted from compartment 4 are stronger than those emitted from compartment 5. Thus, the currents from compartment 4 simulate "flow" currents and those from compartment 5 simulate "ebb" currents.

As will be explained more fully below, the pumps 17 are operated either automatically through a time switch or manually once the level of water present within the display tank has fallen to the low water mark 10 or following a predetermined time interval thereafter. Operation of the pump 17 causes water to flow from the reservoir into the compartment 4. The head of water within the compartment then increases so increasing the flow rate of water re-admitted to the display tank from the compartment 4 through the apertures 25.

Turning now to Fig. 4 of the drawings, the electrical controller 30 illustrated operates selectively to switch on and switch off the various pumps described above at predetermined times.

Before discussing this controller in detail, it would be useful briefly to summarise the tidal and variable current flow phenomena to be simulated through selective operation thereof.

The average time taken for a tide to reach a high water point from a state of low tide is approximately 5 hours. The "flow" currents generated during this time are usually stronger than the "ebb" currents generated during the equivalent time periods when a low water point is to be reached from a high tidal state (approximately 7 hours later). The respective flow and ebb currents are produced by means of the pumps 22, 26 present respectively in the compartments 4, 5, the number or power of the pumps 22 being greater than the pumps 26. Thus, in flow tidal simulated conditions the pumps 22 of compartment 4 are switched on by means of switched power sockets 31 and in ebb tidal simulated conditions the pumps 26 of compartment 5 are switched on by means of switched power sockets 32. The pumps 22, 26 operate sequentially, not in concert.

Once a high tide condition has been achieved (i.e. the water level in the aquarium has reached either level 8 or level 9) the pumps 22 are switched off to simulate a high water slack tidal condition (approxiamately 13 minutes) which is a period of quiet which occurs in nature on conclusion of a flow tide. After this time the pumps 26 are switched on by means of the power sockets 32 for a period of, for example, seven hours until a low tide condition has been achieved (i.e. the water level in the aquarium has reached level 10). The pumps 26 are then switched off to stimulate a period (of, for example, 13 minutes) of low water slack tide. After this slack period, the pumps 22 are once again switched on and the cycle described above repeated. Switching may be effected manually or by means of a suitable electric timing circuit. With the suggested timings given above, the entire cycle would take twelve hours 26 minutes. During this time except for the two 13 minute intervals simulating slack tide conditions, either one or other compartment 4, 5 would be operating to draw water from the display tank, cleanse and oxygenate this water, and return the treated water to the display tank.

It is to be understood that the timings given above are merely exemplary and that, if desired, actual timings taken from an appropriate Admiralty tide table could be followed to simulate more accurately natural conditions.

In an unillustrated embodiment, cleansing and life support compartments similar to compartments 4, 5 are located at positions remote from the display tank, being connected thereto via suitable conduits. In this embodiment, water is simply recirculated from and to the display tank on a continuous basis, thereby avoiding any build-up of bacteria which may occur in stagnant filter material during periods of time when water is not circulating through the compartments 4, 5 illustarated in Figs. 1 and 2.

It will be appreciated from the foregoing that operation of the pumps 22, 26 of compartments 4 and 5 do not, in themselves, materially affect the level of water contained within the aquarium display tank 1. Indeed, one or both of the compartments 4, 5 can be employed in isolation in an aquarium to simulate variations in sub-surface water currents. Thus, such an aquarium may be as illustrated in Figs. 1 and 2 but without the reservoirs 2, 3. One such aquarium will be discussed in greater detail below with reference to Fig. 7 of the drawings.

Variations in the level of water contained in the display tank 1 to simulate tidal conditions are produced by selective operation of one or more of the pumps 17 present within the reservoir 2 by operation of switched sockets 33 or 34. The choice of which socket 33, 34 is to be operated depends upon whether a "spring" or "neap" tide is to be simulated. The high tide level achieved during a spring tide is higher than that achieved in a neap tide and in any given three week period spring tides will occur during one week of that period and neap tides for two weeks or vice versa. Typically, a recurring tidal pattern comprises a 7 day high spring tide, a 7 day medium neap time, a 7 day low spring tide and a 7 day low neap tide. The level 8 corresponds to a spring tide high water level and the level 9 corresponds to a neap tide high water level. To simulate these conditions, the socket 33 is operated to drive one or more additional pumps present within the reservoir 2 to cause the higher high water level 8 to be reached during the required one week period than is achieved in the two week "neap" period.

