



- (51) International Patent Classification:
F03B 13/00 (2006.01) *E21F 7/00* (2006.01)
- (21) International Application Number:
PCT/AU2012/000095
- (22) International Filing Date:
3 February 2012 (03.02.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
2011900362 4 February 2011 (04.02.2011) AU
- (71) Applicant (for all designated States except US):
WESWOOD PTY LTD [AU/AU]; 11A Rosendo Street, Cottesloe, Western Australia 6011 (AU).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **UNDERWOOD, Paul Wesley** [AU/AU]; 11A Rosendo Street, Cottesloe, Western Australia 6011 (AU).

- (74) Agent: **WATERMARK PATENT & TRADE MARKS ATTORNEYS**; Level 2, 302 Burwood Road, Hawthorn, Victoria 3122 (AU).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

[Continued on next page]

(54) Title: DIFFERENTIAL PRESSURE ENERGY GENERATION

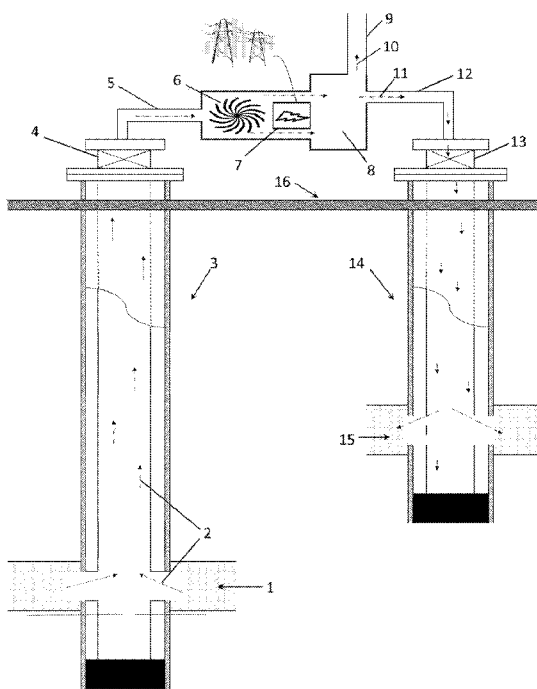


Figure 1

(57) Abstract: A method, system and means of generating electricity from fluid flow 2 from at least one subterranean first zone 1 containing fluid and connected via a flowpath to a second zone 15. The flowpath can include pipes, casings or conduits 3, 5, 2 and 14. At least one turbine 6 is in the flow path(s). Each turbine 6 has an inlet connected directly or indirectly to the first zone and an outlet connected directly or indirectly to the second zone. Pressure difference between the inlet and the outlet of each turbine provides a flow of the fluid from the respective inlet to the respective outlet to drive the turbine(s). At least one electricity generator 7 is integrated into or operatively connected to the turbine(s). Multiple turbines (Figs 3 and 4) can be in series and/or parallel in the flowpath(s). The first and/or second zones can be subterranean formations, such as depleted or dis-used oil or gas reservoirs.

WO 2012/103591 A1

SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). **Published:**

— with international search report (Art. 21(3))

DIFFERENTIAL PRESSURE ENERGY GENERATION

FIELD OF THE INVENTION

The present invention is generally directed to flow out of, into or between
5 subterranean formations and in particular to extracting power from said flow.

BACKGROUND OF THE INVENTION

There are known many methods, systems and means for extracting fluids
(liquids and/or gasses) from subterranean formations and for injecting fluids into
10 subterranean formations via pipes or conduits including well bores. However, the
energy present in the fluid flow through the pipes or conduits is rarely extracted
and harnessed. When fluids are extracted from subterranean formations, they
can be processed at the surface to extract the required components, with any
waste fluids being re-injected into a nearby well. The processing and the re-
15 injection of fluids can both consume power.

It would therefore be desirable to provide a method, system and/or means
to extract energy (preferably in the form of electricity) from the flow of fluid out of,
into or between subterranean formations.

20 SUMMARY OF THE INVENTION

With this in mind, there is provided a method of generating electricity from
fluid flow (i.e. flow of liquid and/or gas) from at least one subterranean first zone
containing fluid to a second zone, the method including: connecting the first zone
to the second zone by at least one flow path; providing at least one turbine in the
25 at least one flow path, the or each turbine having an inlet connected directly or
indirectly to the first zone and an outlet connected directly or indirectly to the
second zone, a pressure difference between the inlet and the outlet of the or each
turbine providing a flow of fluid from the respective inlet to the respective outlet,
thereby driving the at least one turbine; and providing at least one generator
30 integrated with or operatively connected to the at least one turbine to generate
electricity.

