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(58) Field of Search
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INT CL^7 **F01D** 5/14, **F03B** 3/04 3/12 13/12 13/22 13/26, **F03D** 1/00 1/06
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(54) Abstract Title
Turbine

(57) A turbine comprises a hollow hub, which may contain a generator 3, supporting v-shaped vanes 14, which enable the turbine to be rotated in the same direction, regardless of the direction of flow through the turbine. The hub is supported within an outer shell 5, on a shaft 18 which is supported by bearings 12, the shell 5, being mounted on a support 9. A grid 19 is provided to trap material which would otherwise damage the turbine. Inlet and outlet guide vanes, and a governor and electronic speed control system are provided. The turbine may utilise tidal or river flow or waves when it may be mounted vertically in an L-shaped duct so as to be driven by an oscillating water column (fig. 4) or air column (fig. 8). Alternatively, the turbine may be driven by the wind (fig. 5) or by steam.

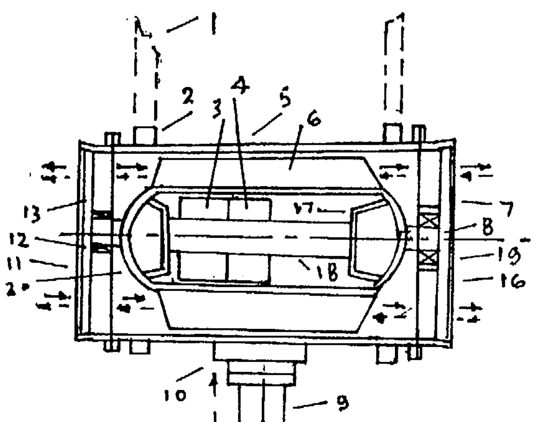

FIG 1.

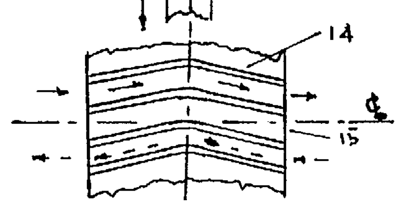

FIG 2

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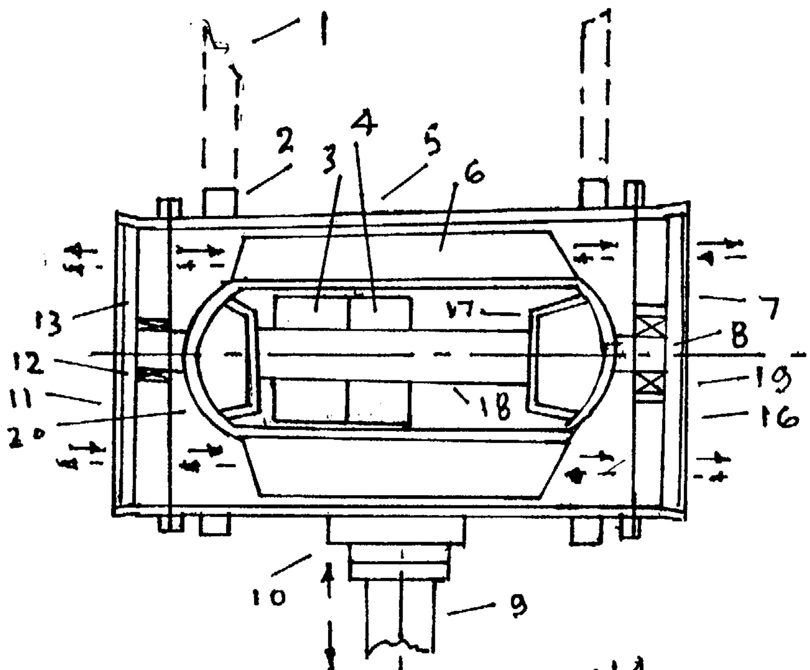


FIG 1.