During the seven hour period when the pumps 26 of compartment 5 are operating, the pumps 17 present within the reservoir 2 are switched off and water passes from the display tank to the reservoirs 2, 3 via the apertures 10. The flow rate of water through the apertures 10 is time controlled using an adjustable bleed valve to ensure that the water level within the display tank falls gradually during the appropriate seven hour period. On conclusion of this period, the pumps 26 present within compartment 5 are, as mentioned above, switched off and those present within compartment 4 are switched following the 13 minute slack water period. The pumps 17 are operated in concert with the pumps 22 to cause water to flow at a controlled rate through the pipe 18 and bleed valve 19 from the reservoir into compartment 4 thereby increasing the head of water present in compartment 4 and consequently the rate at which water flows into the display unit through the apertures 21. Since the volume of water admitted through the apertures 25 is greater than that leaving the display tank via the apertures 10, the level of water present within the display tank 1 gradually rises from the low water level 10 towards the respective high water level. Any surplus water over and above that permitted to flow through the bleed valve 19 is simply returned to the reservoir 2 via a weir 16 placed at level 8.

Where neap tides are to be simulated, the level achieved within the display tank after the aforementioned 5 hour period is that indicated by water mark 9 and for simulation of spring tidal conditions, the water level will rise to the high water level 8. Any excess water leaves the displays tank over a weir or a series of apertures positioned at the high water level 8 and is collected within the reservoirs 2, 3.

As mentioned previously, the various electrical connections illustrated in Fig. 4 may be operated manually or by means of an electric timing circuit which, for the times given above, would repeat itself after any given 28 day period.

The aquarium illustrated in Figs. 5 and 6 (in which like integers to those illustrated in Figs. 1 and 2 have been given the same reference numerals) is of an open construction and includes inner and outer reefs 40, 41, a rock pool area 42 and a beach area 43. The frontal glass to this aquarium curves outwardly to provide an attractive viewing area for the aquarium. The reservoirs 2, 3 and compartments 4, 5 can be seen to the sides of the display tank. Also positioned to one or both sides of the display tank are surf units 44 which operate to simulate the presence of surf waves on the surface of the water contained within the display tank. Each surf unit includes a pump 46 connected to draw water from the display tank 1 and to discharge such water into tiltable buckets 47 which, when filled to a predetermined level, pivot to discharge water onto the surface of the water content of the display tank.

As will be seen from Fig. 6, the reservoirs extend across the full width of the display tank below the reefs 40, 41, rock pool area 42 and beach area 43 to provide an increased water retention capability. In addition, a treatment and remote life support system similar to that disclosed and claimed in my copending patent application 8615046 may be located towards the rear of the display tank 1 below the weir 35. This treatment and remote life support system is indicated by reference numeral 48 and operates to draw water, not only from the display tank 1 via weir 35, but also from the reservoir via an inlet aperture 49. Treated water leaves the system 48 and is admitted to the reservoir through an aperture 50 incorporating a non-return valve 51.

Lighting 52 may be suspended above the display tank 1. This lighting may comprise fluorescent tubes or incandescent mercury vapor discharge lamps or both.

The aquarium illustrated in Figs. 5 and 6 is particularly suitable for demonstrating to a class or audience the effects and conseuquences of sub-surface currents and tidal flows. Thus, the various pumps which operate to produce the ebb and flow currents and the neap and spring tides can be operated manually or via a controller, such as illustrated in Fig. 4, to demonstrate phenomena which occurs in nature. By suitable operation of the pumps and selection of the bleed and discharge apertures, the rate at which high and low tide conditions are achieved can be varied at will.