The flow path may include at least one well bore (or any part thereof including a casing, annulus, production bore, or tubing). The flow path may additionally include at least one pipe or conduit.

5 The at least one subterranean first zone may include a subsurface formation, chamber or reservoir.

The second zone may be a subsurface formation, chamber or reservoir. For example, the second zone may be an empty or depleted reservoir. The second zone may be at a lower pressure than the first zone. Alternatively or additionally, the second zone may be below the first zone such that flow through
10 the turbine is at least in part due to gravity.

The method may include the step of connecting the first and second zones by a single well bore.

Alternatively, the at least one flow path may include a first well bore, a second well bore and a pipe, the method including the steps of connecting the
15 first zone to the first well bore, connecting the second zone to the second well bore, and interconnecting the first and second well bores using at least the pipe. The at least one turbine may include at least one turbine in the first well bore and/or at least one turbine in the pipe and/or at least one turbine in the second well bore.

20 The step of providing at least one turbine in the at least one flow path may include providing two or more turbines in series in the at least one flow path.

The flow path may include a well bore, the method may further include providing the at least one turbine and the at least one generator in the well bore, the method further including transmitting said electricity to the surface.

25 The method may include transmitting at least a portion of said electricity to a power distribution grid.

The at least one turbine may be driven solely by the pressure difference between the respective inlet and the outlet. Alternatively, the at least one turbine may be partially driven by the pressure difference between the respective inlet
30 and the outlet and partially driven by a combustion reaction.

The fluid in the first zone may be (or include) a liquid at high pressure. Additionally or alternatively, the fluid in the first zone may be (or include) a gas at high pressure.

The fluid in the first zone may include a liquid and/or gas in a mineral or hydrocarbon deposit.

The second zone may include a receiving means on or near the surface. The method may further include the step of using at least a portion of said electricity and/or energy to re-inject said fluid.

Alternatively, the method may include the step of providing separating means in the receiving means to separate the fluid into at least a first and a second component. The method may further include the step of using at least a portion of said electricity and/or energy to inject said second component of the fluid into a second subterranean reservoir. Alternatively, the method may further include the step of using at least a portion of said electricity to supply at least a portion of the power for the separating means.

One or more forms of the present invention may provide a power generating means for generating electricity from fluid flow from a subterranean first zone containing fluid to a second zone, the power generating means including: a flow path connecting the first zone to the second zone; at least one turbine in the flow path, the or each turbine having an inlet connected directly or indirectly to the first zone and an outlet connected directly or indirectly to the second zone, a pressure difference between the inlet and the outlet of the or each turbine providing a flow from the respective inlet to the respective outlet, thereby driving the at least one turbine; at least one generator integrated with or operatively connected to the at least one turbine to generate electricity. The flow path may include at least one well bore (or any part thereof including a casing, annulus, production bore, or tubing). The flow path may additionally include at least one pipe or conduit.

One or more forms of the present invention may provide a system for generating electricity from the flow of fluid from a subterranean first zone to a second zone, the system including: fluid in the first zone; a flow path connecting the first zone to the second zone; at least one turbine in the flow path, the or each turbine having an inlet connected directly or indirectly to the first zone and an outlet connected directly or indirectly to the second zone; a pressure difference between the inlet of the or each turbine and the outlet of the or each turbine providing a flow through the or each turbine from the respective inlet to the

respective outlet, thereby driving the turbine; at least one generator integrated with or operatively connected to the at least one turbine to generate electricity. The flow path may include at least one well bore (or any part thereof including a casing, annulus or tubing). The flow path may additionally include at least one pipe or conduit.

It will be convenient to further describe the invention by reference to the accompanying drawings which illustrate preferred aspects of the invention. Other embodiments of the invention are possible and consequently particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Figure 1 is a schematic view of a first possible embodiment of the present invention.

Figure 2 is a schematic view of a second possible embodiment of the present invention.

Figure 3 is a schematic view of a third possible embodiment of the present invention.

Figure 4 is a schematic view of a modification to the third possible embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

In this specification, the term "fluid" refers to any liquid or gas or any combination of liquids and/or gasses. Similarly, references to a turbine include any machine in which the kinetic energy of a moving fluid is converted to mechanical power (or to electrical power with the aid of a generator or similar device).

