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Sieber

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(54) **ENDLESS BELT ENERGY CONVERTER**

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F03D 5/02	(2006.01)
F03B 17/06	(2006.01)
F01D 23/00	(2006.01)
F03B 9/00	(2006.01)
F03D 9/00	(2016.01)
F03B 13/26	(2006.01)

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CPC ***F03B 13/12*** (2013.01); ***F01D 23/00*** (2013.01); ***F03B 9/00*** (2013.01); ***F03B 13/264*** (2013.01); ***F03B 17/06*** (2013.01); ***F03B 17/066*** (2013.01); ***F03D 5/02*** (2013.01); ***F03D 9/008*** (2013.01); *F05B 2240/40* (2013.01); *F05B 2240/93* (2013.01); *Y02E 10/28* (2013.01); *Y02E 10/70* (2013.01)

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USPC 60/495, 496
See application file for complete search history.

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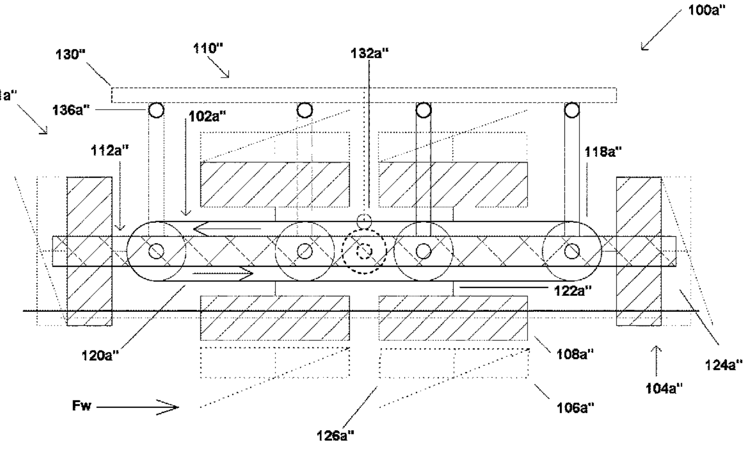
(57) **ABSTRACT**

The present invention relates to a way to convert energy from a fluid flow, using a fluid-flow transducer, having a frame anchorable against the flow, an elongated conveyor supported by the frame, and a plurality of vanes distributed along the conveyor, adapted to engage the fluid flow and to drive the conveyor in response to urging of the fluid flow, in combination with a power take-off coupled to be driven by the conveyor and adapted to drive a load.

19 Claims, 12 Drawing Sheets



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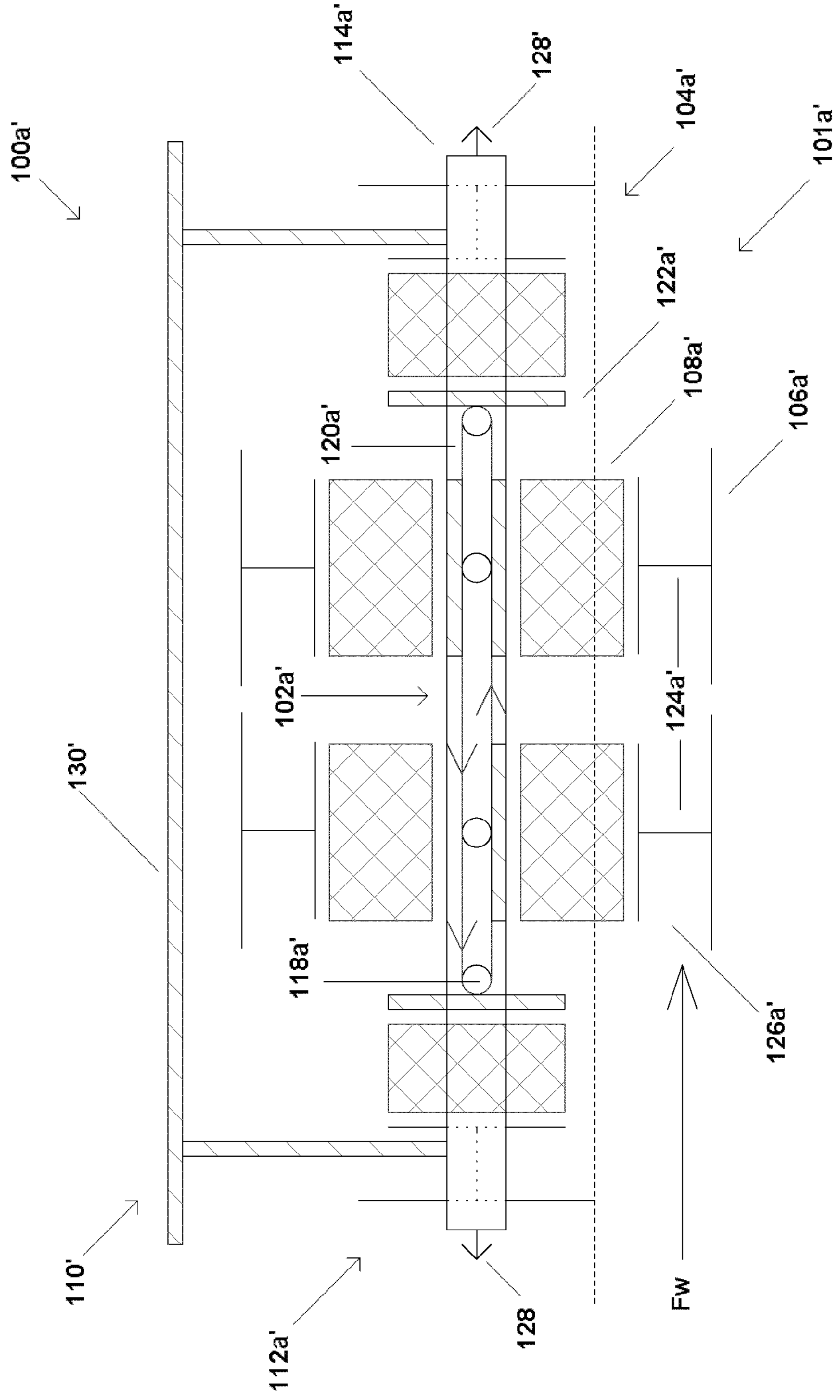
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126a'
110'
112a'
128
Fw

Figure 1

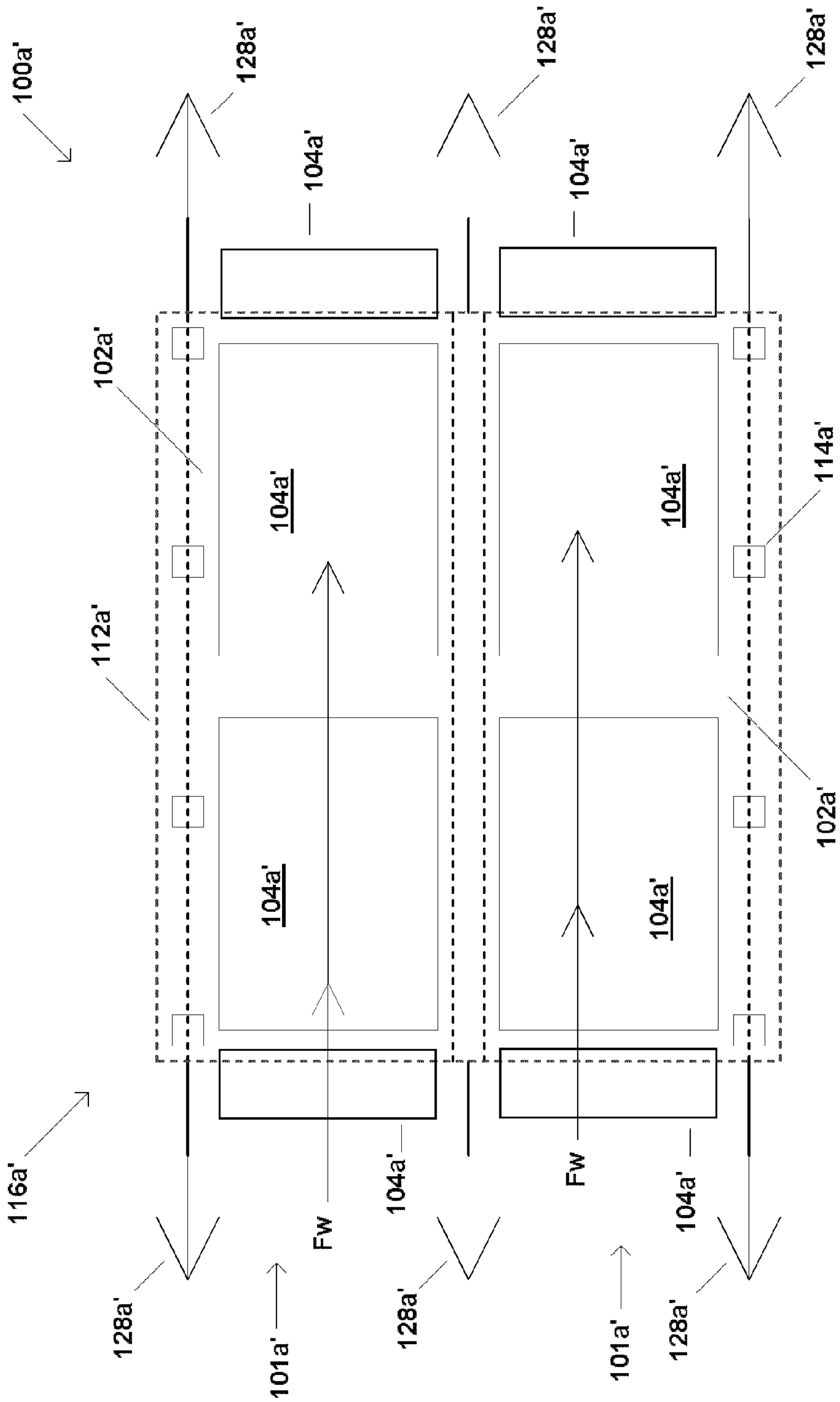
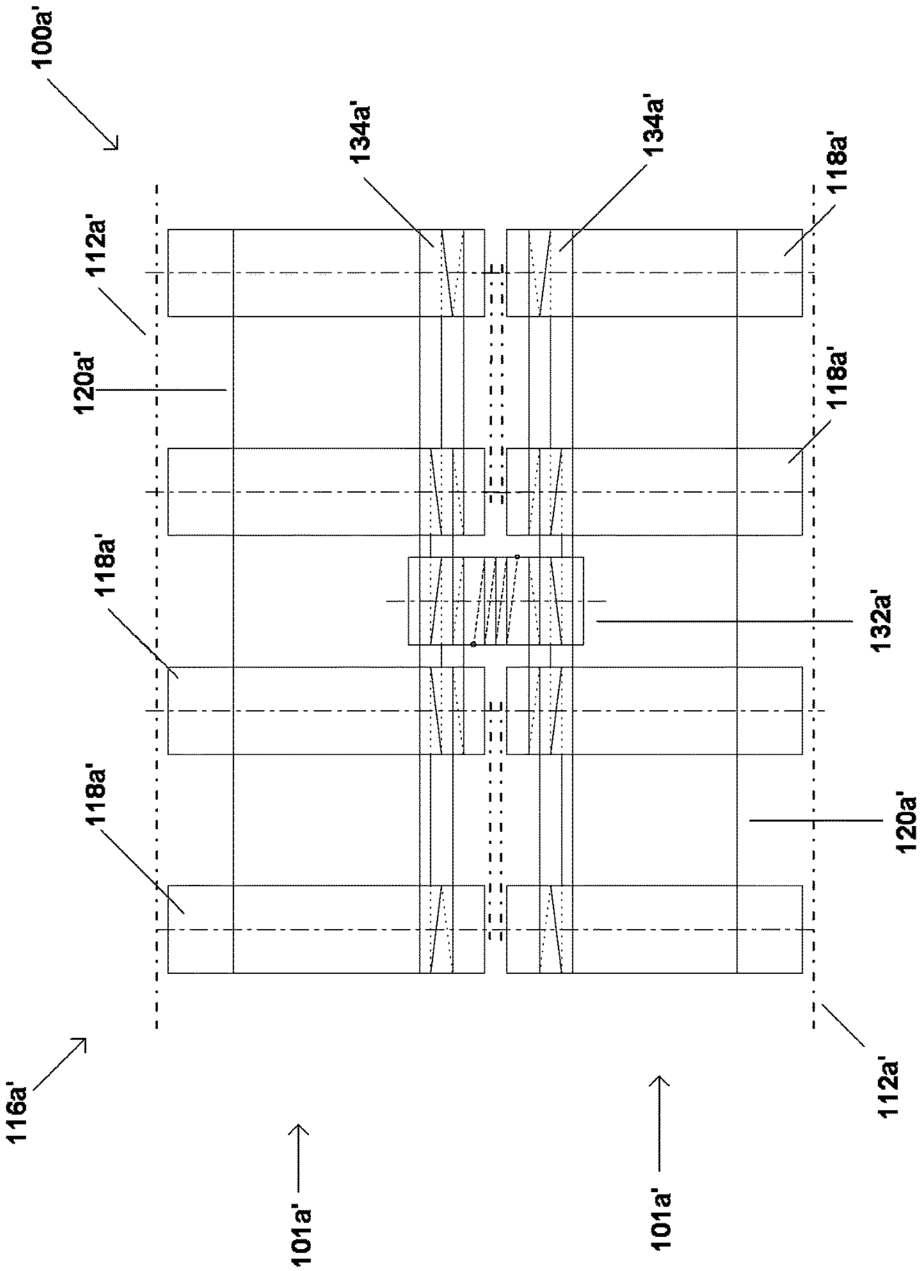