Turning now to Figs. 7 and 8 of the drawings (in which like integers to those described above have been accorded the same reference numerals), the display tank includes a single compartment 4 housing, in addition to the pump or pumps 22, a second pump or pumps 60 (only one of which is illustrated) having an outlet pipe 61 inclined at an angle to the outlet pipe 62 of pump 22. The power or number of pumps 60 is greater than the power or number of pumps 22 so that the respective currents induced vary in force and direction. Thus, the effects of variations in sub-surface currents generated during ebb and flow conditions can be simulated. The pumps 22, 60 may be operated through a suitable timing circuit or manually.

As illustrated in Figs. 9 and 10, aquaria in accordance with the invention may include an additional compartment 70 connected to the display tank 1 by a series of holes formed in partition wall 6 and/or 7 below the water level 10. Positioned within compartment 70 is a rotatable shaft 71 which carries either a series of shaped vanes or a single helical vane. The vane or vanes are so shaped that upon rotation of the shaft 71, waves are created which pass into the display tank 1 through a series of vertical slots 72 in the partition 6 and/or partition 7. The shaft is preferably positioned below water level 10 and is driven by a motor housed within the compartment 70 or separate therefrom. In the embodiment illustrated in Fig. 9, the shaft is aligned in a substantially horizontal plane and in the Fig. 10 embodiment is inclined to the horizontal.

Similar wave simulation effects can be achieved in accordance with the invention by pulsing or varying the power supplied to a pump positioned within compartment 70 to cause the water level therein to rise and fall to levels respectively at or below the apertures or slots which place compartment 70 in communication with display tank 1.

It is to be understood that the foregoing is merely exemplary of various embodiments in accordance with the invention and that modifications can be made thereto without departing from the true scope of the invention.

CLAIMS

1. A self contained variable water level Aquarium system comprising various compartments, hidden from the main viewing area, which house submersible pumps to control the height of water within the main viewing area.

2. A self contained variable water level Aquarium as claimed in claim 1. wherein, in a *first* compartment is housed a submersible pump or pumps to re-circulate the water from the main Aquarium viewing area through a mechanical detritus removing filter housed in the first compartment then returning it back into the main Aquarium viewing area in the form of midwater currents.

3. A self contained variable water level Aquarium as claimed in claim 1. or claim 2. wherein, in a *second* compartment is housed a submersible pump or pumps to draw water from the *second* compartment and transfer a measure quantity of water from the *second* compartment to the *first* compartment by means of an adjoining conduit which enters the *first* compartment above the *maximum* attainable height of the water level in the first compartment. Thus forming an anti-syphon link.

4. A self contained variable water level Aquarium as claimed in claim 1. or 2. or 3. wherein, within the *second* compartment is placed a bleed valve to allow the transverence of water from the main viewing area through the panel wall back into the *second* reservoir at a controlled rate, sited on the *minimum* water level line.

5. A self contained variable water level Aquarium as claimed in Claims 1. 2. 3. or 4. wherein, within the conduit allowing the transfer of water from the *second* compartment into the *first* compartment is placed a bleed valve to enable a *measured* quantity of water to flow from the *second* compartment into the *first* compartment by allowing a measured amount of water being pumped from the *second* compartment to return directly back into the *second* compartment.

6. A self contained variable water level Aquarium as claimed in claims 1.–5. wherein, within the panel wall separating the *second* compartment from the main Aquarium viewing area are placed a quantity of holes to form an overflow weir sited on the *maximum* water level line.

7. A self contained variable water level Aquarium as claimed in claims 1.–6. wherein, in a *third* compartment sited at the opposite end of the Aquarium to compartments one and two, is housed a pump or pumps to re-circulate the water in the form of an opposing midwater current, operating by means of a dual function timer to allow timed variable currents within the main Aquarium.

8. A self contained variable water level Aquarium as claimed in claims 1.–7. wherein are situated various compartments housing pumps to control the variable water level within the main viewing area, each pump being controlled either singly or in concert by a dual timing device.

9. A self contained variable water level Aquarium as claimed in claims 1.–8. which incorporate within the main viewing area a

fourth compartment to house essential life support—filtration—and cleansing equipment. The water flowing from and returning to the fourth compartment on a continuous basis, in direct communication with the main viewing area, by means of a pump or pumps placed within the fourth compartment.

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