Referring initially to Figure 1 a first zone 1 is connected by a flow path, in this embodiment by pipes, casings or conduits 3, 5, 12 and 14 (including first and second "cased" wells 3 and 14 bored below the surface 16) to a second zone 15 which is at lower pressure. Fluid 2 is located at pressure in the first subterranean formation or zone 1 and flows up through the "cased" well 3, through the well

head 4 and the pipe 5. The fluid then flows through a turbine 6 or past the rotor of a turbine which drives a generator 7 to generate electrical power. The fluid can be passed through a separation process 8 to be split into two components 10 and 11. The useable or saleable component 10 is harvested and output through pipe 9. At least a portion of the fluid may be considered waste fluid 11 and that portion can be flowed (via the pipe 12 and the well head 13) down the second well 14 into the second subterranean formation or zone 15 which may be a vacant or depleted reservoir.

For example, the first well 3 may be a production well tapping into the formation (or first zone) 1 containing hydrocarbons (for example methane gas rich in CO₂ or other impurities) at relatively high pressure to bring them from the subterranean reservoir, to the surface. The pressure of these hydrocarbons at pressure is harnessed to generate electricity by passing it through a turbine type mechanism 6 attached to a generator 7. While there is only one turbine shown, located at above, or on the surface, multiple turbines can be used and can be located at any point (or distributed) through the wells 3 and 14, and other pipes. The electricity generated is preferably used to assist the economics of the hydrocarbon production either through being used in the plant or sold into an electricity market. The electricity can be used in the plant for running the surface production and separation facilities, including those facilities required to separate out liquids, CO₂ or other impurities in the gas stream. The energy from the gas at high pressure in the reservoir zone is harvested to both generate electricity and as an energy source to re-inject the separated CO₂ and other impurities back into another vacant reservoir.

As noted above, although Figure 1 shows the turbine(s) and generator(s) at the surface, they can be provided at any point along the flow path between the first and second zones. For example, the turbine and generator can alternatively or additionally be located in-line in the production well and/or the re-injection well. The pressure at a first side or the inlet of such a turbine (the inlet or first side being connected to the first zone) is higher therefore than the pressure on the opposite (second) side or outlet of said turbine. That pressure difference provides a flow driving the turbine.

Figure 2 shows a similar example, but in this case the fluid is not separated and no portion of it is harvested. Instead, the fluid in the first reservoir 1 connected to the first well 3 is at a higher pressure than the pressure in the second reservoir 15 connected to the second well 14. The pressurised fluid in the first reservoir is flowed out through the well head 4 and through pipes 5 to the turbine 6 which reduces the pressure in the fluid in exchange for mechanical energy which is used to drive the generator 7. The fluid, now at lower pressure, is passed through pipes 12 and the well head 13 into a second well connected to the second reservoir 15. As noted in discussion of Figure 1, turbines may be placed in alternative or additional positions in either of the wells. For example, if the fluid is a liquid, the re-injected fluid flowing down the second well bore 14 may gain sufficient energy from gravity that a turbine can be placed in the second well bore 14 to drive a generator and provide additional (or all of the) electrical power output.

The arrangement shown in Figure 2 therefore provides a method for producing electrical power (for example, for input into a power distribution grid) without generating emissions from combustion of a hydrocarbon for example. It uses as its source subterranean fluid at pressure, which may be a liquid or gas that for example is too high in impurities to be economically viable to separate and extract, or otherwise of no other commercial value. Chambers or formations including such fluids may be encountered during drilling of wells for the extraction of resources such as oil or gas for example. An example applicable to both Figures 1 and 2 is in the production of oil and gas when the wells typically end their life producing significantly more water than hydrocarbons and this water similarly cannot be introduced into surface waterways and must be injected into subterranean reservoirs. This invention can therefore utilise existing wells that either failed to produce the expected fluid resource for extraction, or have depleted the resource to a level where the well would otherwise be capped and disused, the ability to harness pressure to generate and sell electricity thereby increasing the commercial viability of such wells.

In Figure 3, the turbine 6 and generator 7 are shown situated in-line in the well 3 to generate power/electricity from the flow of fluid between two subterranean reservoirs 1 and 15 interconnected by the single well 3.