Figure 2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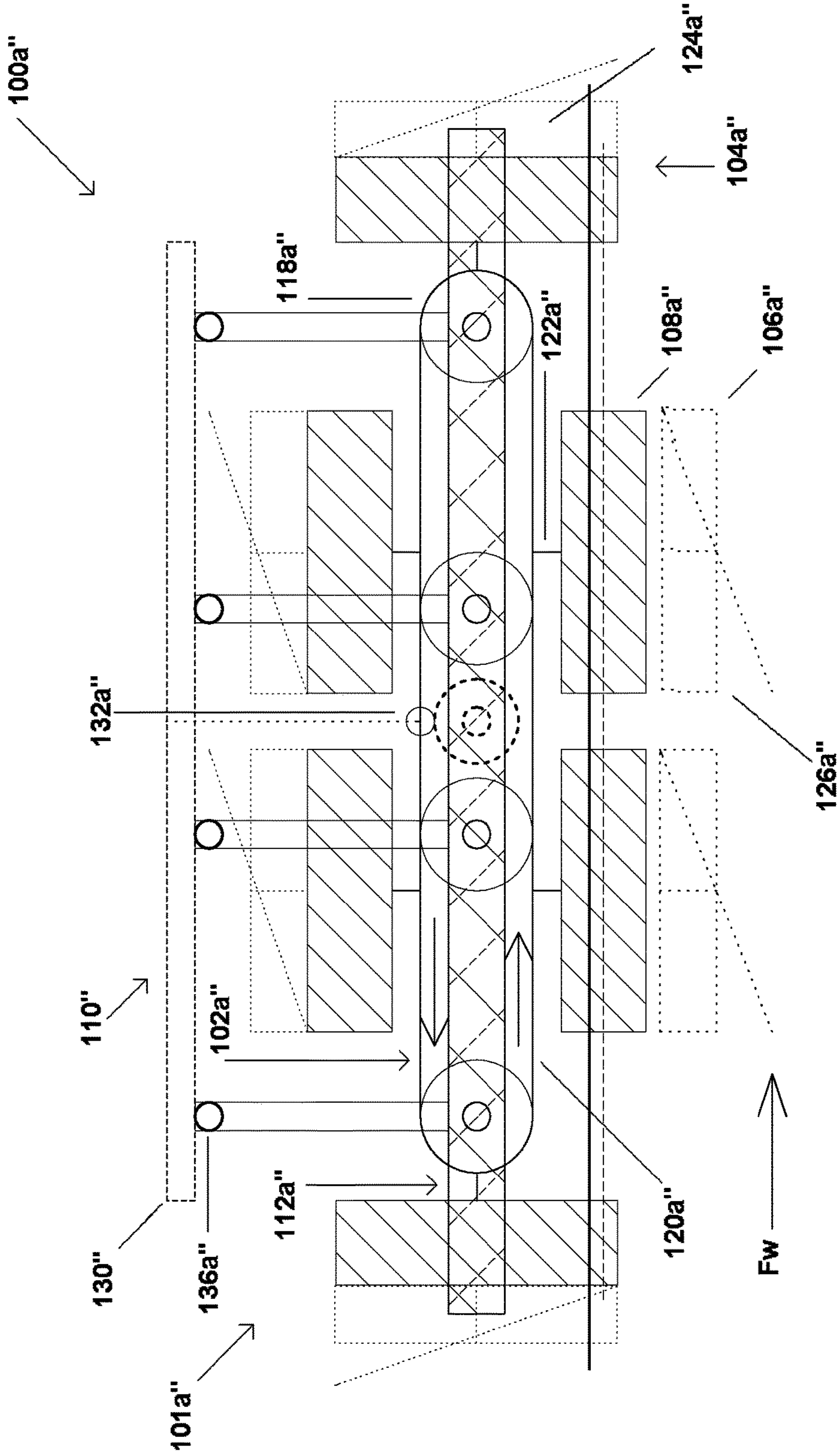
101a'
101a'

