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(54) Improvements in or relating to the extracting of energy from a moving mass of water

(57) Apparatus for extracting energy from a moving body of water comprises a structure adapted to be mounted in or to float at anchor in the water and having passages 2a/b arranged to face upstream; sliding valve members 3*a*, 3*b* for suddenly arresting the flow of water out of the passage, and an air chamber in communication with the downstream end of the passage in such manner that air in the chamber is compressed by the momentum of the water entering the passage after the interruption of the out-flow. Such a chamber includes an outlet for such compressed air which may be utilised to drive a motor either mounted on the structure, or situated on land and connected to the chamber by means of suitable piping. The motor may be in the form of a reciprocating piston air motor or in the form of a low pressure air turbine mechanism. Sluice gates 5*a*, 5*b* are interconnected and open alternately to admit water to passages 2*a*, 2*b*.

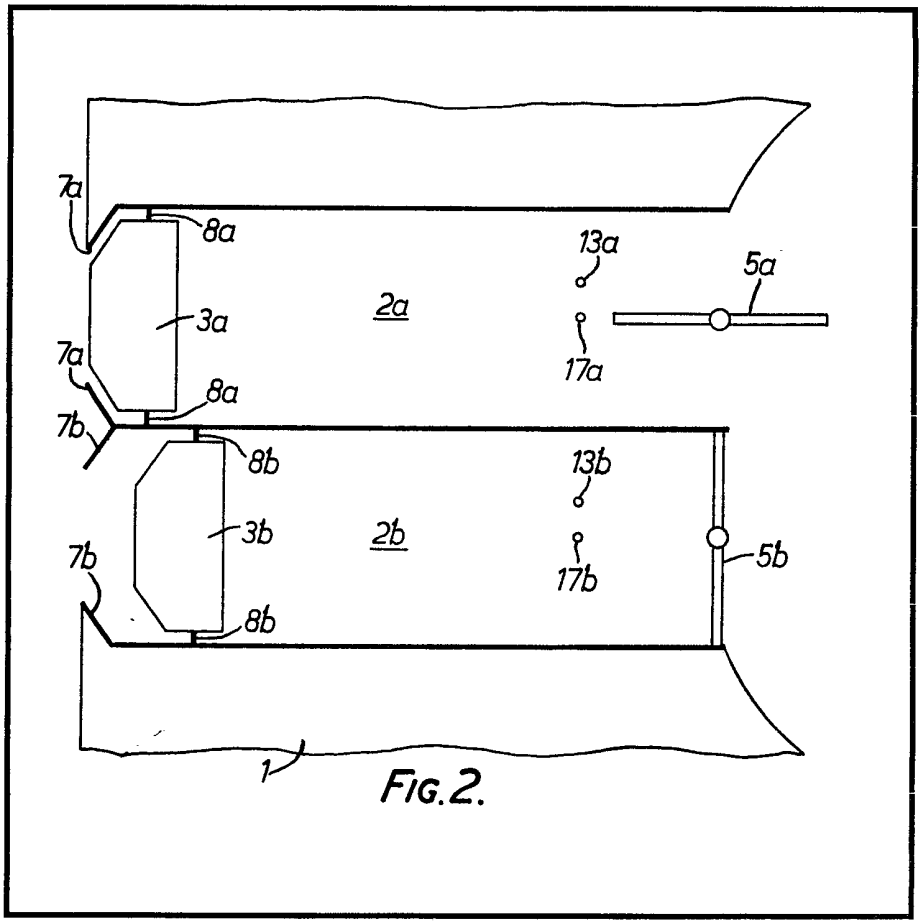

FIG. 2.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

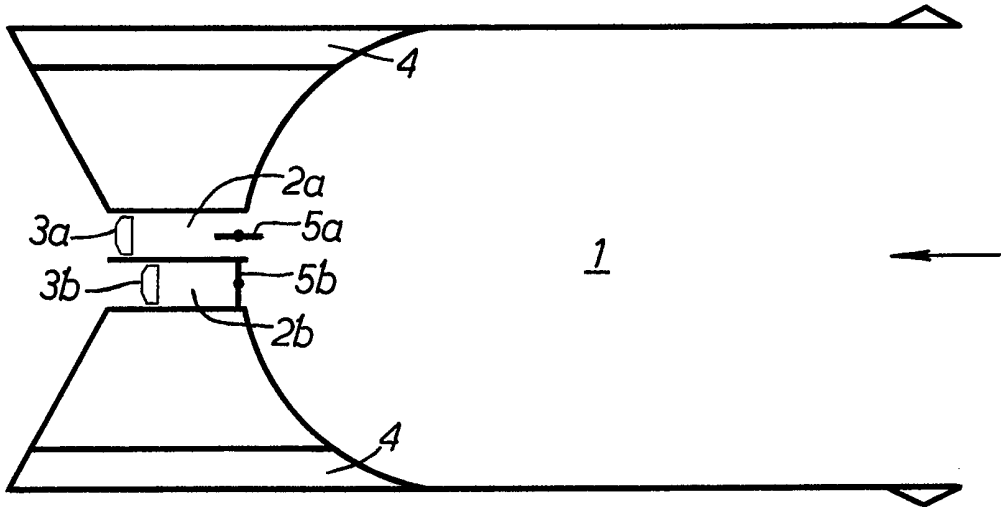
4
2a
3a
5a
1
3b
5b
2b
4

FIG. 1.

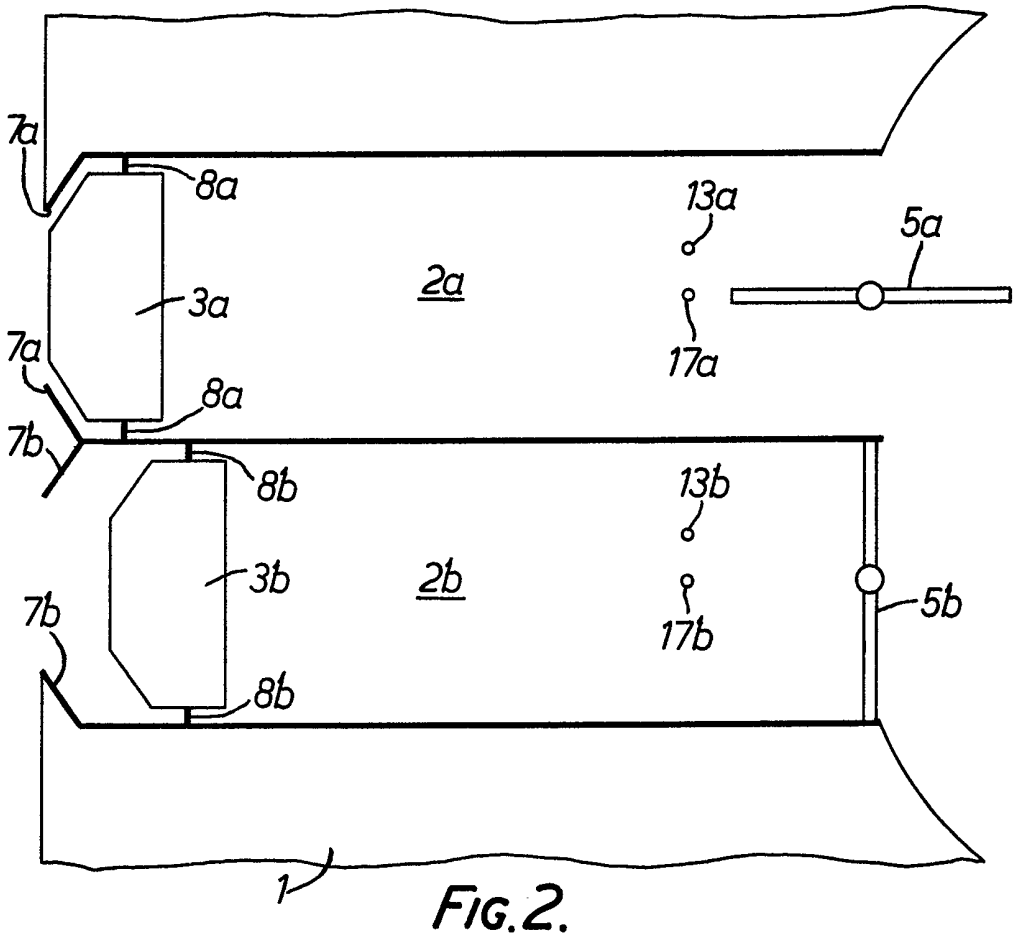
7a
8a
13a
5a
2a
3a
17a
7a
8a
7b
8b
13b
3b
2b
17b
5b
7b
8b
1

FIG. 2.

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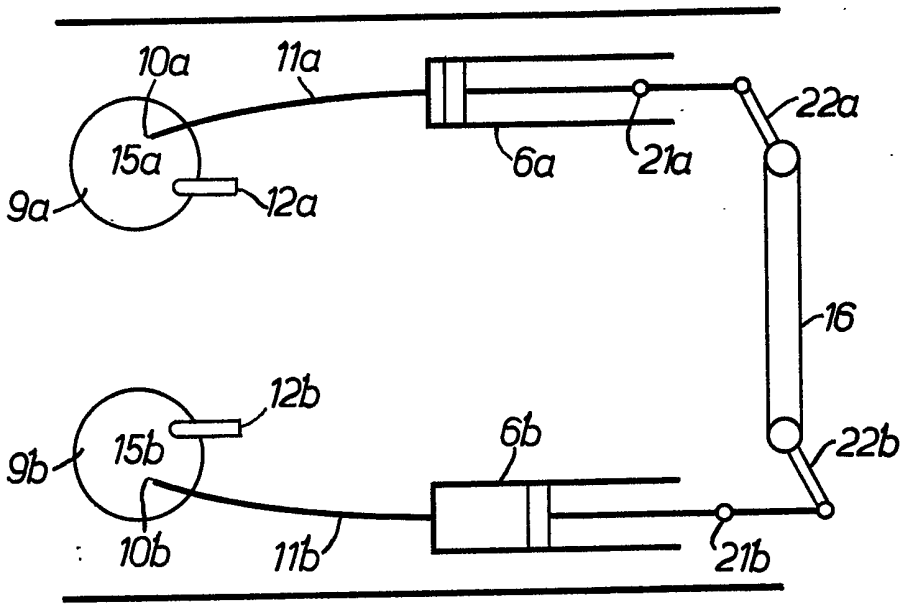

FIG. 3.

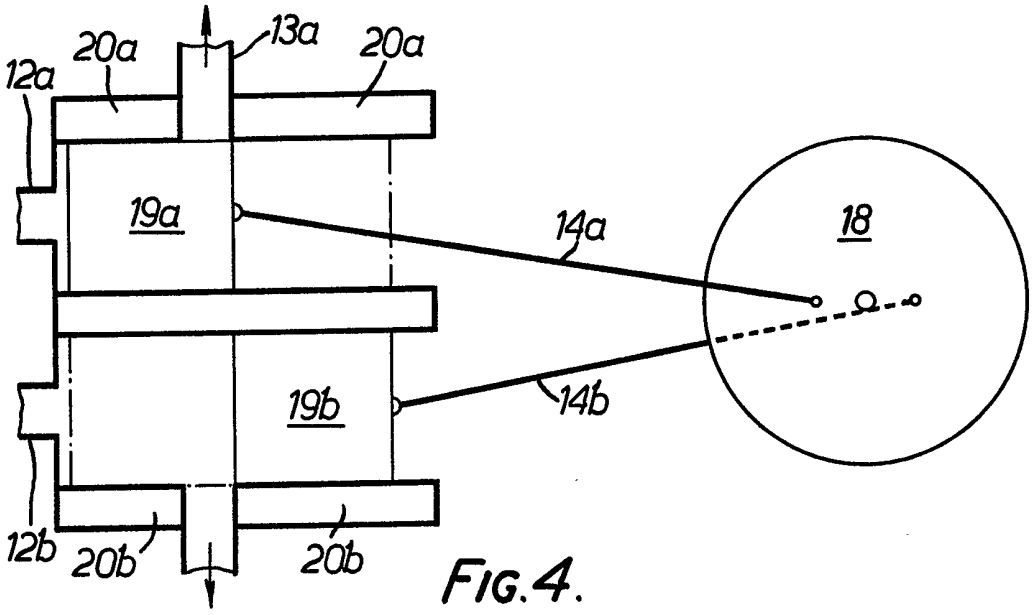

FIG. 4.

SPECIFICATION

Improvements in or relating to the extracting of energy from a moving mass of water.

This invention relates to the extraction of energy from a moving body of water. It is an object of the present invention to provide apparatus for extracting energy from a moving body of water which may include a river, a tidal narrows surf or other water which moves in a body.

Accordingly the present invention provides apparatus for extracting energy from a moving body of water comprising a structure adapted to be mounted in or to float at anchor in the moving body of water and having a passage arranged to face into the movement of the water; and having means for converting the energy contained in water entering the passage to a transmittable form.

The energy conversion means may take various forms.

One preferred form comprises means for suddenly arresting the flow of water through the passage, and an air chamber in communication with the passage in such manner that air in the chamber is compressed by the water entering the passage upon the interruption of the flow therethrough. Such a chamber includes an outlet for such compressed air which may be utilised to drive a motor either mounted on the structure, or situated on land and connected to the chamber by means of suitable piping. The motor may be in the form of a reciprocating piston air motor or in the form of a low pressure air turbine mechanism. Alternately the reciprocating piston motor may use the water shock wave directly to drive the pistons. The motor wherever located may drive an electricity generator or do other useful work.

In a preferred arrangement of the apparatus, two such inlet passages are arranged side by side and means is provided to interrupt the flow of water through the passages alternately.

In order to promote a fuller understanding of the above and other aspects of the present invention, an embodiment will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic plan view of an embodiment of the invention,

Figure 2 shows an enlarged detail of the side by side passages in Fig. 1,

Figure 3 shows schematically the operation of the sluices of Fig. 1, and

Figure 4 is a schematic diagram of the air motor associated with the embodiment of Fig. 1.

In these drawings, the following numbers are used to represent the following parts of the device:

1	A large inlet channel.
2 a/b	Small channels.
3 a/b	Sliding valves.
4	Buoyancy chambers.
5 a/b	Sluices.
6 a/b	Sluice operating cylinders.
7 a/b	Valve seats.
8 a/b	Spring loaded wheels of sliding valves.
9 a/b	Air inlet valves from atmosphere.
10 a/b	One way valves to 11 a/b
11 a/b	Small bore air pipes.
12 a/b	Large bore air pipes.
13 a/b	Inlet valves from motor exhaust.
14 a/b	Motor cranks.
15 a/b	Top of air chambers.
16	Sluice synchronising mechanism.
17 a/b	Air inlet valves from atmosphere.
18	Free wheel, fly wheel and generator.
19 a/b	Pistons of air motor.
20 a/b	Cylinders of air motor.
21 a/b	Sluice cranks.
22 a/b	Sluice shafts.

Referring to the drawings, Fig. 1 shows the body, mounted or anchored in the water flow in such a way that the level of the roofs of the water channels is the same as the level of the outside flow. Not shown are the mounting or anchor nor means for preventing the ingress of flotsam and jetsam. The length of the body is aligned in the direction of flow. The body has a large inlet passage 1 leading into two smaller passages 2 *a/b* where the velocity of flow will be many times the velocity of the outside flow. Each of the passages 2 *a/b* is provided at its outlet with a valve seat indicated at 7 *a/b*. The valve members 3 *a/b* are movably mounted in the passages 2 *a/b* respectively. These valve members may, as in the drawing, be valves sliding in runners contained in either the bottom and top or the sides of the passages, through wheels containing springs arranged so that without any outside force exerted on the valve members, they remain in an open position.

Alternatively they may be heavy flap valves hanging from the top of the ends of the water passages, which close suddenly when the water flow forces them to a predetermined angle with the perpendicular. Otherwise any suitable valve, which by the action of the water flow, suddenly closes, may be used.

In the drawings are shown sluices 5 *a/b* which are operated by air cylinders 6 *a/b* supplied by air lines bled from the air chambers 15 *a/b*. The sluices are connected by the synchronising band 16 so that when one is open the other is closed. Instead of this sluice mechanism another mechanism such as a flap valve may be preferred to direct the flow into alternate channels.

In operation, water flows into channel 1

and so into the small channel 2 *a*. When it reaches the downstream end of 2 *a* it will close the valve 3 *a*. As a result a large moving mass of water, extending from the outside flow to the valve 3 *a* is suddenly decelerated to stop. This results in a shock increase in hydraulic pressure in the passage. A pressure connection is taken from the point in the roof of the passage at roughly the point marked X on Fig. 2 which leads into the air chamber 15 *a* which is directly overhead, so that water under pressure is fed into the air chamber 15 *a*. This is provided with an outlet 12 *a* through a large bore pipe to the air motor shown in Fig. 4 where it actuates a piston 19 *a* to turn a combined fly wheel and free wheel to operate an electrical generator.

The air chamber 15 *a* is also provided with a one way valve 9 *a* to allow air to enter after the shock wave has passed in order to assist water evacuation from the air chamber.

At the same time as air passes through the large bore pipe 12 *a* to the motor it also passes through the small bore pipe 11 *a* to the sluice control cylinder 6 *a* closing the sluice 5 *a* and opening the sluice 5 *b*, when the same sequence of events occurs in the channel 2 *b*, the air chamber 15 *b* and the piston 19 *b*. Thus a cycle develops to produce alternate shock waves in the two channels 2 *a/b* which drive the air motor. To assist with water evacuation from the channels 2 *a/b*, the exhaust from the motor may be led back to the points 13 *a/b* just downstream of the sluices 5 *a/b*, where are also situated one way valves 17 *a/b*. These have the double function of introducing air before the shock wave, so that some compression in the air chamber occurs beforehand and after the shock wave has passed off brining in air to assist the rapid evacuation of water from the channels 2 *a/b*.

In an alternative arrangement, the air motor may be replaced by a reciprocating piston hydraulic motor connected, by way of suitable one way valves, directly to the outlets of the inlet passages to receive water under pressure as a driving medium, without the intermediary of compressed air.

It will be understood that while the invention in its broadest concept comprises a single inlet passage with a preferred arrangement having two such inlet passages, the invention extends to the provision of a larger number of such inlet passages in a single or modular multiple structure.

As best seen from Figs. 2 and 3, the sluice valves, pivoted about a central vertical axis, are operated by means of pressure piston cylinder devices 6 *a/b* through the intermediary of cranks 21 *a/b* operative on the shafts 22 *a/b* on which the sluice valves 5 *a/b* are respectively pivoted and the shafts are coupled by means of a chain and sprocket 16 or similar drive so that when one sluice valve is opened, the other is automatically returned, with its fluid pressure operated device to the closed position.

Fig. 4 shows in some detail a reciprocating piston air pressure motor, which may form part of the device. The twin cylinders 20 *a/b* are placed alongside one another to allow pistons 19 *a/b*, each on its own power stroke to return the other to the starting point. The dotted lines show the reversed position of the pistons. This form has been adopted to obviate pressure losses owing to the operation of the crank shafts 14 *a/b* but other forms of simple motor may be preferred. Alternatively, the compressed air may be stored in a reservoir and fed out as power is required, when the use of an air turbine may be more appropriate. It will be appreciated that while a double arrangement of passages 2 *a/b* is shown, a single passage arrangement is possible with suitable valve control arrangement to operate the sluice valve at the entry to the passage.

In any of the above arrangements it may be arranged that the floor of the passages 2 *a/b* slope downwards in the downstream direction.

Means may be taken to control and govern the flow of water in the passages 2 *a/b* so as to ensure operation of the air motor at uniform speed.

Where a device being an embodiment of this invention is operated in surf, means will be taken to further strengthen the floating body and to reduce internal pressure by the operation of a series of blow-off valves so as to reduce vulnerability to severe storms.

While devices which operate on the principle of using the inertia of a flow of water which is suddenly arrested have been used for many years to pump water, the devices of the invention attain superior potency by maximising the following:

1. Mass of water decelerated, dictated by mass of water contained in the device.
2. Mass of water decelerated, dictated by evacuation of water remaining after previous deceleration in the same channel.
3. Rate of deceleration, dictated by velocity of flow of water arrested.
4. Number of cycles in any one given period.
5. And by reduction in back pressure (by creating eddy area just downstream of exit valve).

CLAIMS

1. Apparatus for extracting energy from a moving body of water comprising a structure adapted to be mounted in or to float at anchor in the moving body of water and having an inlet passage arranged to face into the movement of water; and having means for converting the energy contained in water entering the inlet passage to a transmittable form.

2. Apparatus as claimed in Claim 1, in which said conversion means comprises means for suddenly arresting the flow of water through the inlet passage, and an air chamber in communication with the passage in such manner that air in the chamber is compressed by water entering the inlet passage upon such interruption of the flow.

3. Apparatus as claimed in Claim 3, in which said air chamber is provided with an outlet in communication with a fluid pressure operated motor device for conversion of the pressure energy of the air to mechanical energy.

4. Apparatus as claimed in Claim 1, 2, or 3 in which said flow arresting means comprises a valve member which is disposed at the ed of the passage which is downstream in operation, and which is resiliently biassed to an open position and movable under the influence of water flow through the inlet passage to a closed position to arrest the flow of water through the passage.

5. Apparatus as claimed in Claim 2, 3 or 4, in which the inlet passage is provided with a sluice valve device at its end which is upstream in operation arranged to close off the passage after operation said flow arresting means so that it may empty after the compression of air in said chamber.

6. Apparatus as claimed in Claim 5, in which said sluice valve device is pneumatically operated, being powered by air compressed in said chamber.

7. Apparatus as claimed in Claim 2, 3, 4 or 5 in which said air chamber is provided with an air inlet having a one-way valve operable therein to allow air into the chamber when water drains from the inlet passage.

8. Apparatus as claimed in any one of Claims 5 to 7 in which said inlet passage is provided with a one-way valve air inlet positioned immediately downstream of said sluice valve device.

9. Apparatus as claimed in any one of Claims 5 to 8, in which compressed air from said air chamber is bled into the inlet passage at a point downstream of said sluice gate device to assist in emptying the passage after arrest of the flow of water through the passage.

10. Apparatus as claimed in any one of Claims 2 to 9, comprising two or more such inlet passages disposed in a parallel arrangement and having their flow arresting means arranged to operate in sequence.

11. Apparatus as claimed in Claim 10, comprising a pair of such inlet passages arranged side by side.

12. Apparatus as claimed in Claim 11, in which said pair of passages share a single sluice valve device arranged so that water can only flow into one passage at a time.

13. Apparatus as claimed in Claim 11 or 12, in which said air chambers are connected to a respective side of a double acting fluid pressure operated motor device.

14. Apparatus as claimed in Claim 11, 12 or 13, in which a convergent entry is provided to said inlet passages.

15. Apparatus as claimed in any preceding claim, in which the effect of the sudden arrest of a moving body of water is increased by the maximising, within a given volume, of the mass of water which is arrested, by increasing the velocity of the arrested water and by reducing the length of the period between one arrest and the next and by reducing back pressure in the device.

16. Apparatus for extracting energy from a moving body of water substantially as herein described with reference to the accompanying drawings.

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