Fluid 2 located in a high pressure subterranean formation or first zone 1 is flowed into a second subterranean formation or zone 15. The second zone 15 is at a lower pressure than the first zone 1 and can for example be a depleted or at least partially vacant reservoir. A packer 21 is shown expanded in the well borehole to isolate the fluid flowing section of the well from the upper section of the well and the well head 4, since in this example, none of the fluid is brought to the surface for use or sale. A plug 22 is fitted in the well bore below the first zone to ensure that the high pressure fluid from the first zone does not leach downwards.

The in-well valve 23 is surface controlled and can permit the high pressure fluid to pass upwards in the well bore, the fluid flow driving one or more turbines 6 which in turn drive a generator 7. The valve can also be used to seal the high pressure fluid below the turbines, as required for services of the turbines. The number of turbines can also be reduced during the life of the well, as the pressure of the fluid 2 in the first zone 1 is depleted. The electricity generated is transmitted to the surface via an umbilical type arrangement 25 for use or sale into an electricity market, for example via a power distribution grid.

In this embodiment, the gas and/or liquids are not necessarily sold to a market or otherwise used at surface but simply transferred from one zone to another, as in Figure 2. However, optionally there may additionally be some in-well separation (not shown) with saleable fluid being released to surface through the valve 26 and the well head 4. Some or all of the electricity generated could be used in this in-bore separation process and/or in further refining or pumping processes on the surface.

The embodiment shown in Figure 3 would suit a situation whereby a deep high pressure gas and/or aquifer system can be flowed into a depleted reservoir in the same well, although if the source chamber or formation of the first zone is above the second reservoir or second zone and the fluid is relatively dense (i.e. a liquid rather than a gas) then the source of fluid in the first zone may only need to be at sufficient pressure to expel the fluid into the well bore, with gravity generating the pressure to drive a turbine further down the well prior to the fluid entering the second zone.

Figure 4 shows modifications to Figure 3. The generator 7 is now above the packer 21 in the well bore to move the electricity generating components out of the operating fluid volumes of the well. Also the source chamber or formation of the first zone 1 is physically above the second reservoir or second zone 15.

5 Although deeper formations are usually at higher pressure, if the second zone is a depleted reservoir, it may be at lower pressure than the first zone. In addition to the pressure difference between the first and second zones, the action of gravity on the fluid in the well bore can also contribute to the pressure differential across the turbine. In this case, the pressure in the subterranean formation of the first
10 zone 1 can be lower than the pressure in the subterranean formation of the second zone 2, as this does not necessarily equate to a lower inlet pressure than outlet pressure at the turbine(s) 6 due to the head of the fluid in the well bore. For example, gravity acting on the column of fluid in the well bore, i.e. the potential energy of the fluid, can be the main source of energy driving the turbine.

15 In addition to being able to use existing unsuccessful exploratory resource extraction wells or wells connected to depleted chambers or formations, the present invention can also be applicable to the production of coal bed methane which requires that the wells be de-watered prior to gas production. This water must be disposed of and cannot often be introduced to the surface water ways.
20 The invention is applicable to the extraction of energy from a pressurised fluid in a subterranean reservoir where all or a portion of that fluid cannot be introduced into surface waterways and must be injected into other subterranean reservoirs.

The turbine may be any device in which flow of fluid or pressure difference between the inlet and outlet drives rotation of at least one rotor, such as an
25 impellor, fan, or vaned or bladed rotor. For example, the turbine may include any of various machines with at least one rotor, usually with vanes or blades, driven by the pressure, momentum, or reactive thrust of a moving fluid, either occurring in the form of fluid flow over the rotor(s) or as a fluid passing through and entirely filling a housing (such as a cowling) around the rotor.

30 The generator may be integrated into the turbine, particularly in the examples shown in Figures 1 to 3. For example, the turbine blades can have magnetic tips and the housing of the turbine can include windings so that rotation of the turbine blades generates relative motion between the magnetic tips of the

blades and the windings in the housing or cowling, generating current in the windings.