Figure 3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101a"
Fw

Figure 4

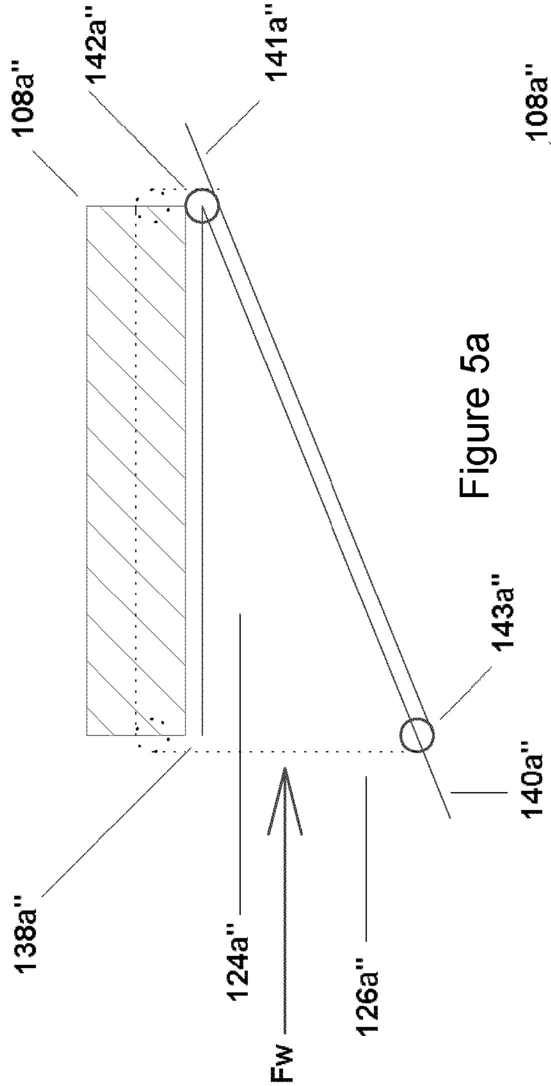


Figure 5a

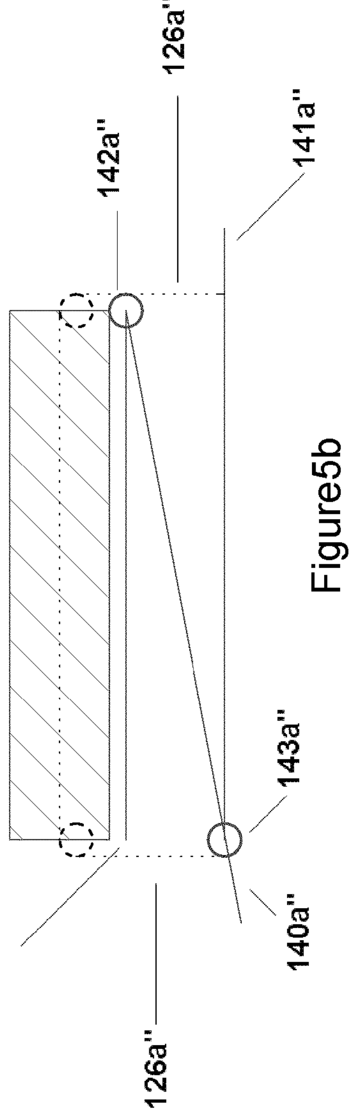


Figure5b

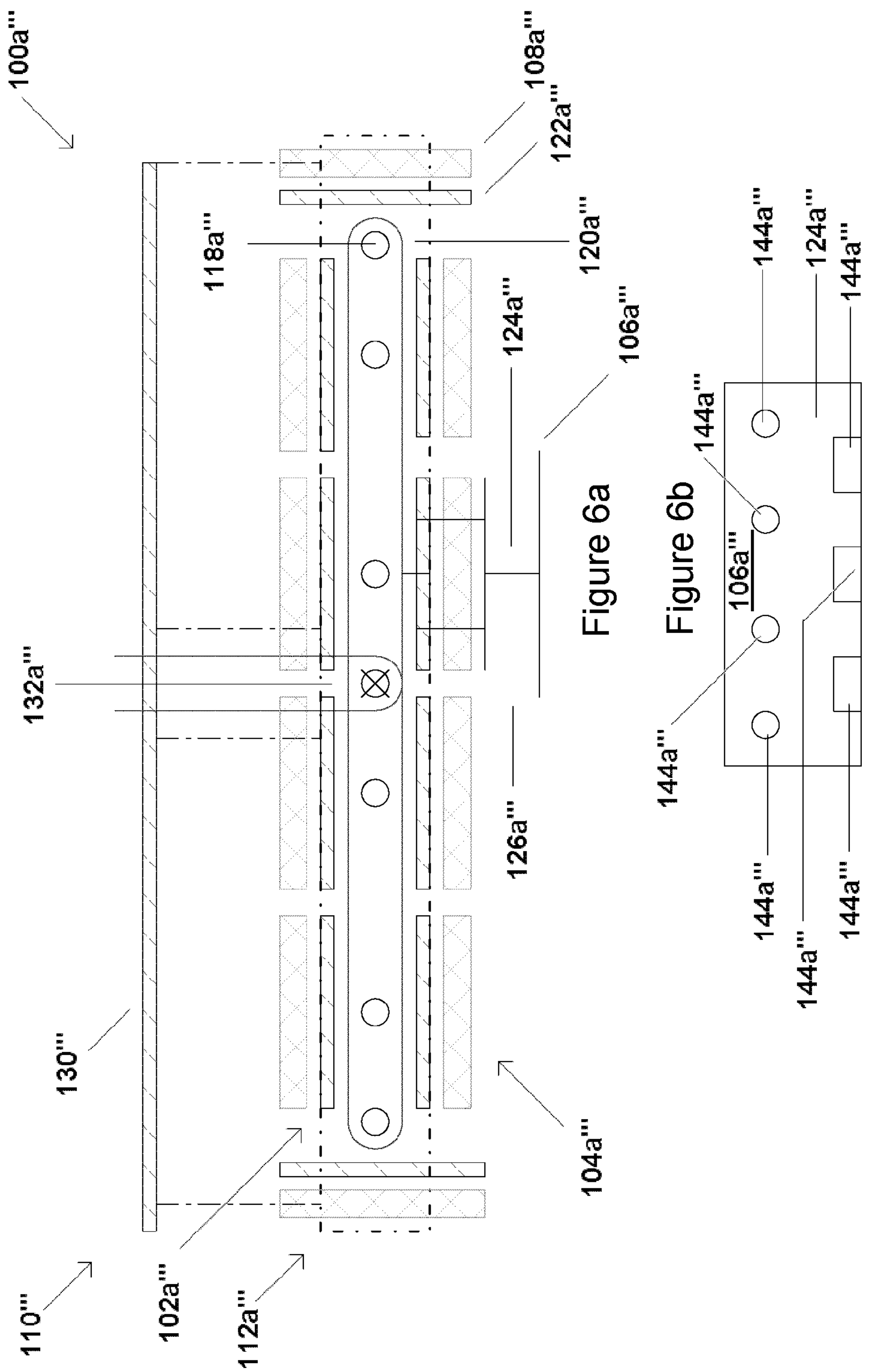
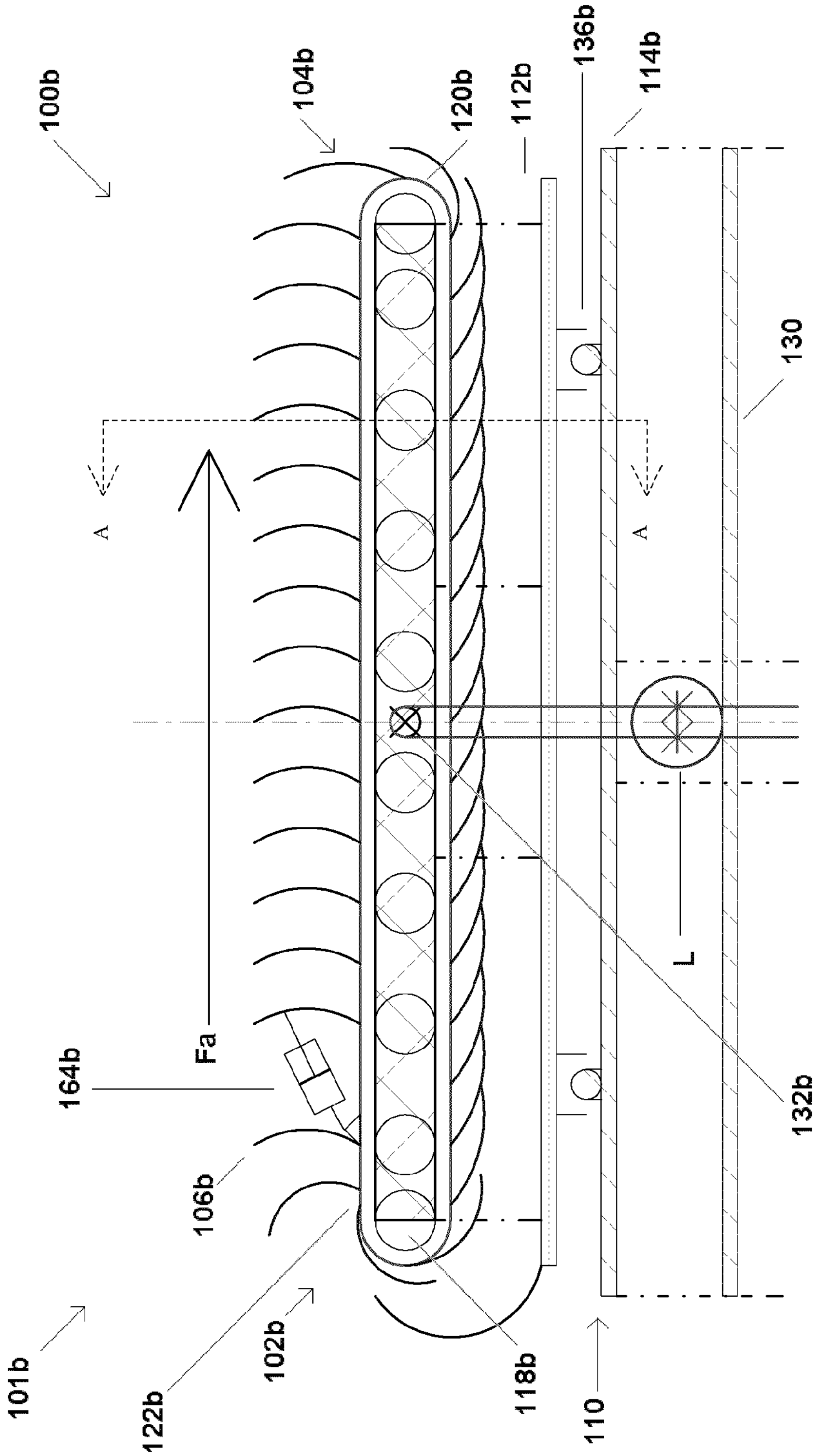