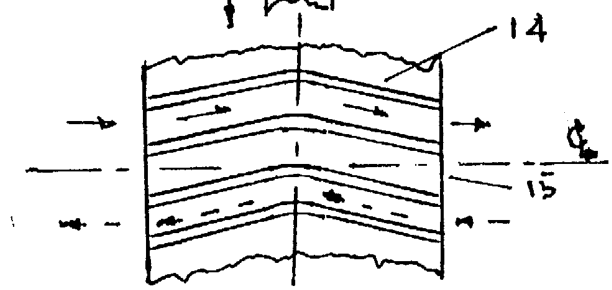


FIG 2

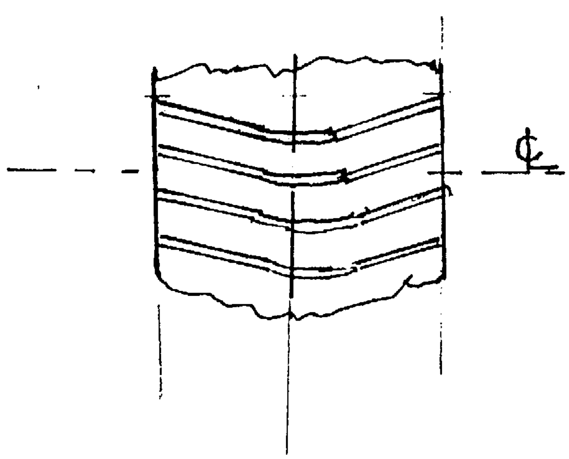


FIG 3

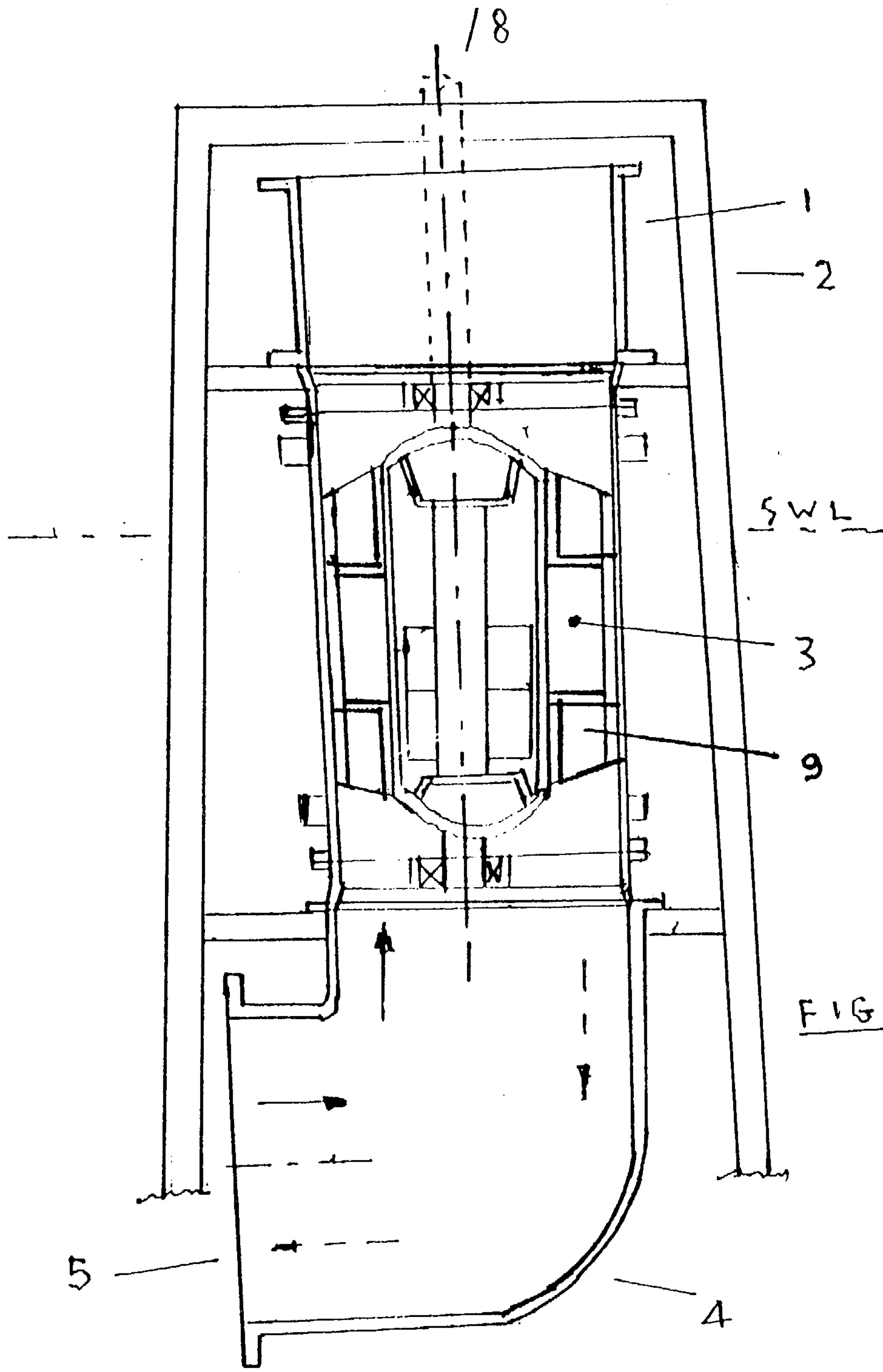
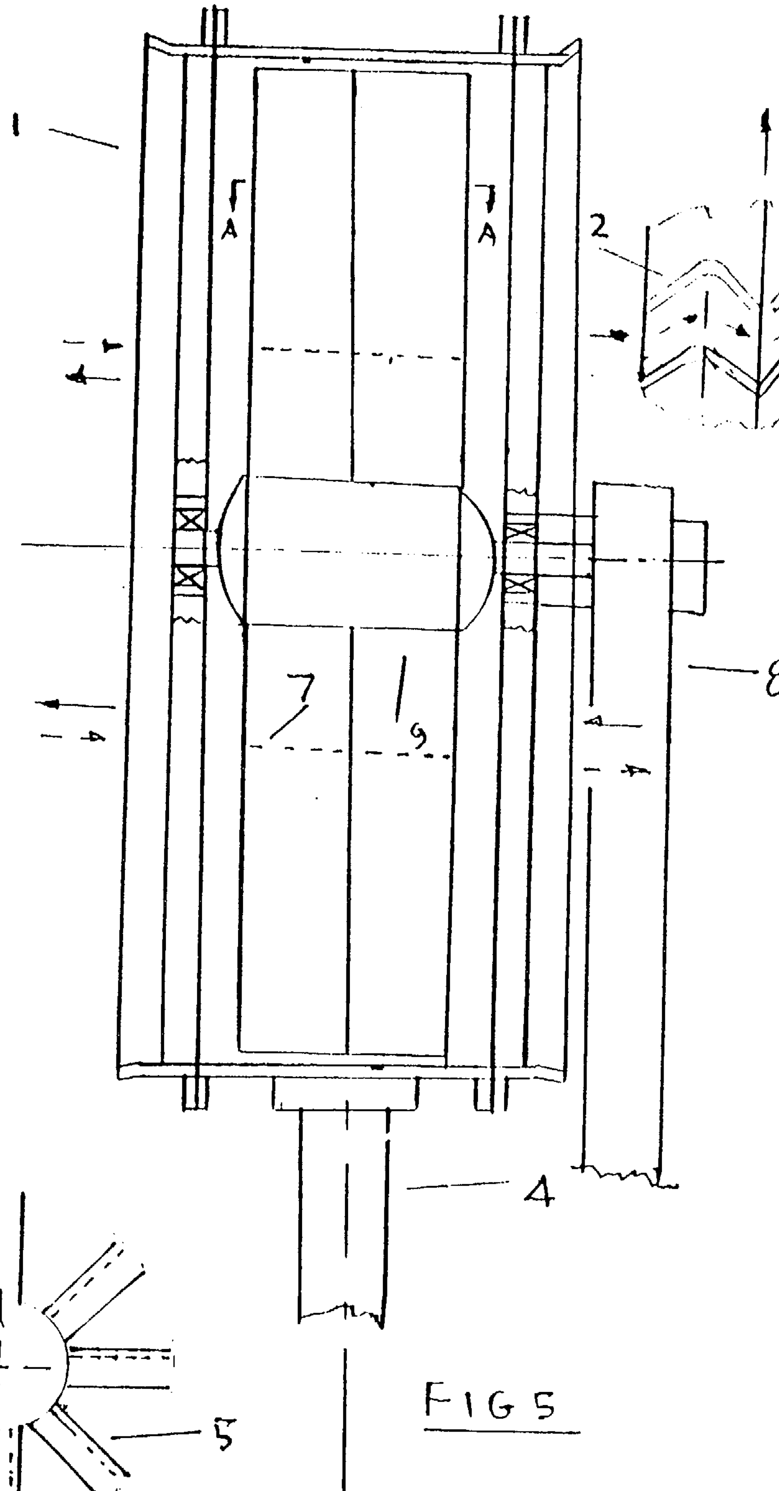
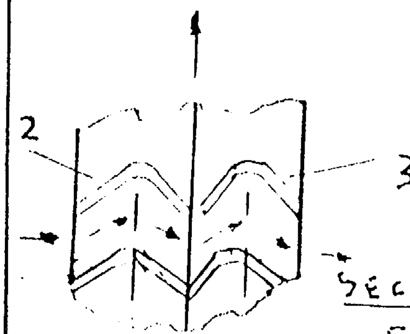