CLAIMS:

1. A method of generating electricity from fluid flow from at least one subterranean first zone containing fluid to a second zone, the method including:
connecting the first zone to the second zone by at least one flow path,
5 providing at least one turbine in the at least one flow path, the or each turbine having an inlet directly or indirectly connected to the first zone and an outlet directly or indirectly connected to the second zone, a pressure difference between the inlet and the outlet of the or each turbine providing a flow of fluid from the respective inlet to the respective outlet, thereby driving the at least one
10 turbine,
providing at least one generator integrated with or operatively connected to the at least one turbine to generate electricity.
2. A method as claimed in claim 1, the flow path including at least one well bore, well bore casing, annulus, production bore, tubing, pipe or conduit.
- 15 3. A method as claimed in claim 1 wherein the second zone is a subsurface formation, chamber or reservoir.
4. A method as claimed in claim 3 wherein the second zone is an empty or depleted reservoir.
5. A method as claimed in claim 3 wherein the second zone is at a lower
20 pressure than the first zone.
6. A method as claimed in claim 3 wherein the second zone is located lower than the first zone such that flow through the turbine is at least in part due to gravity.
7. A method as claimed in claim 3 including the step of connecting the first and second zones by a single well bore.
- 25 8. A method as claimed in claim 3 wherein the at least one flow path includes a first well bore, a second well bore and a pipe,

the method including the steps of connecting the first zone to the first well bore, connecting the second zone to the second well bore, and interconnecting the first and second well bores using at least the pipe.

9. A method as claimed in claim 8 wherein the at least one turbine includes at
5 least one turbine in the first well bore.

10. A method as claimed in claim 8 wherein the at least one turbine includes at least one turbine in the pipe.

11. A method as claimed in claim 8 wherein the at least one turbine includes at least one turbine in the second well bore.

10 12. A method as claimed in claim 1 wherein the step of providing at least one turbine in the at least one flow path includes providing two or more turbines in series in the at least one flow path.

13. A method as claimed in claim 1 wherein the flow path includes a well bore, the method further including providing the at least one turbine and the at least one
15 generator in the well bore, the method further including transmitting said electricity to the surface.

14. A method as claimed in claim 1 including transmitting at least a portion of said electricity to a power distribution grid.

15. A method as claimed in claim 1 wherein the at least one turbine is driven
20 solely by the pressure difference between the respective inlet and outlet.

16. A method as claimed in claim 1 wherein the at least one turbine is partially driven by the pressure difference between the respective inlet and the outlet and partially driven by a combustion reaction.

17. A method as claimed in claim 1 wherein the fluid in the first zone includes a
25 liquid at high pressure.

18. A method as claimed in claim 1 wherein the fluid in the first zone includes a gas at high pressure.

19. A method as claimed in claim 1 wherein the fluid in the first zone includes a liquid or gas in a mineral or hydrocarbon deposit.

5 20. A method according to any of claims 17 to 19 wherein the second zone includes a receiving means on or near the surface.

21. A method as claimed in claim 20 including the step of using at least a portion of said electricity and/or energy to re-inject said fluid.

10 22. A method as claimed in claim 20 including the step of providing separating means in the receiving means to separate the fluid into at least a first and a second component.

23. A method as claimed in claim 22 including the step of using at least a portion of said electricity and/or energy to inject said second component of the fluid into a second subterranean reservoir.

15 24. A method as claimed in claim 22 including the step of using at least a portion of said electricity to supply at least a portion of the power for the separating means.

20 25. A power generating means for generating electricity from fluid flow from a subterranean first zone containing fluid to a second zone, the power generating means including:

a flow path connecting the first zone to the second zone,

25 at least one turbine in the flow path, the or each turbine having an inlet connected directly or indirectly to the first zone and an outlet connected directly or indirectly to the second zone, a pressure difference between the inlet and the outlet of the or each turbine providing a flow from the respective inlet to the respective outlet, thereby driving the at least one turbine,

at least one generator integrated with or operatively connected to the at least one turbine to generate electricity.

26. A means as claimed in claim 25, the flow path including at least one well bore, well bore casing, annulus, production bore, tubing, pipe or conduit.

5 27. A system for generating electricity from the flow of fluid from a subterranean first zone to a second zone, the system including:

fluid in the first zone,

a flow path connecting the first zone to the second zone,

10 at least one turbine in the flow path, the or each turbine having an inlet connected directly or indirectly to the first zone and an outlet connected directly or indirectly to the second zone,

a pressure difference between the inlet of the or each turbine and the outlet of the or each turbine providing a flow through the or each turbine from the respective inlet to the respective outlet, thereby driving the turbine,

15 at least one generator integrated with or operatively connected to the at least one turbine to generate electricity.

28. A system as claimed in claim 27, the flow path including at least one well bore, well bore casing, annulus, production bore, tubing, pipe or conduit.