Figure 6a

Figure 6b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120b
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136b
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A
A
Fa
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106b
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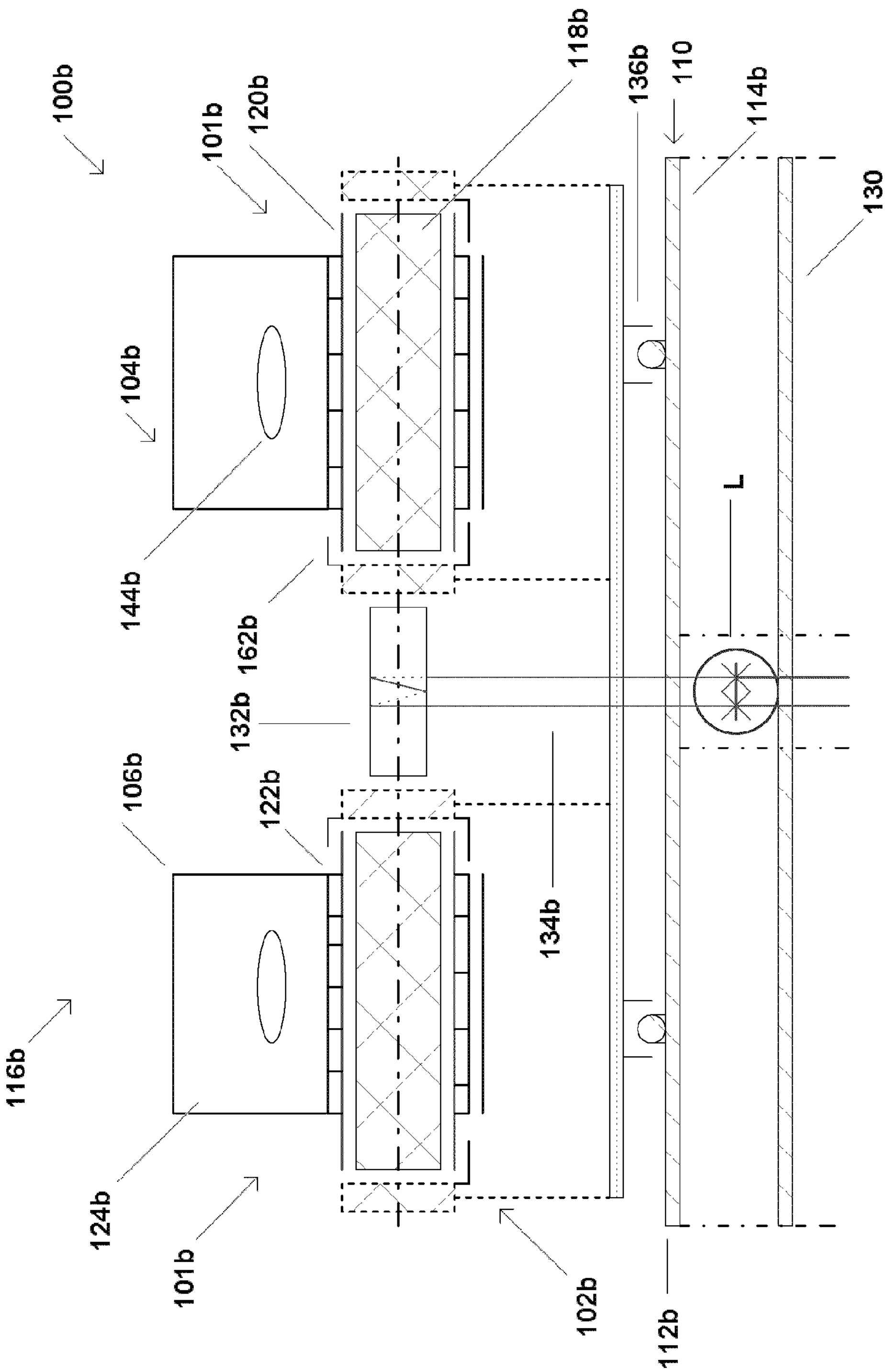
122b
102b
118b
110
L
132b

Figure 7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132b
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122b
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101b
102b
112b

Figure 8

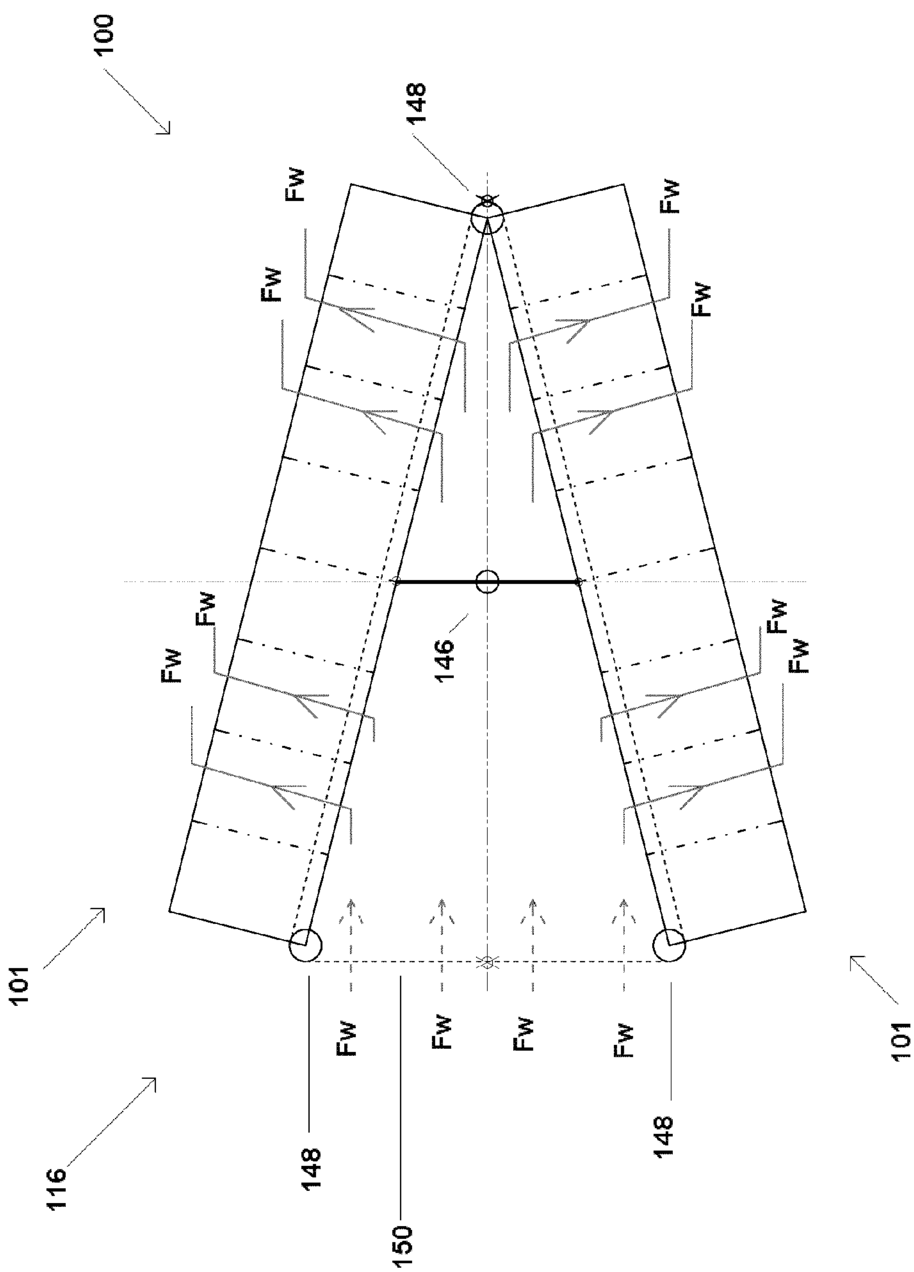


Figure 9

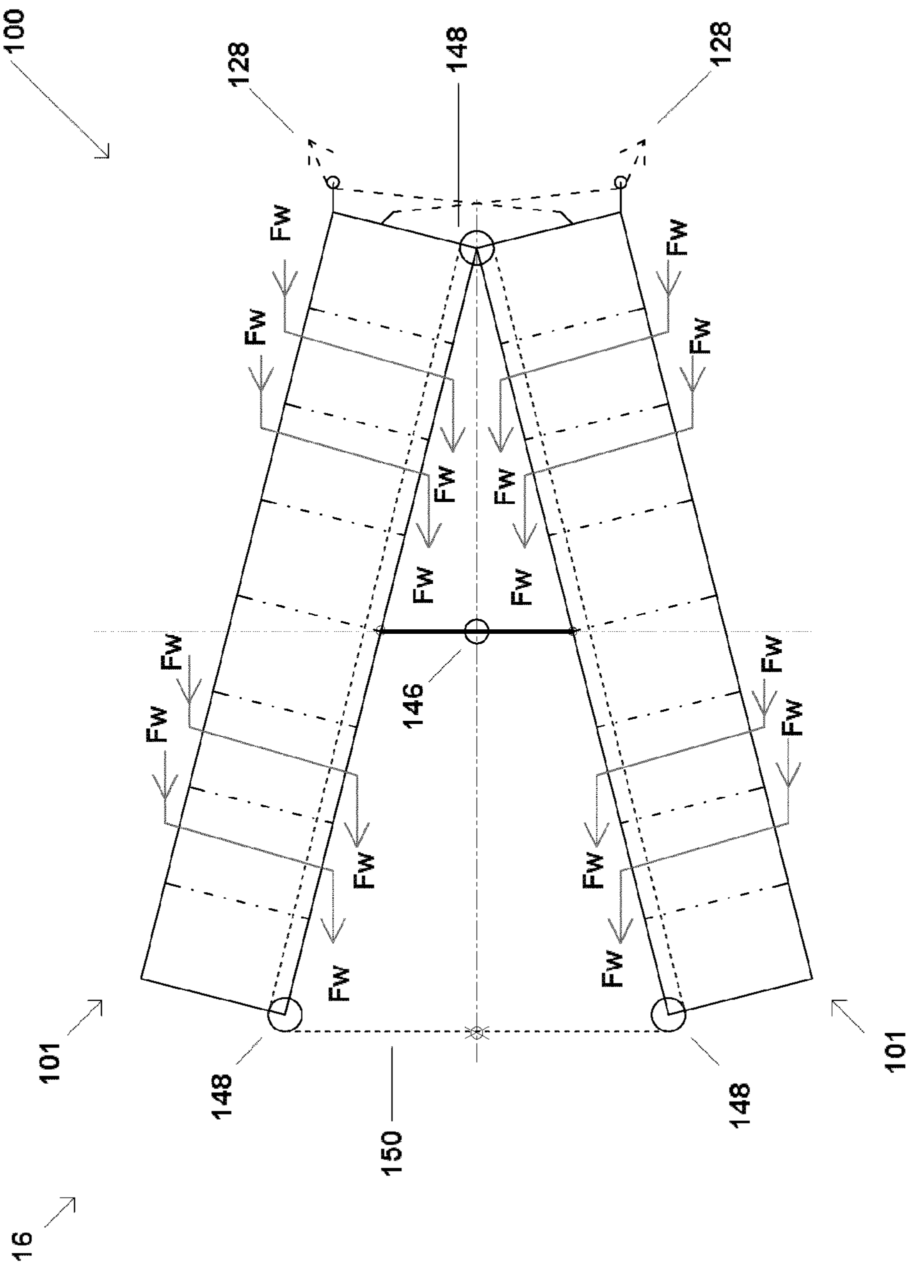
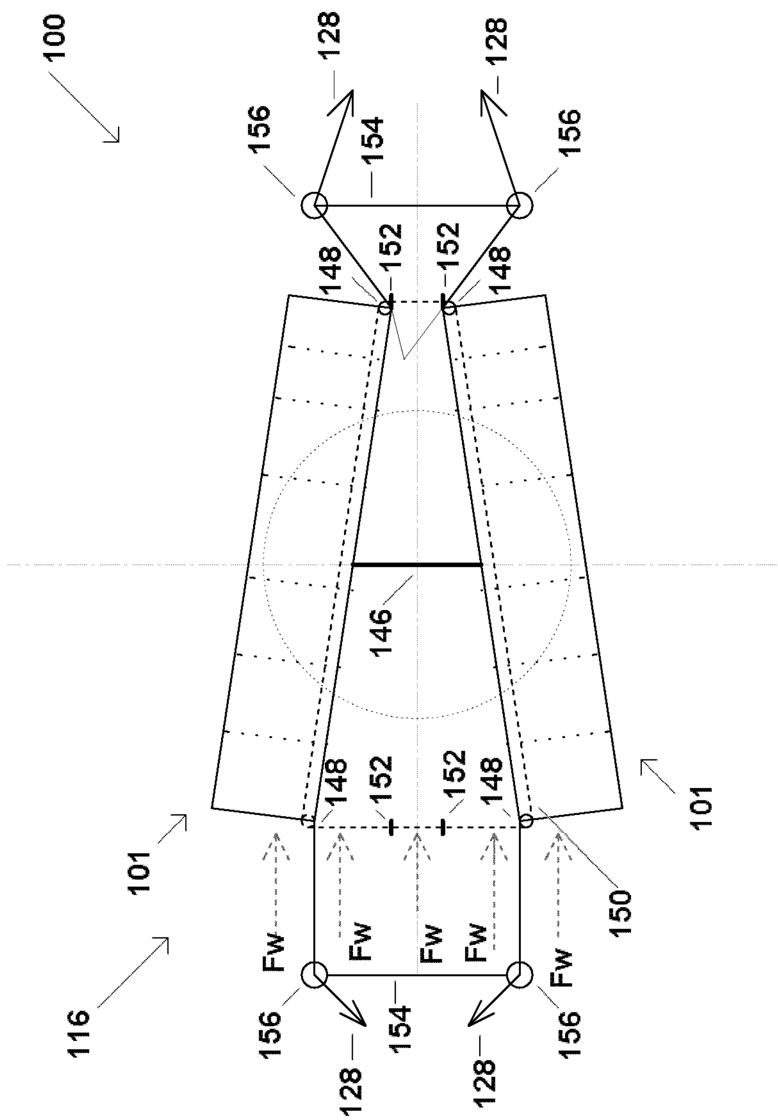


Figure 10


100
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154
156
128
128

Figure 11

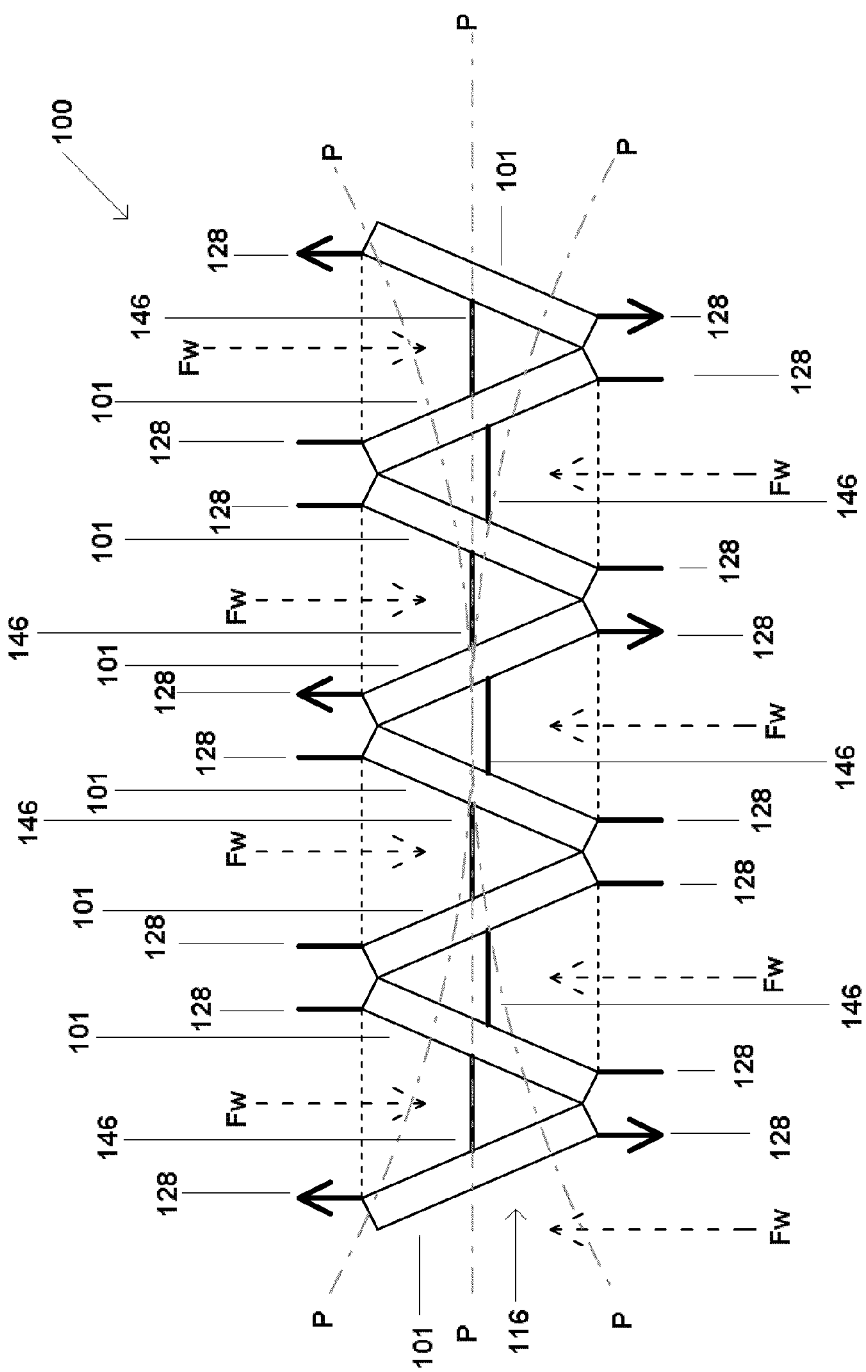

Figure 12

ENDLESS BELT ENERGY CONVERTER

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Patent Application Ser. No. US61/599,933 filed on Feb. 17, 2012, entitled Generator, which is expressly incorporated by reference herein to the extent permitted by law.

BACKGROUND

1. Field

The present invention relates to ways to generate energy by harnessing, transducing, extracting or otherwise converting the kinetic energy of a flowing fluid, including flowing air currents (including wind currents) and flowing water currents (including ocean currents, for example tidal currents, and watercourse currents, for example river currents). In this document, in the absence of contrary indication, the words generate, harness, transduce, extract and convert, in all their various forms, will be used interchangeably.

2. Description of Related Art

Terrestrial wind turbines have shown considerable success; however, they have many shortcomings. They are costly to build and deploy and are prone to damage under severe wind conditions. Their massive size and noisiness make them unattractive to some people. Some people have expressed concerns that such turbines present a health hazard to people and birds, that they affect local weather patterns and that they may affect farming. These concerns are prompting increasingly large and much more expensive offshore deployment of wind turbines.

Nevertheless, the success enjoyed by wind turbines, when the air currents are blowing just right, has enticed some to directly apply this concept to water current energy retrieval. This conventional reasoning suggests that because the density of water is about 800 times greater than that of air, therefore the concentration of energy must also be that much greater, resulting in the need for a much smaller device to extract the same energy. Unfortunately, many popular designs have focused on this oversimplified analogy, ignoring other forces that come into play. One must even be careful in applying concepts drawn from penstock-fed hydraulic turbines in hydroelectric systems.

Installing a water generator submerged in a water flow, for example a tidal current, exposes the generator to uneven and very significant forces, with water being 800 times denser than air. This is the case whether we use a vertical axis or a horizontal axis of rotation. These uneven forces, plus the resistive forces encountered by rotating vanes trying to cut through the dense water medium, have resulted in failures to apparently very substantial devices, thus providing power outputs that pale in comparison to the predicted ratings.

Thus for example, a tidal current stream is typically very slow, relatively speaking, and the water immediately beyond the turbine blades is still present in full force to slow down the turbine rotation. This resistive force, slowing down the envisioned turbine rotation, is almost as great as the forward force of the tidal current that conventional wisdom is attempting to utilize. To illustrate, if we manually or mechanically attempted to spin the turbine at the expected running speed, and while the tidal current speed is nil, we would discover that the required energy is absolutely immense. Almost all of this required energy, or drag, would have to be overcome by the forward force of the tidal current, not to mention what additional energy is required to drive a power take-off to provide the expected power output.

In a hydraulic system, the water stream in the penstock travels at a considerable speed when it reaches the turbine, dependent on the vertical drop, and the turbine spins accordingly fast. The water stream immediately beyond the hydraulic turbine continues to drop and is on the verge of creating cavitations. What this means is that the downstream side of the hydraulic turbine does not have to slice its way through the dense water medium. There is minimal drag, or energy loss. In essence, the turbine spins freely with respect to the downstream side, and is relatively unencumbered.

A similar environment besets a wind turbine. When there is no wind blowing, and if we attempted to rotate the turbine at the rotational speed of operation, we would likewise find that the required energy is immense. Almost all of this required energy, or drag, would have to be overcome by the forward force of the wind, not to mention what additional energy is required to drive a power take-off to provide the expected power output.

There are several tidal current turbines being tested, and we read about their unexpected failures, or we hear nothing about the low and unpublished results. All the blades are torn off one machine, while another is retrieved to prevent total destruction. And so the story goes, with the expected power output of those that have survived being unreachable, being unexpectedly low and/or unpublished.

Devices like waterwheels are caused to operate by the weight of falling water at the circumference of the wheel. Others may be caused to operate by the force of the flowing water on the lower submerged portion of the wheel. In this case the effective lateral force relates directly to the point on the circumference and its submergence. The force is not uniform over the arc of submergence, because the force is strictly lateral acting on a circular and revolving member.

Paddle boats have similar limitations. In this case, for balanced drive, there is a wheel on both sides of the boat. Regardless, the force coming from the engine room is not uniformly applied in the lateral dimension. When the wheel first touches the waterline, a portion of the applied force is downward and is wasted, as it is when the wheel approaches emergence from the water medium, a portion of the applied force is upward and is likewise wasted. The most efficient application of the applied force is at the point where it impacts on the perpendicular radius to the direction of flow.

The rotational force over a lateral distance, described above, is not as efficient as a lateral force over the same distance. Further, none of these applications above can match a continuous lateral force over an identical distance.

Accordingly, what is needed is a better way to capture the almost limitless green-house-gas-emissions-free renewable and sustainable energy, at a lower cost in capital investment, operations and maintenance and with increased energy capture per ton of fabricated material.

SUMMARY

The present invention is directed to this need.

According to one aspect of the present invention, there is provided an apparatus for generating energy from a fluid flow, which includes a flow transducer that transduces energy from a flowing fluid.

According to one aspect of the present invention, there is provided an apparatus for generating energy from a liquid flow, which includes a liquid flow transducer that transduces energy from a flowing liquid, for example a tidal current, an ocean stream or a river stream.

According to another aspect of the present invention, there is provided an apparatus for generating energy from a gas flow, which includes a gas flow transducer that transduces energy from a flowing gas, for example air, for example wind. Terrestrial applications can be sited anywhere, because of their low profile, with a special emphasis on roof-tops of industrial buildings.

According to another aspect of the present invention, the liquid flow transducer and the gas flow transducer cooperate synergistically to generate energy from proximate fluid flows.

Marine applications of fluid flow transducers can be deployed anywhere on the ocean's surface or in rivers and river estuaries where there is measurable current velocity. Such locations are also often blessed with significant wind velocities, and hence the opportunity to simultaneously harness the energy of the prevalent wind stream to drive an adjacent or common generator. Doing so on a single installation automatically enhances the utilization factor.

According to one aspect of the present invention, there is provided an apparatus for converting energy from a fluid flow, including a first fluid-flow transducer, having a frame anchorable against the flow, an elongated conveyor supported by the frame, and a plurality of vanes distributed along the conveyor, adapted to engage the fluid flow and to drive the conveyor in response to urging of the fluid flow, and a power take-off coupled to be driven by the conveyor and adapted to drive a load.

At least one of the plurality of vanes may have an extended position and a retracted position. At least one of the plurality of vanes may have at least one passage therethrough.

The conveyor may include a plurality of rollers, each roller respectively extending transversely across the frame and the plurality of rollers extending longitudinally along the frame, and a closed belt engaging the plurality of rollers for travel thereover.

The first fluid-flow transducer may be a liquid-flow transducer and the plurality of vanes may include flotation sufficient to support the apparatus. The plurality of vanes may be even in number, for example six.

The first fluid-flow transducer may be a gas-flow transducer. At least one of the plurality of vanes may have an energy-accumulator coupled to extract energy from it when it moves between the retracted position and the extended position. The conveyor may be supported on the frame via a turntable.

The apparatus may include a second fluid-flow transducer coupled to the power take-off. The first fluid-flow transducer and the second fluid-flow transducer may both be liquid-flow transducers, for example connected together in a fixed, parallel array. The first fluid-flow transducer and the second fluid-flow transducer may be connected together in a pivoting array; the pivoting array may include a further plurality of fluid-flow transducers pivotally connected together along a path.

The first fluid-flow transducer may be a liquid-flow transducer and the second fluid-flow transducer may be a gas-flow transducer. The first fluid-flow transducer may support a superstructure that supports the second fluid-flow transducer. The first fluid-flow transducer may support the superstructure with a plurality of translation-couplings.

According to another aspect of the present invention, there is provided a method of converting energy from a fluid flow, including distributing a plurality of vanes along an elongated conveyor and anchoring the conveyor proximate the flow such that some of the plurality of vanes are urged upon by the flow and in response urge the conveyor into motion. The method may further include supporting the conveyor on the flow with the some of the plurality of vanes urged upon by the flow.

Further aspects and advantages of the present invention will become apparent upon considering the following drawings, description, and claims.

DESCRIPTION

The invention will be more fully illustrated by the following detailed description of non-limiting specific embodiments in conjunction with the accompanying drawing figures. In the figures, similar elements and/or features may have the same reference label. Further, various elements of the same type may be distinguished by following the reference label with a second label that distinguishes among the similar elements. If only the first reference label is identified in a particular passage of the detailed description, then that passage describes any one of the similar elements having the same first reference label irrespective of the second reference label.

In the document, a reference label "a" is used to particularly designate an element of liquid-flow transducer and a reference label "b" is used to particularly designate an element of a gas-flow transducer. In this document, prime, double prime and triple prime reference labels are used to particularly designate an element of a first embodiment, second embodiment and third embodiment liquid-flow transducer respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation of a first embodiment of a fluid-flow transducer—a liquid-flow transducer in accordance with aspects of the present invention.

FIG. **2** is a plan view of two liquid-flow transducers of FIG. **1** connected into a fixed, parallel array.

FIG. **3** is a plan view detailing a cable-drive on the array of FIG. **2**.

FIG. **4** is a side elevation of a second embodiment of a fluid-flow transducer—a liquid-flow transducer in accordance with aspects of the present invention.

FIG. **5*a*** is a side elevation of a scoop on the liquid-flow transducer of FIG. **4**, with a first blade extended and a second blade retracted.

FIG. **5*b*** is a side elevation of a scoop on the liquid-flow transducer of FIG. **4**, with a first blade partially extended and a second blade partially extended.

FIG. **6*a*** is a side elevation of a third embodiment of a fluid-flow transducer—liquid-flow transducer in accordance with aspects of the present invention.

FIG. **6*b*** is a front elevation of a scoop on the liquid-flow transducer of FIG. **6*a***.

FIG. **7** is a side elevation of a fourth embodiment of a fluid-flow transducer—a gas-flow transducer in accordance with aspects of the present invention.

FIG. **8** is a cross-sectional view of the gas-flow transducer of FIG. **7**, viewed along the cutting plane A-A.

FIG. **9** is a plan view of a pivoting array of two fluid-flow transducers, the two transducers forming a vertex at a downstream end.

FIG. **10** is a plan view of a pivoting array of two fluid-flow transducers, the two transducers forming a vertex at an upstream end.

FIG. **11** is a plan view of a pivoting array of two fluid-flow transducers, the two transducers not converging to a vertex.

FIG. **12** is a plan view of a pivoting array of eight fluid-flow transducers, the array extending along a path.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

(a) General Overview

With reference to FIGS. **1-12**, there will now be described various exemplary embodiments of a converting apparatus **100** that includes a fluid-flow transducer **101**, and more particularly a liquid-flow transducer **101***a* and/or a gas-flow transducer **101***b*.

(i) First General Approach: Liquid Flow

A first general approach focuses on harnessing the energy in a liquid flow, for example a water flow, for example a tidal current, an ocean stream or a river stream.

As illustrated for example in FIG. **1**, an embodiment of this approach might include a liquid-flow transducer **101***a*. The liquid-flow transducer **101***a* might be mounted on a floating vessel (not shown), for example a powered vessel or a barge, anchored in a tidal current stream. The liquid-flow transducer **101***a* includes an elongated conveyor **102***a* along which are distributed a plurality of vanes **104***a*. The conveyor **102***a* is so aligned with the tidal flow Fw such that those of the vanes **104***a* immersed in the flow are propelled backward, thereby driving the conveyor **102***a*, which advances other vanes **104***a* into the flow Fw.

In essence, these vanes **104***a* have similarities to continuous tracks (also known as caterpillar tracks or tank treads) commonly found on heavy equipment, with the vanes **104***a* returning to the front of the vessel (not shown) in the less dense air medium above the water flow Fw. Mechanically coupled to a load L, for example a generator on the surface deck of the vessel (not shown), the conveyor **102***a* could drive the load L.

This arrangement, comprising a small barge and a conveyor **102***a* of comparatively large vanes **104***a* on each side, would be a significant tidal current energy capture device, superior for example to the inverse of the paddle boat concept. Although such a vessel aids in visualizing this approach, the vessel itself is a large and unnecessary drag in the tidal current flow Fw, a drag that needs to be harnessed and eliminated with the opportunity of capturing a much greater amount of energy. By analogy, one may observe a tugboat pulling on a log boom. This effort is frequently observed with the tugboat making minimal progress against a tidal current. The power put to the task is usually a few thousand horsepower diesel engine, which illustrates the immense energy in the tidal flow Fw. One can quickly imagine that instead of a relatively smooth contoured log boom, the towing power required would be considerably increased if scoops projected downward from it.

Inverting this need for a vast amount of power to move a floating object, we may consider instead converting that power of the tidal flow Fw to generate energy. Instead of a vessel to position the liquid-flow transducer **101***a* on the surface of the tidal current flow Fw, we can re-design the liquid-flow transducer **101***a* to include large blocks of floatation **108***a*. More particularly, we can construct each vane **104***a* as a water scoop **106***a* connected to floatation **108***a*, which is in turn connected to a mounting-plate **122***a*, which is in turn connected to the conveyor **102***a*. In combination, each such constructed vane **104***a* that is in contact with the tidal current flow Fw would have sufficient buoyancy to keep the entire liquid-flow transducer **101***a* and its superstructure **110** all afloat, with each vane **104***a* in turn returning to the front of the liquid-flow transducer **101***a* in the less dense air medium above the tidal current flow Fw. As for the superstructure **110**, the entire non-moving assembly above the floatation **108** would be anchored, for example permanently and immovably, fore and aft with anchors (not shown) made from concrete or other benign material.

(ii) Second General Approach: Gas Flow

A second general approach focuses on harnessing the energy in a gas flow, for example a wind.

As illustrated in FIG. **7** for example, an embodiment of this approach might include a gas-flow transducer **101***b*. The design of the gas-flow transducer **101***b* applies many of the same concepts as the liquid-flow transducer **101***a*, but with applications suitable for an air environment. In place of water scoops **106**, the gas-flow transducer **101***b* has sails **106***b*. The gas-flow transducer **101***b* can combine synergistically with the liquid-flow transducer **101***a*, and is mountable on a large turntable **136***b* on the superstructure **110** of the liquid-flow transducer **101***a* to account for situations where the direction of the air flow Fa is not aligned with the direction of the water flow Fw. In this regard, the liquid-flow transducer **101***a* and gas-flow transducer **101***b* can be connected to drive a common load L, for example a generator.

(b) Structure of Specific Embodiments

The structure of the invention will now be further illustrated by explanation of specific, non-limiting, exemplary embodiments shown in the drawing figures, described in greater detail herein.

(i) First Embodiment

With reference to FIGS. **1** and **2**, a first embodiment of a liquid-flow transducer **101***a*' is generally illustrated in side elevation and plan views. The liquid-flow transducer **101***a*' is built on a frame **112***a*' of web beams **114***a*'. The frame **112***a*' additionally provides a way to connect together multiple liquid-flow transducers **101***a*' into an array **116**, for example a fixed, parallel array **116'** of liquid-flow transducers **101***a*' as seen in FIG. **2**. Such arraying provides not only additional generating capacity, but also stability.

The frame **112***a*' supports a conveyor **102***a*', in this embodiment formed from a series of parallel rollers **118***a*' that each extend transversely across the frame **112***a*' and together extend longitudinally along the frame, the parallel rollers **118***a*' engaging a closed belt **120***a*' that longitudinally spans the frame **112***a*', such engagement being sprocket-driven for example.

A series of mounting-plates **122***a*' are affixed to and distributed along the length of the belt **120***a*'. Each mounting-plate **122***a*' retains a block of floatation **108***a*' that radiates outward from the belt **120***a*'. Each block of floatation **108***a*' retains a scoop **106***a*' that radiates outward from the block of floatation **108***a*', such that the scoop **106***a*', the block of floatation **108***a*' and the mounting-plate **122***a*' form a vane **104***a*'. The scoops **106***a*' are formed to engage the fluid flow Fw when immersed, such that the fluid flow Fw urges against the scoop **106***a*' and in response the scoop **106***a*' moves downstream, transmitting its kinetic energy to the belt **120***a*' through the mounting-plate **122***a*'.

Those skilled in the art will recognize that the scoop **106***a*', the block of floatation **108***a*' and the mounting-plate **122***a*' could be merged or combined with other parts to form a vane **104***a*' in a different manner, for example by building floatation into the scoop **106***a*' or configuring the block of flotation **108***a*' to have a scoop-like shape. In this embodiment, there is an even number of vanes **104***a*', in this embodiment six vanes **104***a*'.

As shown in FIG. **1**, one embodiment of a scoop **106***a*' has two separate fixed chambers **124***a*' with oppositely facing mouths **126***a*' that align with the belt **120***a*', such that any water flow Fw with a component normal to one of the mouths **126***a*' will urge against the scoop **106***a'*.

Depending on the position of the belt **120***a*', some of the vanes **104***a*' radiate upward above the frame **112***a*', others of the vanes **104***a*' radiate downward below the frame **112***a*', and still others of the vanes **104***a*' radiate longitudinally from the frame **112***a*'. As deployed on the surface of a water flow Fw, the liquid-flow transducer **101***a*' floats on the surface of the water flow Fw, supported by the buoyancy of those of those blocks of floatation **108***a*' that are at that time radiating downward below the frame **112***a*'. In this embodiment, the buoyancy of those blocks of floatation **108***a*' supports the whole converting apparatus **100**'.

The frame **112***a*' can be held in place against the flow Fw by anchor lines **128***a*' or other means. Those vanes **104***a*' that radiate downward from the conveyor **102***a*', and that are thus immersed in the flow Fw, are urged along by the flow Fw, thereby urging the belt **120***a*'to rotate the rollers **118***a*'as the frame **112***a*' remains in place.

The frame **112***a*' additionally supports the superstructure **110**', which includes for example an operations deck **130**'. The liquid-flow transducer **101***a*' further includes a power take-off **132***a*' coupled by cable-drives **134***a*' to the rollers **118***a*', to transfer a portion of the power from the rollers **118***a*' to a load L, for example a generator supported on the operations deck **130**'. FIG. **3** shows the placement and coupling of the power take-off **132***a*' in greater detail. This arrangement helps equalize the tensions in the belt drive over its entire length.

Those skilled in the art will thus appreciate that this embodiment teaches an apparatus for converting energy **100** from a fluid flow F, having a first fluid-flow transducer **101** with a frame **112** anchorable **128** against the flow F, an elongated conveyor **102** supported by the frame **112**, and a plurality of vanes **104** distributed along the conveyor **102**, adapted to engage the fluid flow F and to drive the conveyor **102** in response to urging of the fluid flow F, and a power take-off **132** coupled to be driven by the conveyor **102** and adapted to drive a load L.

(ii) Second Embodiment

FIG. **4** shows a second embodiment of a liquid-flow transducer **101***a*". The second embodiment liquid-flow transducer **101***a*" is similar to the first embodiment liquid-flow transducer **101***a*' in many respects.

One difference is that the frame **112***a*" includes translation-couplings **136***a*" for slidably supporting the superstructure **110**", as will be described further below.

Another difference is that the second embodiment liquid-flow transducer **101***a*" includes a more sophisticated second embodiment scoop **106***a*", as best illustrated in FIGS. **5***a* and **5***b*. The second embodiment scoop **106***a*" includes a base-plate **138***a*" that suspends a rotatable first blade **140***a*" from a first cable-operated hinge **142***a*". A rotatable second blade **141***a*" is suspended from the first blade **140***a*" by a second cable-operated hinge **143***a*". This more sophisticated second embodiment scoop **106***a*" allows the first blade **140***a*" and the second blade **141***a*" to be trimmed using with the first cable-operated hinge **142***a*" and the second cable-operated hinge **143***a*" to better match the direction and other characteristics of the water flow Fw in which the scoop **106***a*" is immersed. This embodiment also allows the blades **140***a*", **141***a*" to be retracted when returning above the water flow Fw, so that less clearance and resistance to movement in the air return path is required in the superstructure **110**".

(iii) Third Embodiment

FIGS. **6***a* and **6***b* show a third embodiment of a liquid-flow transducer **101***a*'". The third embodiment liquid-flow transducer **101***a*'" is similar to the first embodiment liquid-flow transducer **101***a*' and the second embodiment liquid-flow transducer **101***a*" in many respects.

One difference is that the third embodiment liquid-flow transducer **101***a*'" includes ten instead of six vanes **104***a'"*.

Another difference in this third embodiment is that the fixed chambers **124***a*'" in each scoop **106***a*'" are connected by at least one passage **144***a*'" through which the water flow Fw can pass.

(iv) Fourth Embodiment

FIGS. **7** and **8** show a first embodiment of a gas-flow transducer **101***b*, which nevertheless has many similarities to the previously described liquid-flow transducer **101***a* embodiments, departing to adapt to harnessing a gas flow in place of a liquid flow.

The gas-flow transducer **101***b* is built on a frame **112***b* of web beams **114***b*. The frame **112***b* supports a conveyor **102***b*, in this embodiment formed from a series of parallel rollers **118***b* that transversely span the frame **112***b* and together engage a belt **120***b* that longitudinally spans the frame **112***b*, such engagement being via sprockets for example. The frame **112***b* may include guide-brackets **162***b* to help guide and retain the belt **120***b*.

A series of mounting-plates **122***b* are affixed to and distributed along the length of the belt **120***b*. Each mounting-plate **122***b* pivotally retains one edge of a sail **106***b*, which radiates outward from the belt **120***b* when in a hoisted position and which abuts the mounting-plate **122***b* when in a retracted position. In this regard, the mounting plate **122***b* and the sail **106***b* form a vane **104***b*.

Each sail **106***b* has a preformed pocket **124***b* that aligns with the belt **120***b*, such that any air flow Fa with a component normal to the pocket **124***b* will urge against the sail **106***b* and in response the sail **106***b* will move downstream, transmitting its kinetic energy to the belt **120***b* through the mounting plate **122***b*. In this embodiment, at least some of the sails **106***b* have a passage **144***b* through the pocket **124***b* through which the air flow Fa can pass.

Depending on the position of the belt **120***b*, some of the vanes **104***b* are hoisted and radiate upward above the frame **112***b* in an extended position, while other of the vanes **104***b* are retracted against their respective mounting-plates **122***b* in an retracted position for low-drag travel below the belt **120***b* back to the top of the frame **112***b*. An energy-accumulator **164***b* (for example as taught in U.S. Pat. No. US7,690,900) can be connected between any respective mounting-plate **122***b* and sail **106***b*, both to damp the extending and retracting of each sail **106***b* and to harness the energy of extending and retracting.

The frame **112***b* can be held in place against the air flow Fa by the superstructure **110**, which in turn is held in place by one or more anchor lines **128** or other means. Those sails **106***b* that radiate outward and upward from the belt **120***b*, and are thus immersed in the air flow Fa, are urged along by the flow Fa, thereby urging the belt **120***b* to rotate the rollers **118***b* as the frame **112***b* remains in place.

The gas-flow transducer **101***b* further includes a power take-off **132***b* coupled to the rollers **118***b*, to transfer some of the power from the rollers **118***b* to a load L, for example a generator supported on the operations deck **130**.

The gas-flow transducer **101***b* includes a turntable-mount **136***b* to rotatably mount the gas-flow transducer **101***b* on the superstructure **110** so that the gas-flow transducer **101***b* can rotate to point into the air flow Fa (the wind).

Those skilled in the art will thus appreciate that this embodiment teaches an apparatus for converting energy **100** from a fluid flow F, having a first fluid-flow transducer **101** with a frame **112** anchorable **128** against the flow F, an elongated conveyor **102** supported by the frame **112**, and a plurality of vanes **104** distributed along the conveyor **102**, adapted to engage the fluid flow F and to drive the conveyor **102** in response to urging of the fluid flow F, and a power take-off **132** coupled to be driven by the conveyor **102** and adapted to drive a load L.

(v) More Advanced Arrays

As described above, fluid-flow transducers **101** can be combined together into an array **116**. With reference now to FIGS. **9** to **12**, more advanced arrays **116** will be further described.

The array **116** described above with respect to FIG. **2** was a rigid, parallel array **116**; however, that need not be the case. As best seen in FIGS. **9** to **11**, liquid-flow transducers **101***a* may be pivotally coupled, for example by a linkage **146***a*, for example connecting the adjacent liquid-flow transducers **101***a* at midlength.

With reference back to FIG. **5**, the frame **112***a* of a liquid-flow transducer **101***a* can be coupled to its superstructure **110** by a translation coupling **136***a* such that the superstructure **110** can remain in place while its supporting liquid-flow transducers **101***a* below are adjusted in the water flow Fw. It will be recalled that gas-flow transducers **101***b* supported by the superstructure **110** rest on a turntable-mount **136***b* and so are free to orient into the ambient air flow Fa.

Adjacent liquid-flow transducers **101***a* may have pulleys **148***a* deployed at either end through which a control-cable **150***a* is threaded, as illustrated in a closed loop, to constrain the relative movement of the adjacent liquid-flow transducers **101***a*. As illustrated, the control-cable **150***a* may include adjustable stops **152***a*, to urge against the pulleys **148***a* and further constrain movement of the adjacent liquid-flow transducers **101***a*.

As best seen in FIGS. **9** and **10**, pivotal adjustment of adjacent liquid-flow transducers **101***a* can help orient the vanes **104***a* with respect to the water flow Fw. As best seen in comparing FIGS. **9** and **10** with FIG. **11**, the liquid-flow transducers **101***a* may be placed in abutment at one end (FIGS. **9** and **10**) or not (FIG. **11**).

As best seen in FIG. **11**, a pier **154***a* supported for example by buoys **156***a*, may extend transversely upstream and/or downstream of the liquid-flow transducers **101***a* and direct the anchor lines **128***a* into position to engage the stops **152***a* on the control-cable **150***a* to limit the pivotal adjustment.

With reference now to FIG. **12**, it will be seen that a succession of adjacent fluid-flow transducers **101** can be chained together, for example to span a river. Those skilled in the art will appreciate that such arrays **116** can be chained together along a curved path P, for example to better harness the particular water flow Fw.

(c) Operation of Specific Embodiments

With reference now to FIGS. **1** to **12**, the operation of these specific embodiments of the invention will now be described.

In general terms, the user anchors the converting apparatus **100** such that at least one fluid-flow transducer **101** is proximate a flow F, such that some of its plurality of vanes **104** are urged upon by the flow F and in turn urge the conveyor **102** into motion, since the generating apparatus as a whole is anchored. The moving conveyor **102** brings unurged vanes **104** into contact with the flow F and returns urged vanes **104** from the downstream end of the conveyor back to the upstream end of the conveyor to once again be urged upon by the flow F. In transit, the vanes **104** may be trimmed, to more efficiently engage the flow F, including as the flow changes, and retracted during the return passage. In the case of a liquid-flow transducer **101***a*, the vanes **104** in contact with the flow F additionally support the fluid-flow transducer **101***a* with floatation **108**.

Those skilled in the art will thus appreciate the description of this operation teaches a method of converting energy from a fluid flow F, including distributing a plurality of vanes **104** along an elongated conveyor **102** and anchoring **128** the conveyor **102** proximate the flow F such that some of the plurality of vanes **104** are urged upon by the flow F and in response urge the conveyor **102** into motion. The description further teaches such a method that includes supporting the conveyor **102** on the flow F with the some of the plurality of vanes **104** urged upon by the flow.

A power take-off **132** coupled to the conveyor **102** (and in particular the rollers **118** via a cable-drive **134**) can extract a portion of the kinetic energy of the conveyor **102** and supply it to a load L, for example a generator.

The converting apparatus **100** can include an array **116** of fluid-flow transducers **101**, coupled together either fixedly or pivotally for example. In the case of pivotally coupled transducers **101**, a user can adjust the pivot angles to more effectively position the vanes **104** in the flow F and to extend the array **116** along a path P. In the case of gas-flow transducers **101***b* mounted on a turntable **136***b*, a user can allow the gas-flow transducers **101***b* to align their vanes with the ambient gas flow (wind.)

(d) Description Summary

Thus, it will be seen from the foregoing embodiments and examples that to there has been described a way to generate energy from a fluid flow, using a fluid-flow transducer having a frame anchorable against the flow, an elongated conveyor supported by the frame, and a plurality of vanes distributed along the conveyor, adapted to engage the fluid flow and to drive the conveyor in response to urging of the fluid flow, in combination with a power take-off coupled to be driven by the conveyor and adapted to drive a load.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims. It will be understood by those skilled in the art that various changes, modifications and substitutions can be made to the foregoing embodiments without departing from the principle and scope of the invention expressed in the claims made herein.

While the invention has been described as having particular application for generating electricity, those skilled in the art will recognize it has wider application.

What is claimed is:

1. An apparatus for converting energy from a fluid flow, comprising:

a. a first fluid-flow transducer, having
   i. a frame anchorable against the flow,
   ii. an elongated conveyor supported by the frame, and
   iii. a plurality of vanes distributed along the conveyor to drive the conveyor in response to urging of the fluid flow,
      a) each of the plurality of vanes having a scoop with oppositely facing mouths adapted to engage the fluid flow, wherein at least one of the plurality of vanes has a scoop wherein the oppositely facing mouths are trimmable, further including at least one cable-operated hinge adapted to trim the oppositely facing mouths, and

b. a power take-off coupled to be driven by the conveyor and adapted to drive a load.

2. An apparatus as claimed **1**, wherein the at least one of the plurality of vanes has an extended position and a retracted position.

3. An apparatus as claimed in claim **1**, wherein at least one of the plurality of vanes has at least one passage therethrough through which the fluid flow can pass.

4. An apparatus as claimed in claim **1**, wherein the conveyor includes:

a. a plurality of rollers, each roller respectively extending transversely across the frame and the plurality of rollers extending longitudinally along the frame, and

b. a closed belt engaging the plurality of rollers for travel thereover.

5. An apparatus as claimed in claim **1**, wherein the first fluid-flow transducer is a liquid-flow transducer.

6. An apparatus as claimed in claim **5**, wherein the plurality of vanes includes flotation sufficient to support the apparatus.

7. An apparatus as claimed in claim **6**, wherein the plurality of vanes is an even number.

8. An apparatus as claimed in claim **6**, further including a second fluid-flow transducer that is a gas-flow transducer, having:

a. a second elongated conveyor supported by the frame and coupled to drive the power take-off,and

b. a second plurality of vanes distributed along the second conveyor to drive the second conveyor in response to urging of the gas flow.

9. An apparatus as claimed in claim **8**, wherein at least one of the second plurality of vanes has an extended position and a retracted position, and wherein the at least one of the second plurality of vanes has an energy-accumulator coupled to harness energy from the at least one of the second plurality of vanes when the at least one of the second plurality of vanes moves between the retracted position and the extended position.

10. An apparatus as claimed in claim **9**, wherein the second conveyor is supported on the frame via a turntable.

11. An apparatus as claimed in claim **1**, wherein the apparatus further includes a second fluid-flow transducer coupled to the power take-off wherein the first fluid-flow transducer and the second fluid-flow transducer are both liquid-flow transducers.

12. An apparatus as claimed in claim **11**, wherein the first fluid-flow transducer and the second fluid-flow transducer are connected together in a fixed, parallel array.

13. An apparatus as claimed in claim **11**, wherein the first fluid-flow transducer and the second fluid-flow transducer are connected together in a pivoting array.

14. An apparatus as claimed in claim **13**, wherein the pivoting array includes a further plurality of fluid-flow transducers pivotally connected together along a path.

15. An apparatus as claimed in claim **13** further including linkage pivotally connecting the first fluid-flow transducer and the second fluid-flow transducer at midlength.

16. An apparatus as claimed in claim **15**, further including:

a. a plurality of pulleys respectively deployed at either end of the first fluid-flow transducer and the second fluid-flow transducer, and

b. a control-cable threaded though the plurality of pulleys in a closed-loop configuration to constrain the relative movement of the first fluid-flow transducer and the second fluid-flow transducer.

17. An apparatus as claimed in claim **16**, wherein the control-cable is set to place one end of the first fluid-flow transducer and the second fluid-flow transducer in abutment.

18. A method of converting energy from a fluid flow, comprising:

a. distributing a plurality of vanes along an elongated conveyor, each of the plurality of vanes having a scoop with oppositely facing mouths adapted to engage the fluid flow, wherein at least one of the plurality of vanes has a scoop wherein the oppositely facing mouths are trimmable, further including at least one cable-operated hinge adapted to trim the oppositely facing mouths,

b. anchoring the conveyor proximate the flow such that some of the plurality of vanes are urged upon by the flow and in response urge the conveyor into motion, and

c. trimming the oppositely facing mouths of the at least one of the plurality of vanes using the at least one cable-operated hinge.

19. A method as claimed in claim **18**, further including supporting the conveyor on the flow with the some of the plurality of vanes urged upon by the flow.

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