FIG 4





SECTION 'AA'

FIG 7

FIG 5

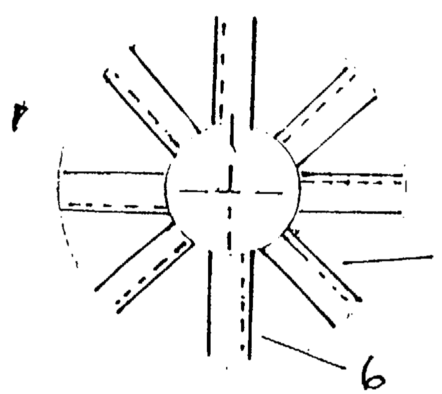


FIG 6

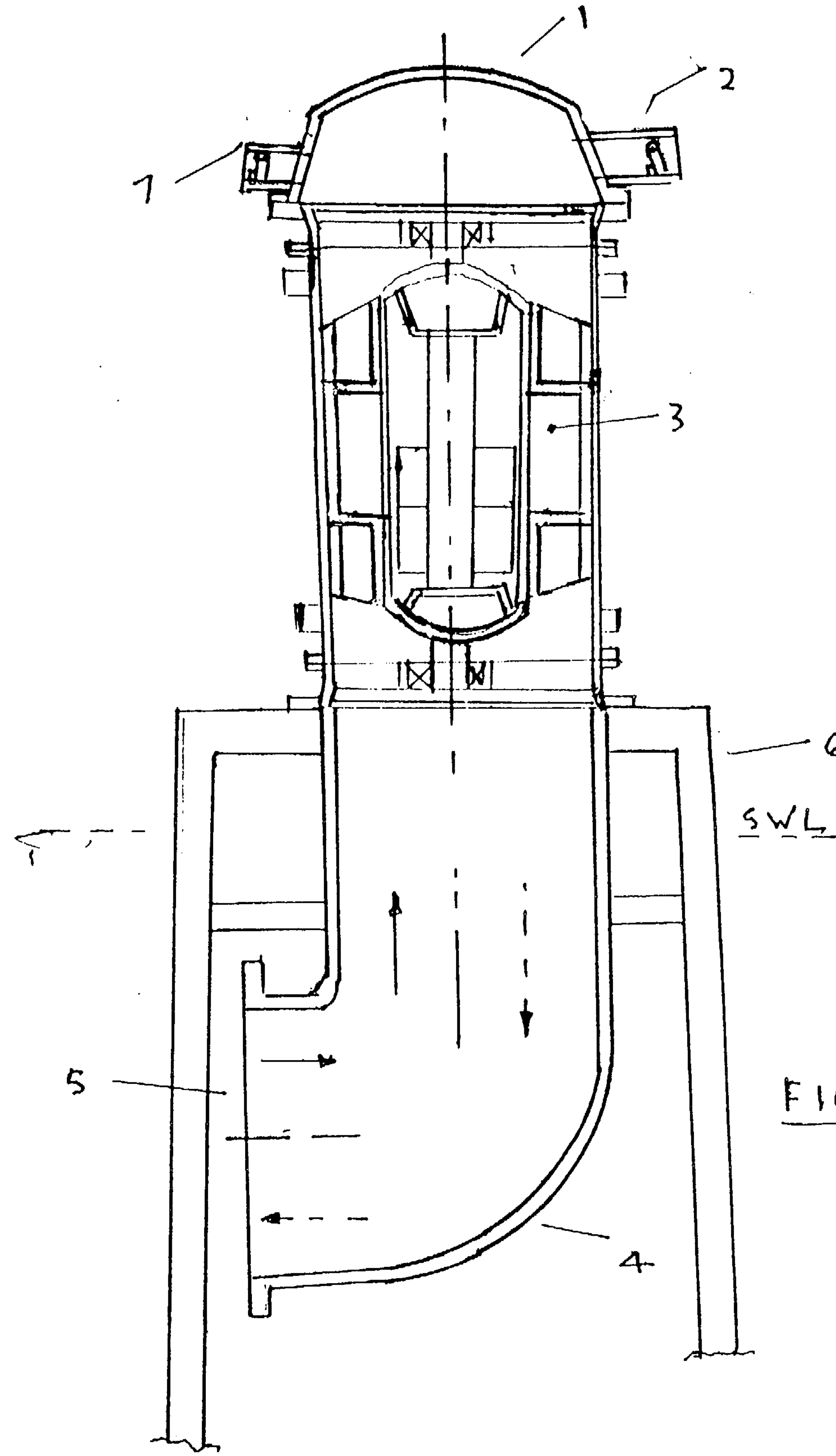
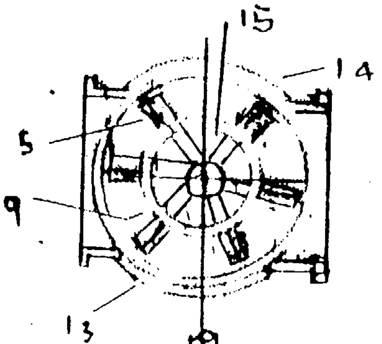


FIG 8



SECTION 'AA'

FIG 11

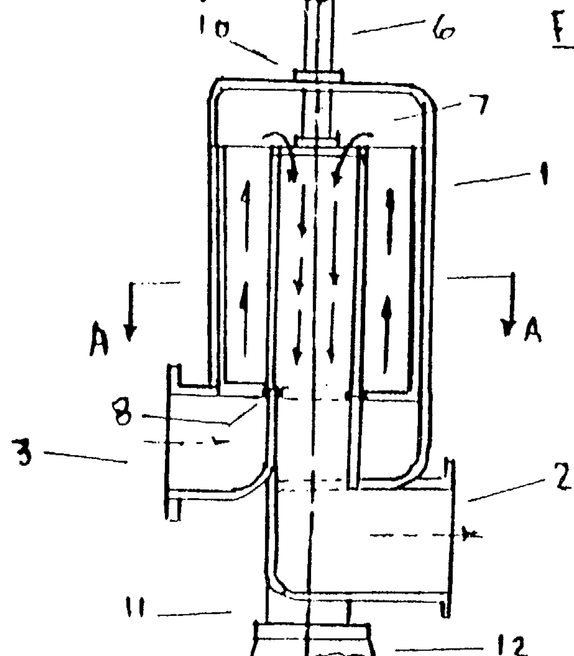


FIG 10

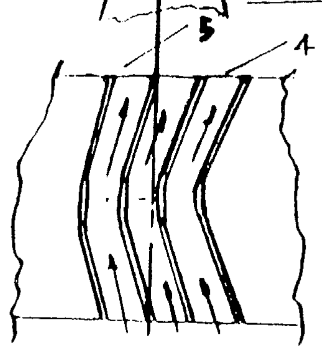


FIG 9

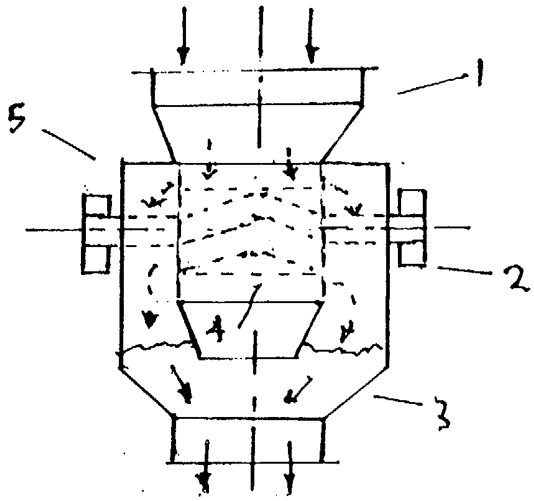


FIG 12

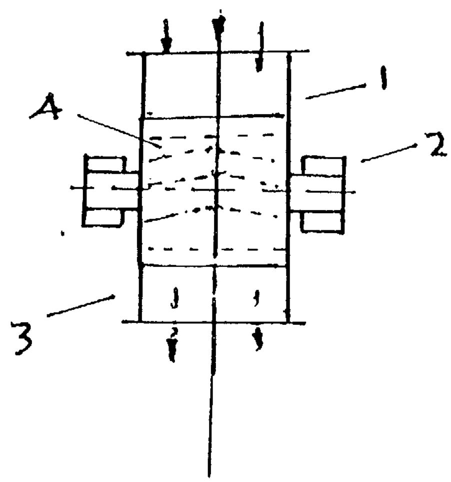


FIG 13

DIRECTIONAL FLOW TURBINE SYSTEM.

The present invention relates to a turbine system design in which forward and reverse flowing fluids can be handled in contrast to conventional turbines,which nearly all are designed for uni-directional fluid flows.The system has a number of unique features allowing it to be used in a large number of applications in the field of renewable wave and wind power.in steam flow power ,hydro-electric power{mainly small systems} and industrial power systems.

Conventional turbine systems normally are designed for inward flow in the one direction.i.e. uni-directional.Where the flow is bi-directional as in sea water tidal flow a conventional flow turbine would not be an appropriate selected design.Turbines which come into this category are the Kaplan; reaction turbines;impulse turbines and others.Other features which distinguish the present invention from conventional designs will be described in the descriptions which follow.

It is an objective of the present invention to provide a compact,low cost sytem to generate low cost power and have the design flexibility to cater for a range of applications in different energy fields.In addition to overcome the restrictions in design in the prior art.

According to a first aspect of the invention there is provided a turbine for generating power or{for other purposes)in which the inward flow to the turbine can be liquid or any type of gas and which the said turbine comprises:

a central hub which may,or may not,house some of the generation components such as the generator and rotor and shaft,

said shaft extending outside the hub shell and located in bearings,

hub shell outside diameter fitted with vanes forming fluid channels around circumference of hub shell,the fluid flow acting on the vanes causing the hub and integral vanes to rotate thus generating power in the generator.

outer shell casing enclosing hub and vanes,

radial rib{s) at either side of hub shell enclosing said bearings and extending radially to the inside of outer shell,

fixed guide vanes at inlet and outlet of outer shell casing where required,to smoothly guide the inlet flow onto the rotating vanes and hub.

support leg for the turbine,positioned anywhere along the length of the outer shell or,on an extension of the shaft to one,or, the other side of the rotating hub,

govenor and electronic control system to control the rotary speed of the turbine within predetermind limits.

According to a second aspect of the invention there is provided a turbine in which the said rotating vanes,forming fluid flow channels, are vee shaped with the top of the left and right leg of the vee connected by a smooth curve shape,thus as the fluid flows through the vee channel,as it rounds the curve shape the centrifugal force acting on the vanes causes the turbine hub and integal vanes to rotate.

According to a third aspect of the invention there is provided a turbine in which ,if the said vee shaped vanes are fitted to the turbine hub the said turbine hub and vanes will rotate clockwise and if the turbine is fitted reverse shaped vee vanes,the rotation will be anti-clockwise.

According to a fourth aspect of the invention there is provided a turbine in which during design the included angle of the vee shape in the vanes can be optimised by narrowing this angle to maximise the turbine efficiency from the resultant fluid flow,taking into account any particular contraints in the design.

According to a fifth aspect of the invention there is provided a turbine with more than one stages of the vee shaped vane channel section located on the hub outside diameter,thus as the fluid flows through these additional vane stages this improves the overall efficiency of the turbine,provided there is sufficient head driving the turbine.

According to a sixth aspect of the invention there is provided a turbine in which more than one

Stages of the vane sections,the fluid inlets of which are positioned on the hub diameter so that the inlets occupy the sectorial space between each successive stage,a design mainly for large turbines.

According to a seventh aspect of the invention there is provided a turbine in which the entry space to the vane channels can be narrow or wide,within limits.

According to an eighth aspect of the invention there is provided a turbine in which the annular space occupied by the vane channels can be reduced,thus increasing the hub diameter and reducing the vane's radial length up to their tips thus increasing the flow velocity through said channels making for a strengthed more compact design.

According to a ninth aspect of the invention there is provided a turbine which is fiited with reverse vee vanes and a tangential flow inlet duct and right and left enclosed side ducts and a Y shaped outlet duct connected to the side ducts,thus as the flow enters the turbine it causes the vanes and the hub to rotate.The flow the exits into to the right and left side ducts thence into the Y duct leaving the turbine.

According to a tenth aspect of the invention there is provided a turbine similar to the ninth aspect but where the inlet duct is tangential and the outlet duct is also tangential.

According to an eleventh aspect of the invention there is provided a turbine in which the flow through the turbine is bi-directional as is required in a turbine submerged in the sea to generate power when the tide flows in and out 24 hours a day.

According to a twelth aspect of the invention there is provided a turbine with a directional entry leading to an outer casing encasing a rotating cylinder,the outside and inside diameter of which are fitted with Vee shaped vane channels,the said cylinder at its base rotating on bearings and at its end connected to the turbine shaft.The fluid enters the turbine and flows through the vane channels of the outsid e diameter of the cylinder,does a U turn and down through the vane channels of the inside diameter causing the turbine shaft to rotate faster before the fluid exits the turbine in a directional outlet duct such turbine being higher in efficiency and more compact

In a first embodiment of the invention a tidal/river power system comprises a bi-directional turbine,Fig1oriented horizontally below the sea level with a support frame extending to the sea-bed.A directional device automatically keeps the turbine facing into the flow at all times.In tidal flow the entry velocity is low about 3m/s.The flow enters the turbine and flowing through the vane channels causes the vanes and the vane hub to rotate generating power in the generator.When the tide reverses the flow enters the opposite entry of the turbine and power is generated by the rotating vanes and turbine hub on a continuous process 24 hours a day all the year round.The location of the system can be anywhere along a coastline.The diameter of the inlet will be large because of the low inlet velocity.If,however.the location is in a tapered channel the inlet velocity will be high and consequently the inlet diameter will be smaller,or,conversely for the same inlet diameter the power generated will be greater.The versality of this embodiment is therefore very good.

In a second embodiment of the invention this is an oscillating water column,Fig 4,comprising a vertical turbine,located on a vertical frame reaching to the sea or river bed,preferably,close to the shore.The turbine has a top duct fixed to the frame and the turbine is suspended from the frame at a submerged level where an inlet right angle duct faces into the flow.The wave flow penetrates the turbine and flows up and down the vane channels causing the vanes and the turbine hub to rotate and generating power in the generator.The latter is located internally in the turbine or on the frame top if of large rating.

In a third embodiment of the invention this also is an oscillating water column similar to the second but comprises a vertical air turbine Fig8 located on the top of the frame with an extended duct fitted to the turbine inlet submerged in the flow and fitted with a right angle inlet facing into the flow.The top of the turbine has an enclosed air chamber.In operation the oscillating water column generated by the rise and fall of wave in the inlet duct causes the air to flow back and forth through the vane channels of the turbine generating power in the process.

In a fourth embodiment of the invention reverse vee vane turbine Fig 12 comprising a vertical turbine with reverse vee vanes and channels.The turbine is supported on trunnion bearings with legs to the seabed and submerged in the flow the latter entering the turbine through horizontal,tangential duct and striking the vee vanes causing the vanes and hub to rotate generating power in a generator.The flow exits the turbine through side ducts at the top and bottom of the turbine finally leaving the turbine ducts by a Y shaped duct aligned with the flow direction.

In a fifth embodiment of the invention,tangential turbine,Fig 13 this comprises a turbine of similar design to the fourth embodiment and located on trunnion bearings and legs in a similar manner.The flow enters the turbine through a tangential inlet duct aligned horizontally in line with the flow direction.After generating power in the turbine and generator the flow leaves through an exit tangential duct also in line with the flow.

In a sixth embodiment of the invention,aerogenerator turbine,Fig 5,comprising vee vanes and channels Fig 7 forming 2 stages of vanes,or several stages of vanes Fig 6 where the vanes in each stage are aligned one behind the other and the corresponding vanes located within the sectorial space of each succeeding vane stage.The aerogenerator vanes are located on a central hub containing the generator.The hub diameter may be expanded to reduce the radial length of the vanes and make for a stronger design.This is limited by the maximum air velocity allowed in the annular space occupied by the radial vanes.Too high a velocity results in spillage of the entry air not entering the vane passages and reduced output.The turbine is supported on a central frame extending to the base inland or offshore.Alternatively the frame can form an extension of the turbine horizontal shaft to one side of the turbine.In this case the outer shell casing may not be required.

In a seventh embodiment of the invention,contra-pass turbine,Fig 9,10 and 11 comprising of a frame above which the generator shaft and generator is located,and below which is located the turbine within an outer casing with inlet and outlet ducts.The turbine is supported on an inner bearing and the upper shaft extends through the outer casing to the generator.The turbine has a hub the inner and outer diameters,of which,respectively,have wrap round vanes forming flow channels.The flow of large head velocity enters the turbine and flows up through outer diameter vane channels Fig 9 and then does a U turn at the top of the outer casing to flow down through the inner diameter vane channels before leaving the turbine by the exit ductThe main applications will be high power turbines for medium size hydro stations or inshore tapered channels on the coastline etc.

Aspects of the present invention will become apparent from the following description when taken in combination with the accompanying drawings in which:

Fig 1 Tidal/river power system with bi-directional turbine.
Fig 2 Reverse Vee shaped vanes for anti-clockwise rotation of turbine.
Fig 3 Vee shaped vanes for clock-wise rotation of turbine.
Fig 4 Oscillating water vertical turbine.
Fig 5 Aero-generator turbine.
Fig 6 Aero-generator vane stages sectorial spacing around the hub.
Fig 7 Aero-generator 2 stage vane channels
Fig 8 Oscillating water column,vertical air turbine
Fig 9 Vee shaped vane for contra-vane turbine
Fig 10 Contra-vane turbine
Fig 11 Cross-section AA of contra-vane turbine
Fig 12 Reverse vee vane turbine

Fig 13 Tangential turbine

Fig 1 shows a tidal/river flow bi-directional marine flow turbine.For a tidal flow installation preferably it should be located just off-shore and supported on the support 9 stretching to the sea base on a suitable grouted foundation.Alternatively the turbine could be suspended from an overhead platform by the metal straps 1 and 2.The turbine comprises an outer shell 5 containing the turbine 20.There is a central hub containing a generator 3,rotor 4 and shaft 18Extending from the hub are the reverse vee vanes 14 forming vane channels 15 around the hub diameter and designed so that the water flow causes the turbine to rotate anti-clockwise no matter the direction of the tidal flow-see Figs 1 and 2.If the hub is fitted with vee shaped vanes the flow through the channels causes the turbine to rotate clockwise-see Fig 3.The flow enters at either end of the turbine at 11 or 16.The entrance is fitted with a grid 19 to trap material which may damage the turbine.The turbine is supported within the outer shell 5 by a radial narrow stay 13 housing at its centre the turbine bearings 12 and bearing shaft 8.For inshore tidal flow the overall length of the turbine will be relatively small compared to the overall flow diameter which will be large because of the low flow velocity i.e about 3m/s.For greater flow velocities,such as in tapered channels, the power output of the turbine will be considerably increased.

Fig 4 shows the oscillating water column vertical turbine connected to a generator within the hub.The turbine is immersed in the sea at its operating level,supported by a frame with legs reaching down to the sea-bed where said legs are grouted into a prepared foundation.Cheaper methos of anchoring the turbine can be adopted.Oncoming waves enter the turbine inlet duct 5 which automatically faces into the flow.Depending on the wave energy content this causes a water column to rise in the annular space occupied by the turbine vane channels surrounding the hub diameter.This causes the turbine hub and the vanes to rotate generating power in the generator.The water column continues to rise above the turbine where it enters the outlet duct 1 from which it descends flowing through the turbine vane channels again to generate more power in the generator.With each wave cycle the water column oscillates up and down generating large amounts of power,Depending on the location of the turbine and the degree of energy in the wave flow very large power outputs can be generated.In addition for large turbines the hub generator may not be of sufficient capacity.In that case the turbine shaft 8 can be extended above the turbine exit and up to the outlet duct 1and onto the frame 2 where it is connected to a large size generator and ancillary plant ,all encased in a structure to protect it against severe weather.

Fig 5 ,6 and 7 shows an aerogenerator based on the design of the turbine.In Fig 5 the outer casing 1 encases two stages of the turbine linked together with the vanes 2 and 3 Fig7,located on the hub diameter 9.The complete aerogenerator has two alternative support gantries 4 or 8.The first 4 is attached to the outer casing 1 and extends to the base foundation,which for an inland site is on the ground,or,for on a building,at sea or in a river.on a foundation appropriate to the site.The second alternative gantry support 8 is attached to the turbine bearing shaft and extends down to an appropriate foundation as described for the above first gantry.Fig 5 with the first gantry 4 allows a bi-directional flow turbine to be designed.The flow enters the turbine at 1 and flows through the turbine vanes and channels as shown in Fig 7.The reverse is the case if the flow is in the reverse direction.In the case of the second alternative gantry 8 reverse flow is unlikely.However the design excludes the outer casing 1.In either design instead of a two stage s in some circumstances one stage would be cheaper.However for large megawatt turbines a multi-stage turbine with the radial vanes surrounding a common hub diameter would be more appropriate especially on off-shore severe weather sites.In these cases Fig 6 shows one stage of radial vanes 6 out of phase with the stage of radial vanes 5 behind it and occupying the sectorial space between the radial vanes.Such a design can be adopted for each successive stage and with large three stage turbines would generate very large outputs.For such turbines the hub diameter can be increased as at 7 Fig 5 to provide for large generators.The effect of this could be to increase the annular space flow velocity and thus reduce the radial length of the vanes provided the increased velocity does no result in spillage of the flow and reduce the efficiency of the turbine.

Fig 8 shows the water column vertical air turbine.It is similar to Fig 4 design but with the oscillating water column from the wave cycle entering the duct 5 and oscillating up and down in phase with the wave cycle.The height of duct 5 is such that the water column does not enter the turbine inlet.All it does is to compress air occupying the turbine vane channels 3 and an air chamber 1 above the air turbine.Thus with each cycle of the wave entering the inlet duct 5 the water column oscillates up and down and successively pressurises and de-pressurises the air in the turbine and the air chamber and with each wave cycle generating power in the turbine generator as the air flows in and out of the turbine vane channels.Flap valve 7 and air flap valve 2 fitted to to the air chamber open and shut with each cycle admitting and rejecting air to maximise the power generated in the turbine air flow.Depending on the vee channel angle the efficiency can be high.The air turbine and the air chamber 1 are installed on a platform 6 with the water column duct 5 suspended below the frame platform 6 at an appropriate level to catch the wave flow.Several systems can be erected on the platform to match any required power demand.

Fig 10 shows a contra-vane turbine suitable where the inlet head is high.It consists of a directional entry 3 leading to an outer casing 1 in which is installed a rotating cylinder 9 Fig 11,the outside and inside diameter of which Fig 9 and 11 are fitted with vee shaped vanes and channels.The said cylinder rotates on bearings 8 by the action of the fluid flowing through the vane channels Fig 9 and the top of the cylinder being connected to the generator shaft 6 to generate power.The flow enters the outer channels 5 Fig11 and flows up to the top of the cylinder where it reverses and flows down through the inner vee channels 15 Fig11 and then out through the exit duct 2.A gantry 12 supporting the turbine completes the design.

Fig 12 shows the reverse vee vane turbine 4 with the turbine having reverse vee vanes over which the inlet fluid flows from the inlet 1.The fluid circulates over the vanes driving the turbine and generating power.It then leaves the vane channels sideways into right and left hand ducts 3 and 5 then both flows link up into the outlet duct.The turbine and its shaft rests on a trunnion bearings 2 which form part of a vertical gantry and foundation not shown.

Fig 13 shows a tangential turbine supported on trunnion bearings and vertical gantry 2.The fluid flows into the inlet duct 1,tangentially and flows over the reverse vee vanes 4 rotating the turbine and generating power.The fluid then leaves the turbine by an exit tangential duct 3.

There are many applications of the various turbines including inland and offshore power generation forming the potential for a worldwide market.In addition the aero-generator applications are both inland and offshore including combinational units consisting of wave power units combined with aero-generators all on the same support.Further designs are where the designs can be adapted to produce compressed air for injection into coastlines which are heavily polluted.

CLAIMS

1. A fluid turbine system in which forward and reverse flowing fluids can be catered for in contrast to most turbine systems
the said system consists of a turbine for generating power,or,for other purposes,and in which the flow to the turbine can be a fluid such as a liquid,or,a gas (e.g air),or steam,the said turbine comprising:
a central hollow hub shell which may,or,may not ,house some of the generation components,such as the generator and rotor and shaft,
said shaft extending outside the hub shell and located on bearings,
hub shell outside diameter fitted with vanes forming fluid channels around circumference of hub shell,the fluid flow acting on the said vanes causing the hub shell and integral vanes to rotate on the bearings thus generating power in the generator,
an outer shell casing enclosing hub shell and vanes, and fitted with a grid plate on the entrance and outlet of the said outer shell casing to trap material contained in the flow,
radial rib(s) at either side of hub shell enclosing said bearings and extending radially to the inside of outer shell,
fixed guide vanes at inlet and outlet of outer shell casing where required to smoothly guide the flow onto the rotating vanes and hub shell,
support leg(s) for the turbine,positioned anywhere along the length of the outer shell casing,or,on an extension of the shaft to one,or,the other side of the rotating hub shell,
governor and electronic control system to control the rotary speed of the turbine within predetermined limits.
2.A fluid turbine system as in claim 1in which the said turbine rotating vanes,forming the fluid flow channels,are vee shaped in cross section with the left and right legs of the vee shape connected at the bottom by a smooth curved surface,thus as the fluid flows through each of the vee channels as it rounds the curved surface the centrifugal force acting on the vanes causes the turbine hub shell and integral vanes to rotate thus generating power in the generator,
3.A fluid turbine system as in claims 1 and 2 in which if the said turbine is fitted with the said vee shaped vanes,then the said turbine hub shell and vanes will rotate clockwise;if the turbine is fitted with reverse shaped vee vanes then the rotation will be anti-clockwise.
4.A fluid turbine system as in any of the claims in which in order to maximise the turbine efficiency the vane vee shaped leg angles should be as near vertical as possible.
5.A fluid turbine system as in any of the claims in which the said turbine is fitted with more than one stage of the vee shaped flow channels each within its own shell casing,this improves the efficiency of the turbine provided there is sufficient driving head in the fluid entering the turbine.Figs 5,6 and 7.
6.A fluid turbine system as in any of the claims in which the said turbine is fitted with vane channels of reduced radial length through adopting an increased hub shell diameter at the expense of an increased channel flow velocity,but overall a strengthend stronger structure.Fig 5.6 and 7.
7.A fluid turbine system in which the said turbine is fitted with reverse vee vanes and a tangential flow entry duct and right and left enclosed side ducts and a "Y" shaped outlet duct connected to the side ducts,thus as the flow enters the turbine it causes the vanes and the shell hub to rotate;the flow leaves the turbine through the side ducts and exits through the "Y" duct.Fig 12
8.A fluid turbine system as in claim 7 but where the turbine inlet duct is tangential as is the outlet duct.Fig 13
9.A fluid turbine system as in claim 1in which the turbine fluid flow is bi-directional as in a sub-sea turbine immersed in the sea wherein the wave flow is tidal over 24 hours per day.Figs 1 to 4
10.A fluid turbine system in which the turbine is designed with a directional entry duct leading

to an outer casing encasing a rotating cylinder,the outside and inside diameter of which are fitted with vee shaped vane channels,the said cylinder at its base rotating on bearings and at its top connected to the turbine shaft;the fluid enters the turbine and flows through the vane channels on the outside diameter of the cylinder,does a "U" turn down through the vane channels of the insid e diameter causing the turbine shaft to rotate faster before the fluid exits the turbine through a directional outlet duct such turbines being higher in efficiency and more compact.Fig 9,10 and 11

11.A tidal/river power system comprising a bi-directional turbine located horizontally below the sea level with a support frame extending to the sea bottom ;a directional device automatically keeps the turbine facing into the flow at all times;the flow enters the turbine and flows through the vane channels causing the vanes and the hub shell to rotate generating power in the generator;when the tide reverses the flow enters the opposite entry of the turbine and power is generated by the rotating vanes and hub shell in a continous 24hour daily process all the year round;located in a sea flow of higher velocity increases the power by the velocity ratio to the power three.Fig 1 to 3

12.A vertical oscillating water column turbine located on a vertical frame reaching to the sea bottom ;the turbine has a top duct fixed to the frame and the turbine is suspended from the frame into the sea at a submerged level with a right hand inlet duct facing into the flow;the wave flow penetrates the turbine and flows up and down the vane channels causing the vanes and the turbine shell hub to rotate generating power in the generator;the latter is located in the shell hub or on the top of the frame if of a large rating.Fig 4

13.A vertical oscillating water/air column turbine similar to claim 12 but located on the top of the said frame with an extended duct fitted to the turbine inlet with a right angle inlet duct facing into the flow;the top of the turbine has an enclosed air chamber with two non-return flap valves ;in operation the oscillating water column generated by the rise and fall of the wave in the inlet duct causes the air to flow in and out of the non-return flap valves in the air chamber in turn causing the air to pressurise and de-pressurise in each cycle and to flow back and forth through the vane channels of the turbine generating power in the process .Fig 8

14.An aerogenerator turbine comprising one or more stages of cross-section inverse vee shaped radial blades contained within a cylindrical duct said blades located on a central shell hub containing the generator and associated equipment,said stages of radial bladess staggered in their circular pitch so that the sectorial spaces are occupied by blades to trap the inflow of air onto each radial blade so increasing the overall efficiency.Fig 5,6 and 7

15.A fluid turbine system as in any of the previous claims but particularily in claim 10,in which the inlet fluid comprises high temperature,pressurised, combustion gases from a burner system and compressor fitted to the inlet duct,generating electric power in the generator as the pressurised gases pass through the turbine stage vee shaped rotating blade system.

16.Turbines in accordance with claims 1 to 15 and drawings Figs 1 to 13.

The Patent Office

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Application No: GB 0114356.9
Claims searched: 1-6

Examiner: C.B.VOSPER
Date of search: 7 August 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F1T(TC,TFDA,TFDX); F1V(VCS)

Int Cl (Ed.7): F01D 5/14 F03B 3/04,3/12,13/12,13/22,13/26; F03D 1/00,1/06

Other: ONLINE:EPODOC,JAPIO,WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2225813 A	LAINE (fig. 1; page 2, line 24, to page 3, line 16; shows all the features of claim 1, except the grid plate and support leg.)	1-3 at least
Y	GB 2099929 A	ESCHER (fig. 1; page 2, line 93 et seq.; shows all the features of claim 1, except the grid plate and speed control)	1-3 at least
Y	GB 2028929 A	ENGLISH (see whole document; shows all the features of claim 1 except the speed control and grid plate)	1-3 at least
Y	GB 1601060	TIDELAND (figs. 1 and 2; page 2, line 43 et seq.; shows all the features of claim 1 except the support leg, grid plate, and speed control)	1-3 at least
Y	GB 1574379	ENGLISH (figs. 10,12,13; page 3, lines 3-59; shows all the features of claim 1, except grid plate and speed control)	1-3 at least
Y	GB 1563337	MOUTON (fig. 2, noting trash screen 42; show all the features of claim 1 except speed control and reverse flow)(See also US 3986787)	1-3 at least

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 0114356.9
Claims searched: 1-6

Examiner: C.B.VOSPER
Date of search: 7 August 2002

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 1500400	DAVID(whole document; shows use of V-shaped vanes to accommodate reverse flowing fluids and thus the features of lines 1 and 2 of claim 1 and of claims 2 and 3)	1-3 at least
Y	GB 1449740	BABINTSEV (fig. 3; shows all the features of claims 1 and 2, except grid plate and speed control)(see also US 3922739)	1-3 at least
Y	WO 83/01656 A1	LEMOS (page 8, line 24, to page 9, line 21; shows electronic control of turbine speed)	1-3 at least
Y	US 4545726	SULZER (see whole document; shows all the features of claim 1, except the gris plate, support leg(s) and speed control)	1-3 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.