1/4

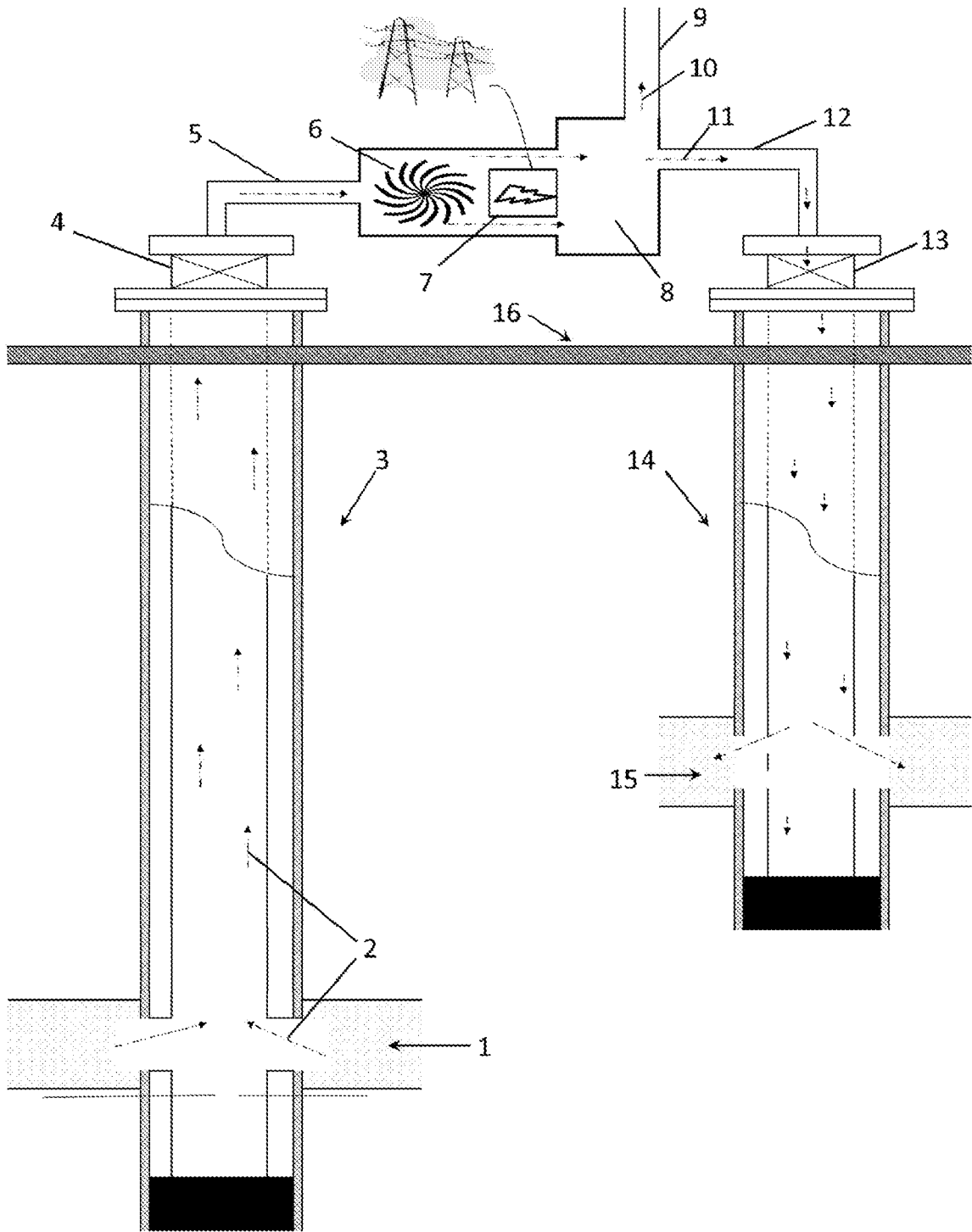


Figure 1

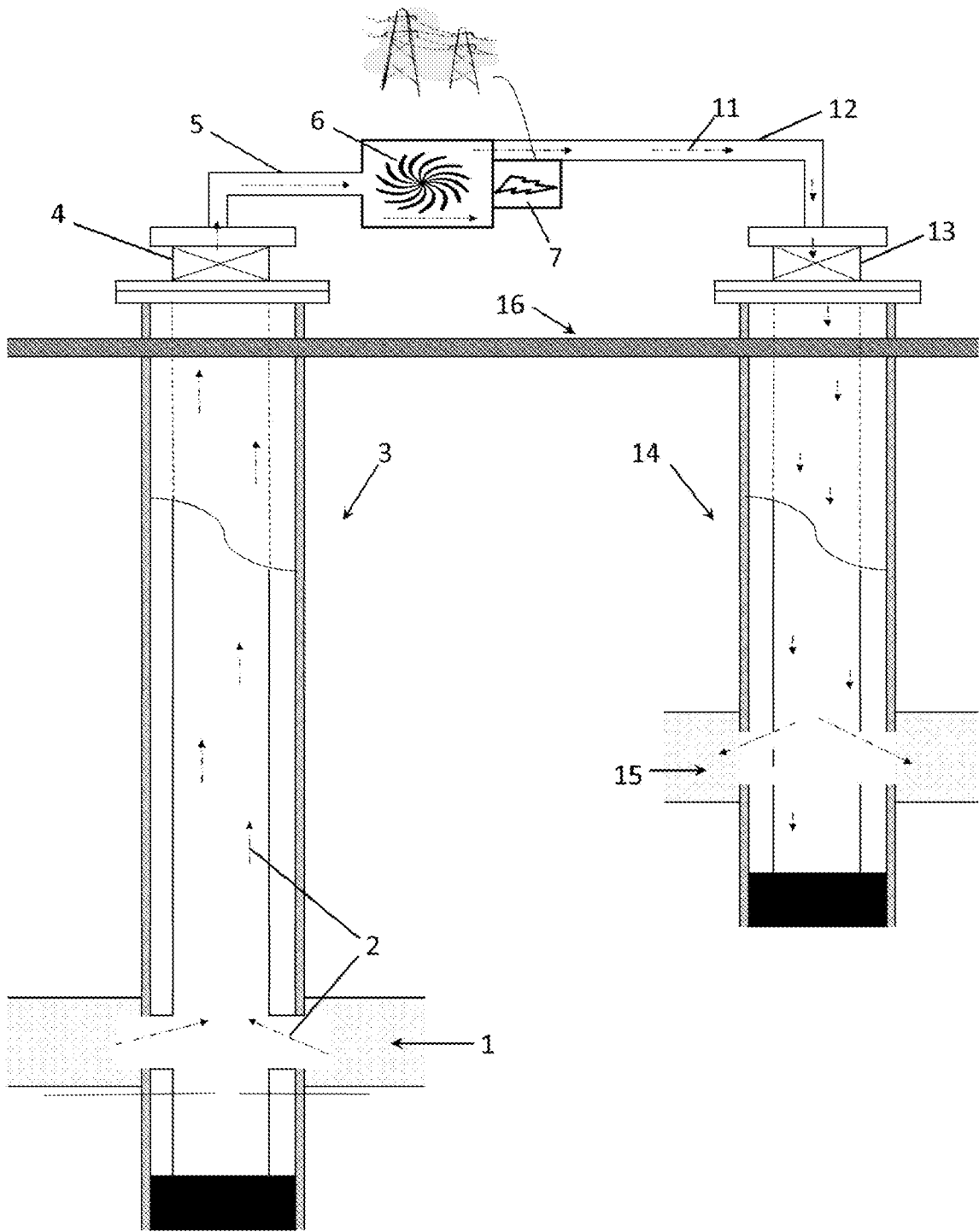


Figure 2

4/4

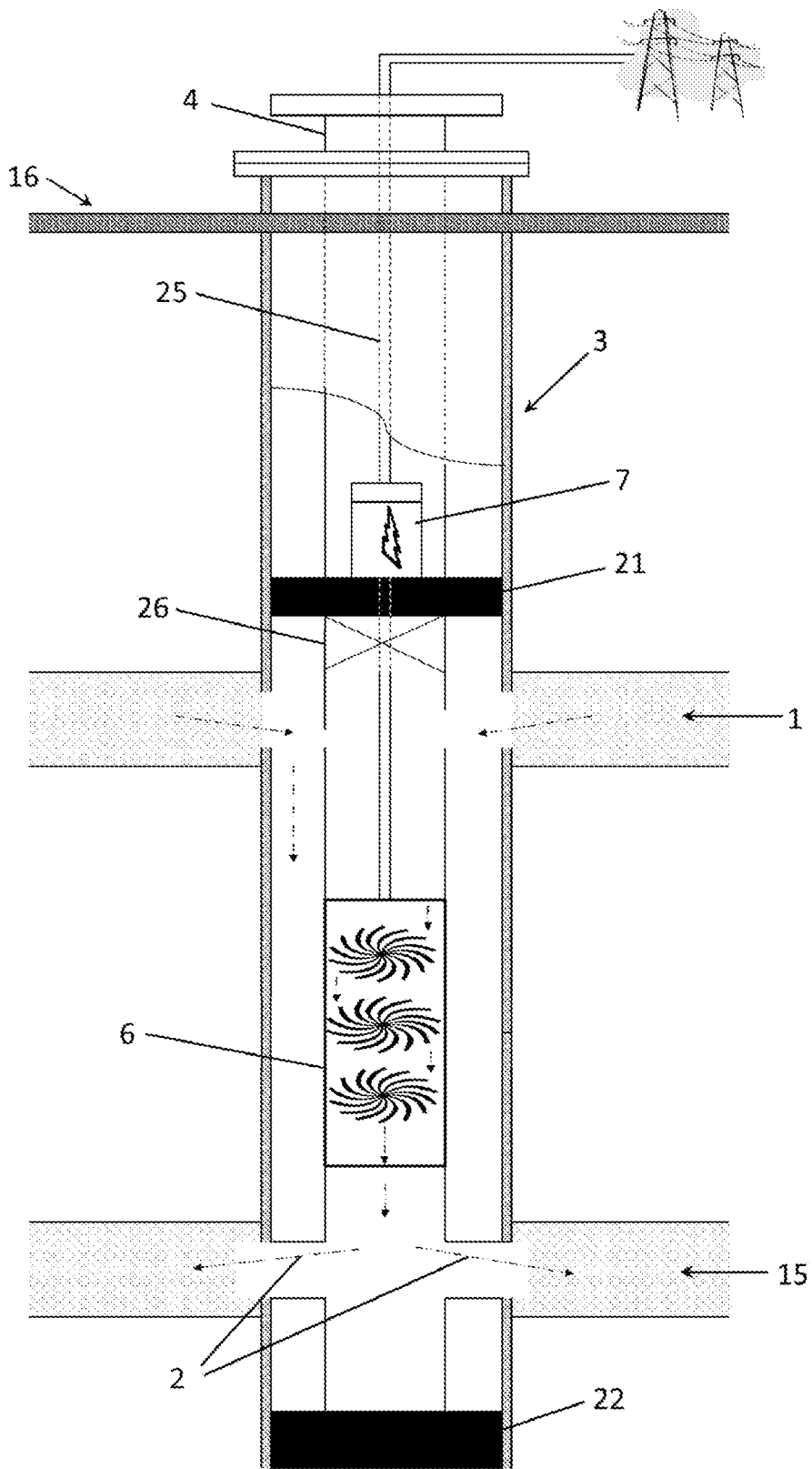


Figure 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2012/000095

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. F03B 13/00 (2006.01) E21F 7/00 (2006.01) F01D 15/10 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
a. WPI, EPODOC: IPC, ECLA: E21F 7/00; Keyword: turbine and like terms.		
b. WPI, EPODOC: Keywords turbine, expander, subterranean, underground, subsurface, mining, well, hole, bore, generator, dynamo, electricity, power and like terms		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5582011 A (BRONICKI et al.) 10 December 1996 column 2, lines 6-21; column 2, line 56 – column 3, line 2; column 3, lines 28-51; column 4, lines 28-31; figure	1-3, 5, 8, 12, 14, 15, 17-20, 22, 25-28
X	US 7002261 B2 (COUSINS) 21 February 2006 column 2, lines 40-64; column 3, lines 35-45; column 4, line 8- column 5, line 19; column 6, lines 51-63; figures 2, 3	1-7, 9-11, 13, 15, 24
X	EP 0196690 B1 (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.) 18 October 1989 column 1, lines 34-55; column 2, lines 7-18; column 2, line 56 – column 3, line 15; column 3, line 65 – column 4 line 10; figure 1	1-3, 5, 8, 15, 17-21, 23, 25-28
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family	
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 05 March 2012	Date of mailing of the international search report 8 March 2012	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer NAVEEN DE SILVA AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2429	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000095**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: **16**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

The claim does not meet the requirements of Article 6 of the PCT because claim 16 is not fully supported by the description.

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2012/000095

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
US 5582011	NONE
US 7002261	NONE
EP 0196690	JP 61226571 DK 140386 CA 1260802

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX