Shutter-like fluid driven motor and tide power harvest system

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Abstract

Why we have to be addictive to rotary turbine for tide or wind energy harvest? Perhaps we are not smart enough to find a new way. Now I propose a rectangular cross section turbine that works in reciprocation mode to harvest energy from any flowing fluid. In a sense, fluid flows in similar way of electric DC (Direct Current), but reciprocal motion of device's ram behaves in similar way of AC (Alternating Current), thus a **DC-AC mechanic inverter** is needed. Of course, inverse utilization of same mechanism renders an **AC-DC mechanic rectifier**, i.e. an exotic pump.

Introduction

The renewable energy is so plentiful, especially a great source of the running water hydrodynamic energy in all rivers and oceans. Nowadays, only high water head resources can be effectively utilized for hydro electricity, but the main resource is of low water head, and never well developed in prior arts, though some experimental tidal turbine projects are under research, such as the Fundy bay tidal energy project in Canada.

Here I present a shutter-like fluid-driven motor and try to apply it to the tidal power harvest system, as showed in **fig. 1**, of course, it can apply to any low head rapid river or stream.

How it works?

Shutter-like, aka **louver-like** motor, categorized in class of board motors, is basically the planar type that receives mechanic energy directly by planar surface from energy carrying fluid which current direction is vertical to the said surface, not by rotating blades as in traditional rotary turbines where fluid direction is never vertical to any blade, but a small angle; and usually the former can interface either a square or rectangular or even more complicated area with fluid power, but the latter only circular area.

For cycling work, all board motors including shutter-style, must run in reciprocal movement.

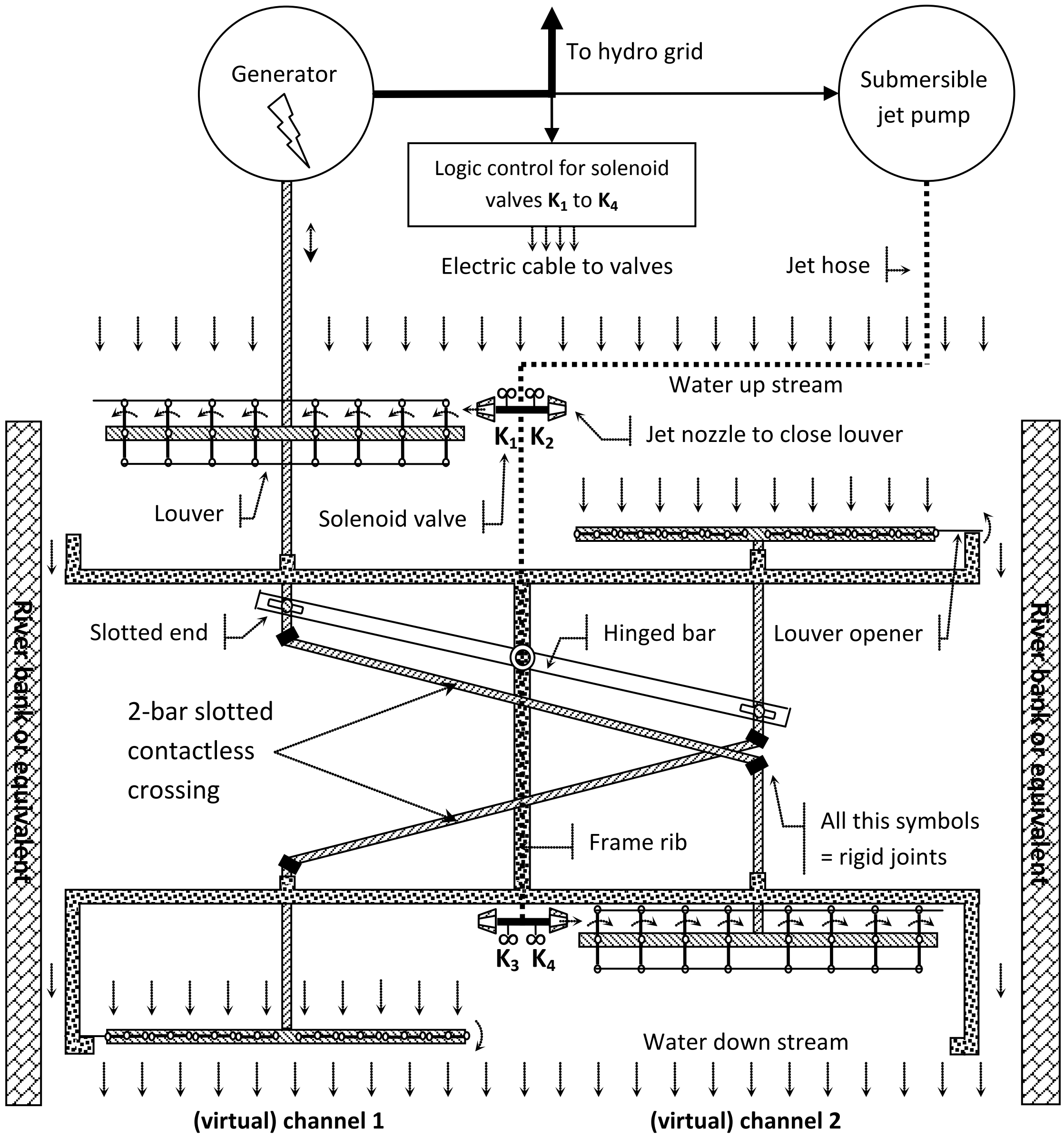

Fig. 1 river or stream low head hydro generator

Abstractly, the board motor absorbs direct current energy of unidirectional flowing fluid, such as running water, and converts it into alternating "current" or motion of rigid movable parts, e.g. ram, in reciprocal mode, and so, in a sense, it is a special **DC-AC** converter or inverter.

Run with the unidirectional flow produces effective work, anyway for recycling run, retraction is a must for next reciprocal cycle, but retraction is always counter-current, that is why the interfacing area perpendicular to flow direction should be reduced to almost zero during retraction by whatever feasible method for save of overhead energy used by internal operation.

In **2**-board mode (undrawn in **fig. 1**), hinging **2** parallel shafts via an end-slotted bar with central pivot pin, the **2** boards can work in **180°** phase difference that means one board's retraction can always be assisted by the other forwarding board pushed by fluid.

Update to **4**-board mode is simple, as showed in **fig. 1**: just combining the two pairs of boards to form quartet in cross linkage configuration, the entire working interface area can be **100%** of stream vertical cross section, if not then only **50%**.

The quartet assembly virtually divides the whole stream to **2** quasi fluid channels, and if a separator wall is inserted in between, though unnecessary, then **2** channels will realize.

The crossing linkage can be done by rigid joint of opposite boards in separate channels, thus, the boards in same channel always run in opposite direction.

To fix the space conflict, one of the two crossing bars can be slotted in middle quoted range, and the other bar runs through the slot.

For large planar motor, a single board can be hard to flip for toggle of interfacing area, because of either non-negligible toggle energy consumption, or not enough turn around room, that is why a shutter style motor is proposed, because every single vane of shutter is just a fractional area of the whole.

Compared with the full shutter board area, the power interface area of shutter rib-frame is almost negligible, so it is not necessary to flip the big size rib-frame, but just only toggling all vanes of the shutter is enough.

Toggling the shutter is identical to say open or fold or close or unfold shutter in semantics, and where open shutter is mentioned, then it means fluid can pass the shutter and the shutter is in retraction stroke; otherwise the shutter is confronting fluid and in working stroke.

In the figure, closing or unfolding shutter is done by water jet, and opening or folding shutter by flange hit, though water jet can be optional.

The timing of shutter toggle is important for efficient energy harvest, and solenoids can execute timing instructions from logic control module.

The water jet is produced by jet pump, and mini-size could be okay because of low energy consumption of toggling shutter. The absolute pressure of water jet is better to equal the fluid static pressure plus atmosphere pressure plus a threshold value that is determined by engineering conditions, because if too high then not economic else if too low unworkable.

In fact, toggling vanes of shutter should not be only credited to the jet power, but also the subsequent fluid power, because the yaw effect of fluid will assist and quicken the toggling transition, though the jet initialized or triggered and created the vane's non-equilibrium state, and that is also the reason why toggling energy is negligible.

For convenience of characterization, as the operating rationale aka working principle is well explained in context of all above description, I abstract and define such a rationale as **fluid-DC-AC** that means the unidirectional fluid pushes vanes that are alternatively changing orientation in parallel or vertical to stream by aforementioned mechanism so as to output mechanic energy during reciprocal movement. It applies to both planar and quasi planar vanes, such as plain board, shutter-like, or even umbrella-like.

By narrowing a waterway, the water current velocity can be increased significantly, so as to harvest more energy, as the illustrated river banks in the figure.

As a rule of thumb, fluid motor is submersed in stream, generator is mounted on platform over water body and anchored to riverbed, and most applications work in shallow water except ocean application.

Coupling the fluid motor and above-water generator is via transmission, such as sprocket mechanism, though direct coupling may work if the generator is well water-sealed for submersible use and not big enough to block waterway.

Comparison with rotary turbine

Obviously the blades of a rotary turbine can only occupy very small percentage of whole circular area, and there is a small angle between fluid force and blade surface so as to induce torque for rotation.

A quartet board turbine, usually in rectangular shape, can make full use of all cross section area of running fluid, and flowing force directly push boards forward, such advantages can over-perform far greatly than the regular simple rotary turbine.

The loss of rotary turbine is only caused by friction, but for a turbine of board type, extra overhead energy is needed for driving jet pump and logic controller and solenoid valves.

As long as the fluidic power can cover the said overhead energy, i.e. overcoming the breakeven threshold, then the fluid-DC-AC mechanism can work.

Generally speaking, the overhead energy is very low, and none river holds dead water, so whatever low head river resource can be utilized for energy production with this invention.

If deployed in water body, such system is safe for fishes, unlike rotary turbines can kill fishes.

This mechanism can also be utilized to harvest wind energy where an air compressor replaces jet pump, but a yawing system or other complicated control system is needed to track wind direction. Such system almost has no noise, and is safe for birds.

Extended application – the fluid-AC-DC reciprocal pump

It is well known that most electric motors can also be used as generators with minor modification, though efficiency could be very low.

This is also true in fluid circuit.

Therefore, herein fluid-DC-AC motor can also be used as fluid-AC-DC pump with minor logic configuration, but the static leaking of fluid may frustrate some applications if substantial modification is not done.

Post script

For details, please check out my pending patent US15/267,122.