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(54) **Title**: COMBINED CYCLE ENERGY GENERATION SYSTEM

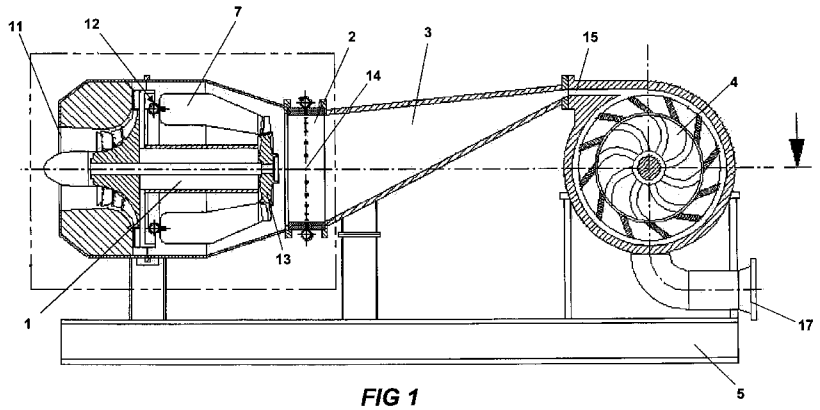

FIG 1

(57) **Abstract**: The present invention refers to an energy generation system in a rotary shaft that uses the combined cycle concept and has the preferential purpose to create an energy generation system with a high yield and low cost. More particularly, the mechanical energy generator system, in accordance with the present invention, comprises the combination of a gas turbine (1) coupled with a steam generator chamber (2), that in turn, is coupled to at least one steam turbine (4) by means of a conducting duct (3), being that preferentially, said turbine is a steam turbine (4) of parallel disks (8).

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"COMBINED CYCLE ENERGY GENERATION SYSTEM"

FIELD OF THE INVENTION

The present invention refers to a mechanical energy generation system in a rotary shaft, more particularly a system that uses the combined cycle concept with the purpose to create an energy generation system with high performance and low manufacturing cost.

More preferentially, the present invention refers to an energy generating system, of combined cycle type, which comprises technical and functional characteristics capable of generating very high energy in the shaft of a turbine. In brief, but more detailed in the following description , the system according to the present invention is constituted by the combination of a gas turbine coupled with a steam generator chamber, which, in turn, is coupled to a steam turbine, preferentially a parallel disks steam turbine, and more preferentially the type of a Tesla with Pelton effect blades.

BACKGROUND OF THE INVENTION

As it is well known by the person skilled in the art, there are many way to obtain mechanical energy, as well as in the generation of electrical energy. Among several methods, there are a lot of models of equipment and systems responsible for the generation of energy, which, despite apparently satisfying current needs, reveals certain problems, which, in the long term, can compromise the life of human beings, for example: the scarcity of the natural sources commonly used in the generation of energy.

Taking into account that the system according to the present invention uses the combination of a gas turbine, a steam generator and a steam turbine, some following clarifications will be done about their background until the development of the present invention.

Gas turbines normally operate in open cycles, based on the thermodynamic cycle known as the Brayton cycle. This establishes that the

comburent agent (air) is admitted at atmospheric pressure and compressed in the compressor to later mix itself with the fuel in a combustion chamber, in which the burning also occurs. The gases generated in this manner are mixed, undergo expansion and are discharged back to the atmosphere after passing through the turbine.

This type of cycle, performed by gas turbines, presents as one of its essential properties, the obtainment of very high temperatures, reaching peaks in the order of 1000 to 1300°C in the power turbine. Furthermore, it is capable of generating power and liberates the gases with a large energetic availability, with temperatures in the order of 500 to 650°C.

With respect to the steam generation, it is known that for decades, conventional boilers have been in used which excessively consume fuels (biomass, gas, oil and other combustible liquids), in order to obtain heat generation by its combustion. These boilers are composed of heat exchangers completed by a flow of water that is heated until its vaporization, which can result in saturated or superheated steam.

The aforesaid steam, whether saturated or superheated, can be directed to a reservoir, in which it is accumulated until it reaches the pressure and temperature necessary for use in the conventional steam turbines.

However, as can be observed, this type of equipment and system reveals a series of inconvenient related to the efficiency, agility, fuel wastage and, also, physical space. More specifically, it is observed that:

i) the time to heat the heat exchangers is very slow, which results in an excessive consumption of fuels;

ii) all the heat generated during the heating exchangers process is lost;

iii) the boilers are large and take up considerable physical space, requiring complex and expensive installations;

iv) the boilers present flow problems.

As an alternative, it is possible to use a source of available heat derived from another process, in which the boiler's water can be heated and vaporized using this available heat and dispensing the burning of the fuel in this cycle of vaporization. This process is also known as the Rankine cycle. In this case, the combination of the Brayton and Rankine cycles is called combined cycle and the boiler used is denominated recovery boiler.

The main inconvenient revealed by the steam turbine action mechanisms of the state of the art is related to the steam generation in the necessary conditions. More particularly, there is a big problem, which is currently confronted, and which will have future consequences, related to the scarcity of sources of fuel and the degradation of natural resources those of which compromise the environment with the pollutant emission.

It should be highlighted that the burning of fuels during the initiation process of boilers operation, i.e. in the initial stages when steam cannot be obtained, all the fuel and also the generated heat is wasted since it is not possible to obtain the pressure and temperature in a instantaneous way.

Therefore, it remains clear that the equipments and mechanical energy generating systems known in the state of the art present some inconvenient and limitations related mainly to the efficiency, power, yield and agility, principally in the steam generation process, in a manner that direct and indirectly compromises the environment.

BRIEF DESCRIPTION OF THE INVENTION

Thus, it is objective of the present invention a mechanical energy generation system, preferentially the combined cycle type, which objectively and effectively resolves and improves the deficiencies of the systems and energy generating equipments of the state of the art, as identified above.

More preferentially, it is objective of the present invention a mechanical energy generating system that substantially eliminates fuel

wastage, besides efficiently providing a high quantity of mechanical energy in an efficient way.

The objective of the present invention is a mechanical energy generating system that, preferentially, but not limited to only this purpose, is coupled with an electrical energy generating system.

It is also the objective of the mechanical energy generating system, object of the present invention, to provide a compact structure that comprises the combination of a gas turbine with a low pressure and low temperature steam turbine by means a steam generator chamber that is capable of producing steam under the desired conditions, in a substantially instantaneous way.

The present invention also has as objective an energy generating system for varying purposes that uses the mechanical energy produced by the combination of a gas turbine coupled to a steam turbine by means of a high efficiency steam generating chamber.

DESCRIPTION OF THE INVENTION

Accordingly, the mechanical energy generating system, object of the present invention, is comprised by a gas turbine connected to a low pressure and low temperature steam turbine by means of a steam generating chamber, which is capable of obtaining steam from the mixture of water with the gases generated by the combustion from the gas turbine.

The aforesaid steam generating chamber is coupled in the gas outlet of the gas turbine, in such a way that the vaporization water injected into this chamber is instantaneously vaporized due to the temperature conditions and the energy contained in these gases. In this way, it is possible to define precisely the characteristics of the generated steam, which can be saturated, dry or superheated, depending on the purpose of the desired application. In order to obtain steam in these conditions, it is sufficient to control the quantity of

water injected into the aforesaid steam generating chamber.

In a preferential embodiment of the present invention, the steam generating chamber is connected after the power turbine of the gas turbine, and comprises an injector mechanism that injects water directly into the hot gas flow expelled by the gas turbine, in such a way that the contact of the water particles provides an instantaneous vaporization, producing steam mixed with the combustion gases. In this way, the water flow injected into the steam generating chamber and the heat from the combustion gases of the gas turbine define the quality of the saturated steam or the temperature of the superheated steam.

Preferentially, the aforesaid injector mechanisms are nozzles that pulverize the vaporization water. More preferentially, the aforesaid injector mechanism comprises a ring shape provided with a plurality of spray nozzles distributed around its perimeter.

The generated steam is conducted in the direction of parallel disks steam turbine by a directing duct. It should be emphasized that the aforesaid directing duct can present constant or variable section in the shape of a diffuser, which will depend on the size of the inlet and the characteristics of the parallel disks steam turbine . Furthermore, the aforesaid directing duct can comprises a central diffuser that assists in the steam flow conduction and direction in order to the same be focused more efficiently onto the disks of the steam turbine.

In a preferential embodiment, the aforesaid steam turbine is the type of a Tesla Turbine, which comprises the disposition of parallel disks of relatively small thickness arranged away themselves by very small distances. These parallel disks are mounted in a shaft forming a fixed rotor and housed in a cylindrical outer covering, such as a box, forming a stator.

The objective of the steam turbine is to rotate the shaft to produce the mechanical energy that can be used for varying purposes. More preferentially, in view of its properties, the aforesaid generated mechanical

energy is very well applied when the system of the present invention is coupled to an electric generator.

The characteristics of the steam turbine with parallel disks, such as the Tesla type, have as operating principle the use the work fluid to move the aforesaid rotor in which the steam drains from the edge of the disks towards the center, where it escapes by an exhaust outlet. One of the advantages of the Tesla type turbine is in relation to its capacity of use steam in any condition, including at low pressure and low temperature and that it can be operated with steam mixed with combustion gases.

Even more preferentially, in relation to a suitable combination of the steam turbine disks, some of them, or all of them, comprise an non-smooth configuration, in a way to form channels that facilitate and assist the conduction and passage of the flow of the work fluid among the aforesaid plates.

Accordingly, in the preferential embodiment of the present invention, the steam turbine is the type of a Tesla type with Pelton effect blades, whose function is to rotate the shaft, by means of the limit layer effect combined with the effect generated by the Pelton effect blades positioned radially on one of the sides of the parallel disks, obtaining the mechanical energy for the varying purposes. In this embodiment, it is possible to increase considerably the yeld of the system according to the present invention.

Therefore, with the high efficiency in the steam generation through the gas turbine combined with the steam generating chamber, it is able to obtain steam with ideal characteristics to be applied in the steam turbine, in a way to produce high levels of mechanical energy in the shaft of the rotor.

It is also emphasized that one of the principal advantages of using a gas turbine coupled to the steam generating chamber is that, besides being more compact than the recovery boilers, can instantaneously produce steam in the desired and required conditions of quantity, pressure and temperature of

steam for the work performance and power generation from the shaft in the low pressure and low temperature steam turbine.

As previously highlighted, the mechanical energy generation system, according to the present invention, present a large applicability when coupled with an electric generator in order to obtain an energy generating station with a high yeld and low cost of manufacture. Preferentially, the aforesaid electric generator is coupled to the system of the present invention in a single base of type skid.

Alternatively, in order to become the system of the present invention more economical, it is possible to couple a separator condenser device, whose purpose is to capture the gases and the water that goes out through the exhaust outlet of the aforesaid steam turbine and to separate the gases from the water, in order to conduct the latter for reuse by the water injector mechanism in the steam generating chamber.

Also, in an additional embodiment, it is possible to take advantage of the residual heat remaining in the fluid from the outlet of the steam turbine, such as the Tesla type with Pelton effect blades, applying it in the heating of water from a regenerative cycle or for other thermal applications.

BRIEF DESCRIPTION OF THE DRAWINGS

The objectives, technical effects and advantages of the mechanical energy generation system, object of the present invention, will be more apparent to the person skill in the art from the following descriptions made with reference to the attached figures, which illustrate preferred embodiments, but which do not limit the present invention.

The Figure 1 shows a side view of the energy generation system with a combined cycle, in accordance with the present invention, illustrating the respective inlet and outlet flows;

The Figure 2 shows a top view plan of the system illustrated in

Figure 1;

The Figures 3 and 4 show views similar to the ones illustrated in Figures 1 and 2, but with an alternative embodiment of the system according to the present invention;

The Figure 5 shows an enlarged view of the gas turbine, according to a preferential embodiment of the present invention; and

The Figures 6A and 6B show views of the parallel disks steam turbine , in accordance with the embodiment illustrated in Figures 1 and 2.

DETAILED DESCRIPTION OF THE FIGURES

In order to facilitate the understanding of the constitutive elements of the energy generation system according to the present invention, as well as its embodiments, the reference numbers are not repeated integrally in all figures since it would complicate the comprehension of some details illustrated in the figures.

According to the attached drawings, particularly in relation to Figures 1 and 2, it is observed that the mechanical energy generating system comprises a combined cycle in a single block, which is constituted by a gas turbine (1) connected to a steam generating chamber (2), interconnected to a directing duct (3) whose outlet end is in communication with at least one steam turbine (4).

In this preferential embodiment of application, the mechanical energy generation system is installed over a support base (5) and is coupled with an electric generator (6), which is capable of producing modular energy for any purpose.

Also with reference to Figures 1 and 2, the flow of the aforementioned combined cycle in a single block can be seen , in which starts with the air capturing and introduce the air into the inlet opening (11) of the gas turbine (1), which mixes with the fuel injected by the feeding nozzles (12) in the

combustion chamber (7), generating gas with high temperature that is expanded into the power turbine (13).

The aforesaid power turbine (13) provokes the expulsion of the hot gases from the gas turbine (1) in the direction of the steam generating chamber (2) equipped with water injection mechanisms (14). The water enters into the aforesaid steam generating chamber (2), where the energy of the gases from the combustion chamber (7), from the gas turbine (1), promote the instantaneous vaporization of the injected water, obtaining a flow of steam as a result. This is denominated as contaminated or vitiated steam due to the mixture with the combustion gases that is conducted by the directing duct (3).

The aforesaid directing duct (3) has the purpose to conduct the flow of contaminated steam in the direction of the air inlet (15) of the steam turbine (4). It is important to emphasize that the characteristics of the aforesaid directing duct (3) can depend on the power and size of the steam turbine (4). For example, the aforesaid directing duct (3) can have a constant section to supply steam to several parts of the turbine but can also present a variable section similar to a diffuser.

Alternatively, as illustrated in the embodiment illustrated in Figure 2, inside the aforesaid directing duct (3) it is possible to introduce a conducting diffuser (16) whose purpose is to guide the steam flow to the inlet(s) of the steam turbine(s) (4). The arrangement of this diffuser (16) is very useful when there is a combination of more than one steam turbine (4) since the aforesaid diffuser can directs t he steam flow towards the inlets of the turbines in a balanced manner.

The steam turbine (4) is preferentially formed by a series of parallel disks (8) arranged side by side and spaced in a relatively small distance among themselves, in such a way that the contaminated steam that runs through the directing duct (3) is introduced into the air inlet (15), which is

tangentially positioned to the aforesaid parallel disks (8).

Accordingly, the flow of contaminated steam is tangentially introduced in the end of the disks (8), through their surfaces, in the space among the disks (8) until being expelled into the central passages. Through this flow of steam, with high temperature and pressure, the shaft (10) that maintains the disks moves, and consequently generates mechanical energy at the end (10') of the aforesaid shaft (10).

In a preferential embodiment, the outlet of the steam from the central region of the parallel disks (8) can be channeled towards an exhaust duct (17), which normally produces condensed steam.

In an alternative embodiment, as illustrated in Figures 3 and 4, the aforesaid exhaust du ct (17) is coupled to a filtering system, or even to a condenser and separator device (21), that includes a gas outlet tube (22) and a water outlet (23), the latter being connected to the water injection mechanism (14) by means of a pipe (24), allowing the reuse of the condensed water.

The aforesaid condenser and separator device (21) have the purpose of condensing the residual steam and allowing the physical separation of the combustion gases that are still dissolved in the water. The hot or cold water returns to the water injection mechanism (14) in the steam generating chamber (2) and the combustion gases are liberated into the atmosphere by the gas outlet tube (22).

In relation to the Figure 5 , it is illustrated the gas turbine (1) coupled to the steam generating chamber (2) equipped with the water injection mechanism (14). In this figure it is illustrated a preferential embodiment of the aforesaid water injection mechanism (14), which comprises a ring (18) provided with a plurality of radially distributed injector nozzles (19) that are fed by channels (20). As must b e appreciated by a person skilled in the art, the quantity and size of the aforesaid injector nozzles (19) depends on the

characteristics of the system project, as a whole.

The Figures 6A and 6B illustrate some details of a preferential embodiment of the steam turbine (3), that comprises a series of parallel disks (8) arranged side by side and spaced among themselves to form passages of the steam flow, as indicated in Figure 6B.

Specifically in relation to Figure 6A, it is possible to observe an alternative embodiment of the configuration of the disks (8) of the steam turbine (4). In the preferential embodiment of the present invention, the aforesaid steam turbine (3) is the type of a Tesla Turbine with Pelton effect blades in order to allow the combination of the limit layer effect with the effect generated by the Pelton type blades positioned radially on one of the sides of the parallel disks. As indicated, the surface of the disks (8) is equipped with some blades (9) in the shape of arches or any other shape that assists the conduction of the steam flow between the edge and the center of the disk (8), denominated as the Pelton effect.

As is well known by the person skilled in the art, the steam turbines with parallel disks are known as Tesla turbines, whose disks comprise smooth surfaces. In an alternative and also advantageous embodiment, it is possible to combine parallel disks and disks with blades to obtain improvements in the speed and torque, which will depend on the objectives and applications for which the system, object of the present invention, is developed.

Finally, it can be highlighted that the energy generation system, according to the present invention, can also include cycles and processes used conventionally in gas turbines such as regenerative cycles and the injection of water or steam into the combustion chamber, or in the air inlet of the compressor, in order to make it possible to obtain improvements in the efficiency, reduction of the temperature of the turbine and reduction of the NOx emission.

CLAIMS

1. COMBINED CYCLE ENERGY GENERATION SYSTEM, characterized by comprising a sequential combination of a gas turbine (1) connected to a steam generating chamber (2), interconnected to a directing duct (3) which the outlet end is connected with at least one steam turbine (4).

2. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact that said steam generating chamber (2) comprises a water injection mechanism (14) arranged in the proximity of the power turbine (13) of the gas turbine (1).

3. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 2, characterized by the fact that said water injection mechanism (14) comprises a ring (18) provided with a plurality of radially distributed injector nozzles (19) that are fed by channels (20).

4. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact that said directing duct (3) is connected to the steam outlet of the steam generating chamber (2) and in the air inlet (15) of the steam turbine (4), and comprises a constant section.

5. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact that said directing duct (3) is connected to the steam outlet of the steam generating chamber (2) and in the air inlet (15) of the steam turbine (4), and comprises a variable section.

6. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact that said directing duct (3) additionally comprises a conducting diffuser (16) that guides the steam flow in the direction of the inlet(s) of the steam turbine(s) (4).

7. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact that said steam turbine (4) is preferentially formed by a series of parallel disks (8) arranged side by side and

spaced in a relatively small distance among themselves and maintained by a shaft (10).

8. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 7, characterized by the fact that the air inlet (15) of the steam turbine (4) is arranged at a tangentially position of the parallel disks (8).

9. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 7, characterized by the fact that said parallel disks (8) are equipped with steam outlet arranged in the central region of its surface.

10. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact that the steam outlet of the central region of the parallel disks (8) is channeled towards an exhaustion duct (17).

11. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 10, characterized by the fact that said exhaustion duct (17) is connected to a filtering system or a condenser and separator device (21) including a gas outlet (22) and a water outlet (23) in communication with the water injection mechanism (14) of the steam generating chamber (2).

12. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 7, characterized by the fact that the disks (8) of the steam turbine (4) are equipped with some blades (9) in the shape of arches or any other shape that assists the conduction of the steam flow between the edge and the center of the disk (8).

13. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with anyone of the claims 1 to 12, characterized by the fact that the steam turbine (4) comprises a combination of smooth disks and with blades (9).

14. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 13, characterized by the fact that the steam turbine (4) is the type of a Tesla Turbine with Pelton effect blades.

15. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact of being interlinked to an electrical generator (6).

16. COMBINED CYCLE ENERGY GENERATION SYSTEM, in accordance with claim 1, characterized by the fact of being installed over a support base (5), of a skid type.

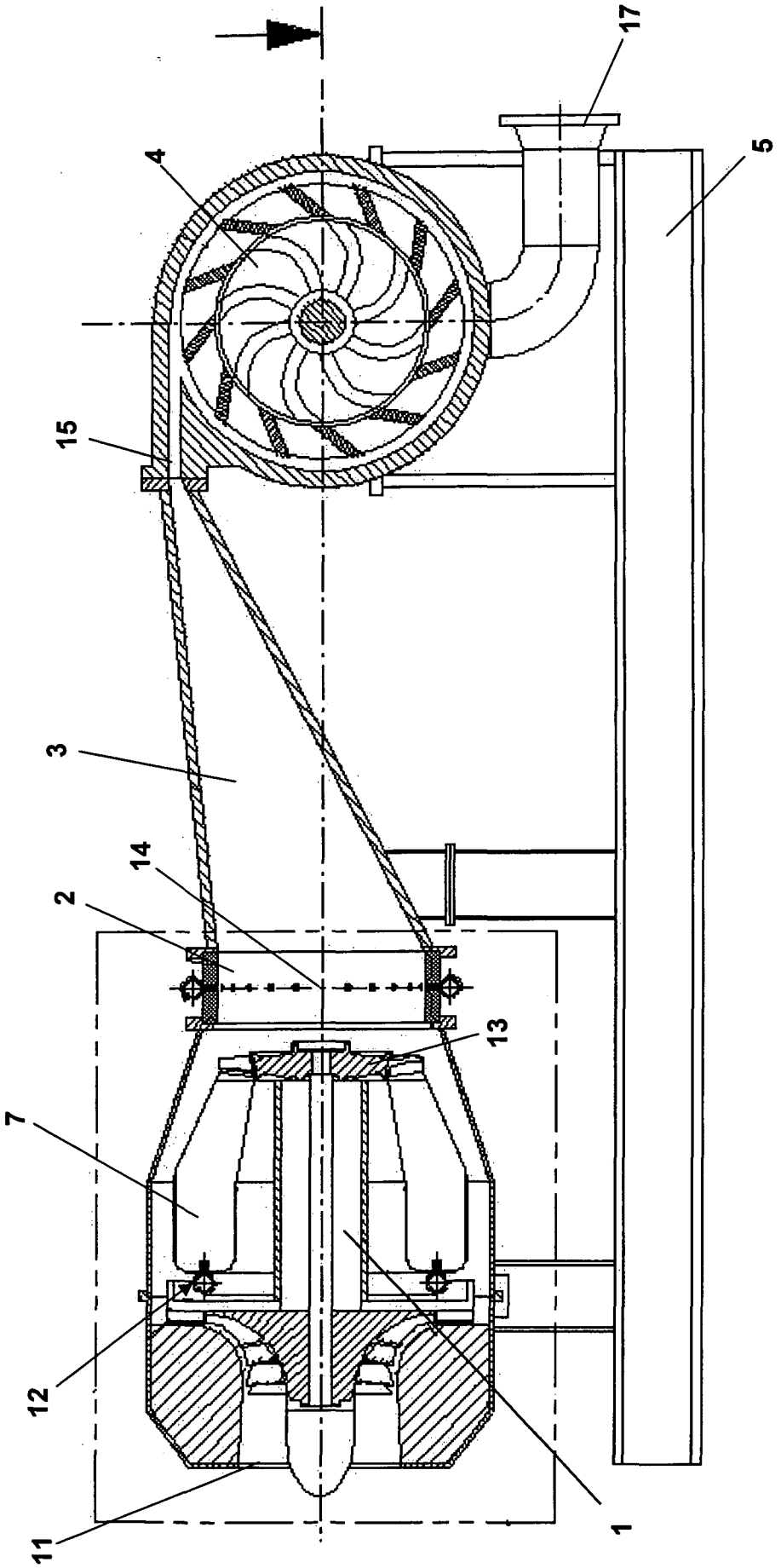

FIG 1

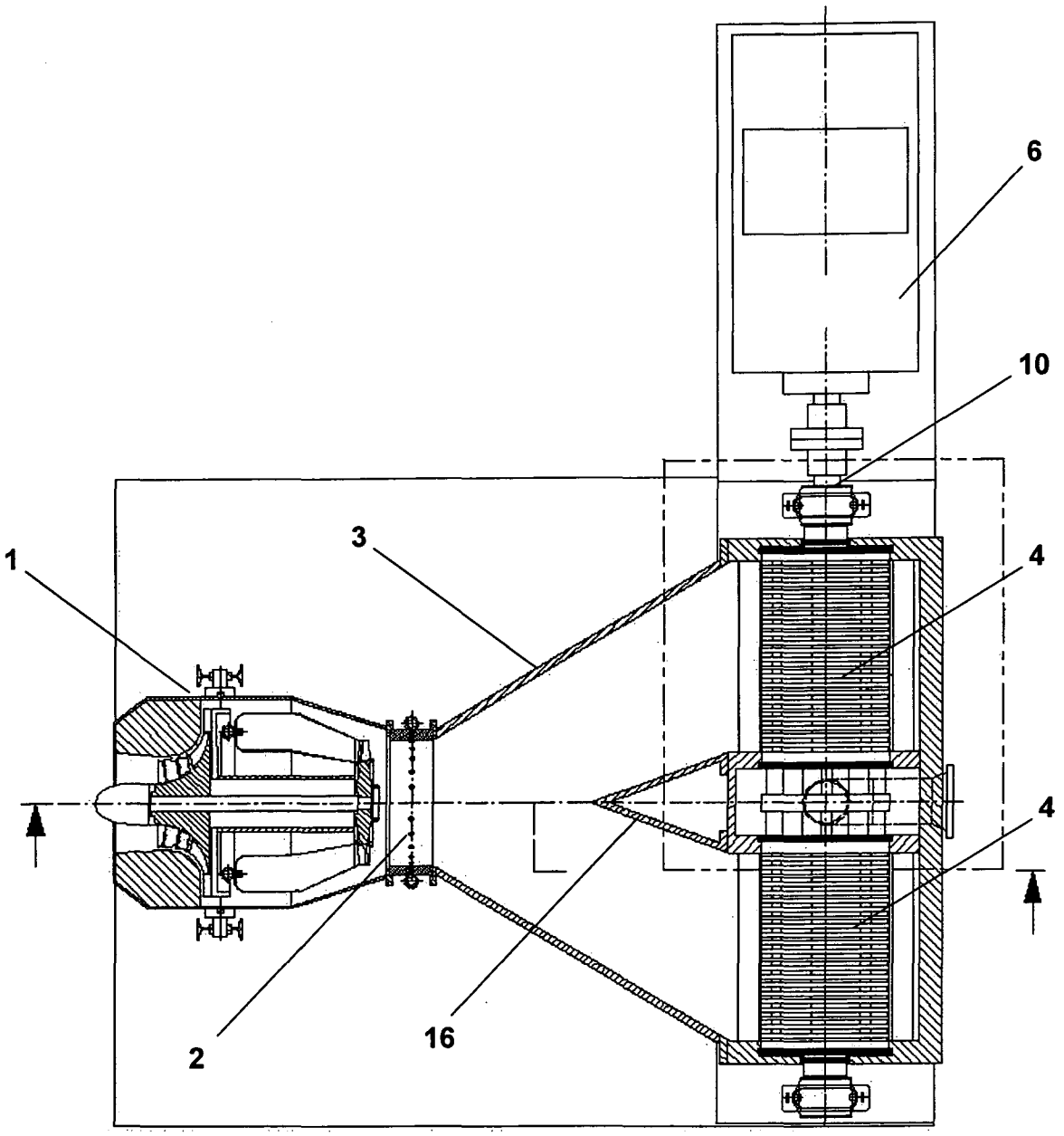

FIG. 2

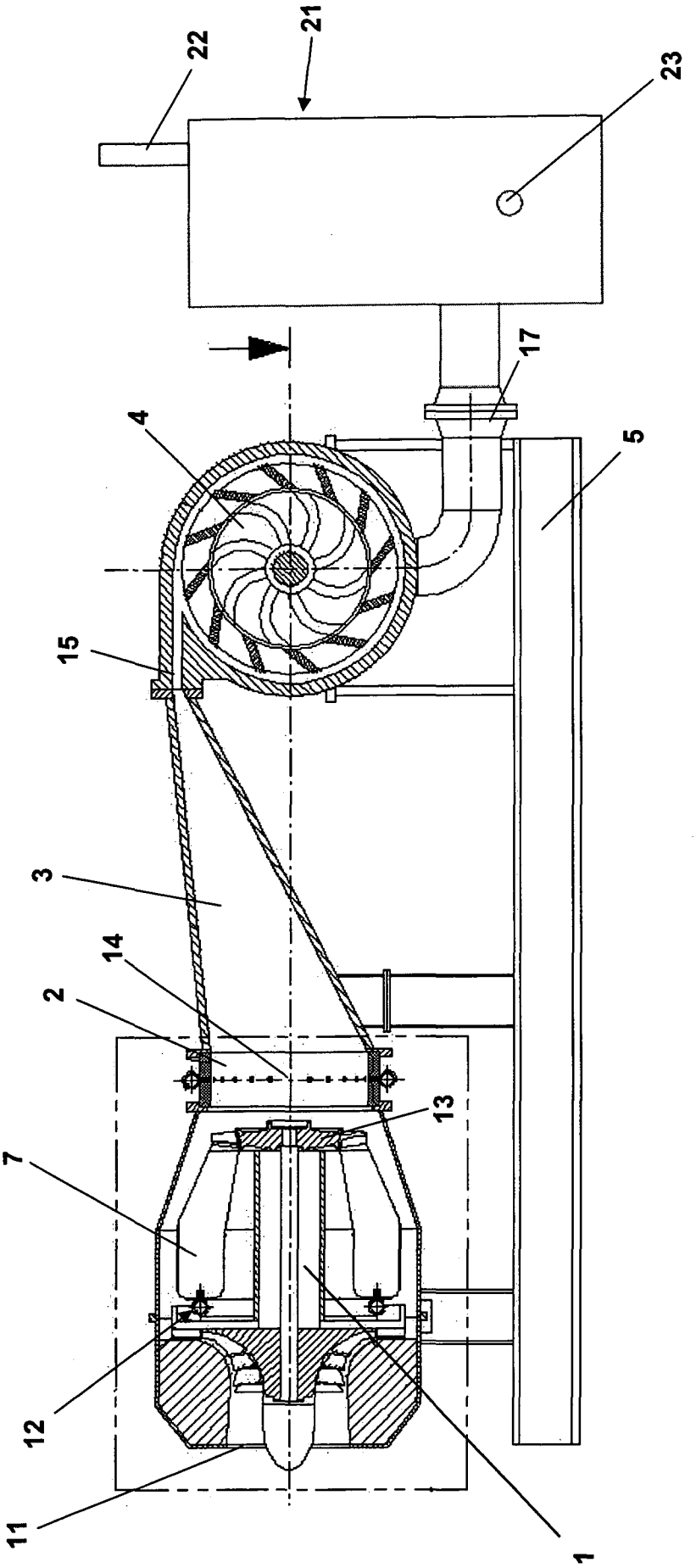

FIG 3

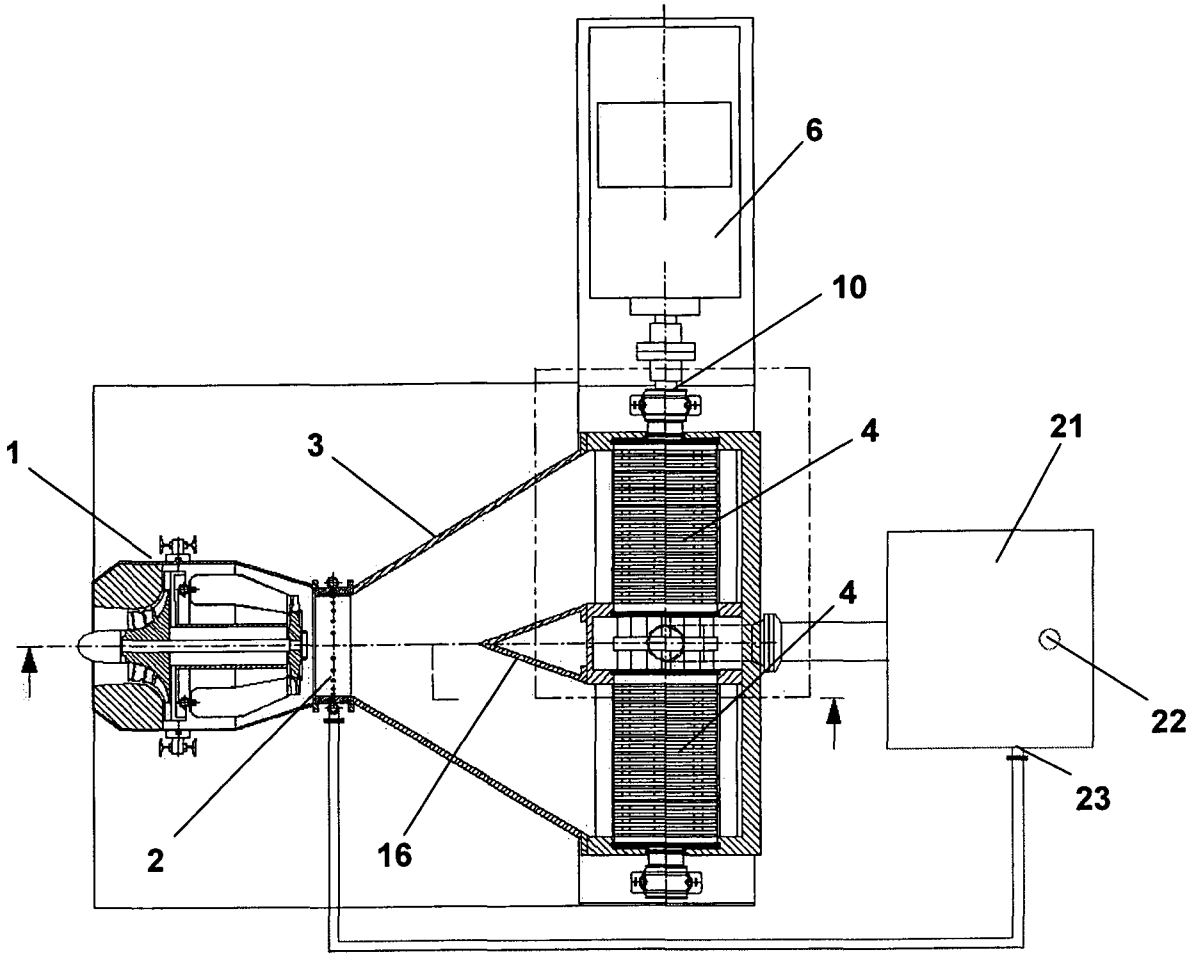

FIG. 4

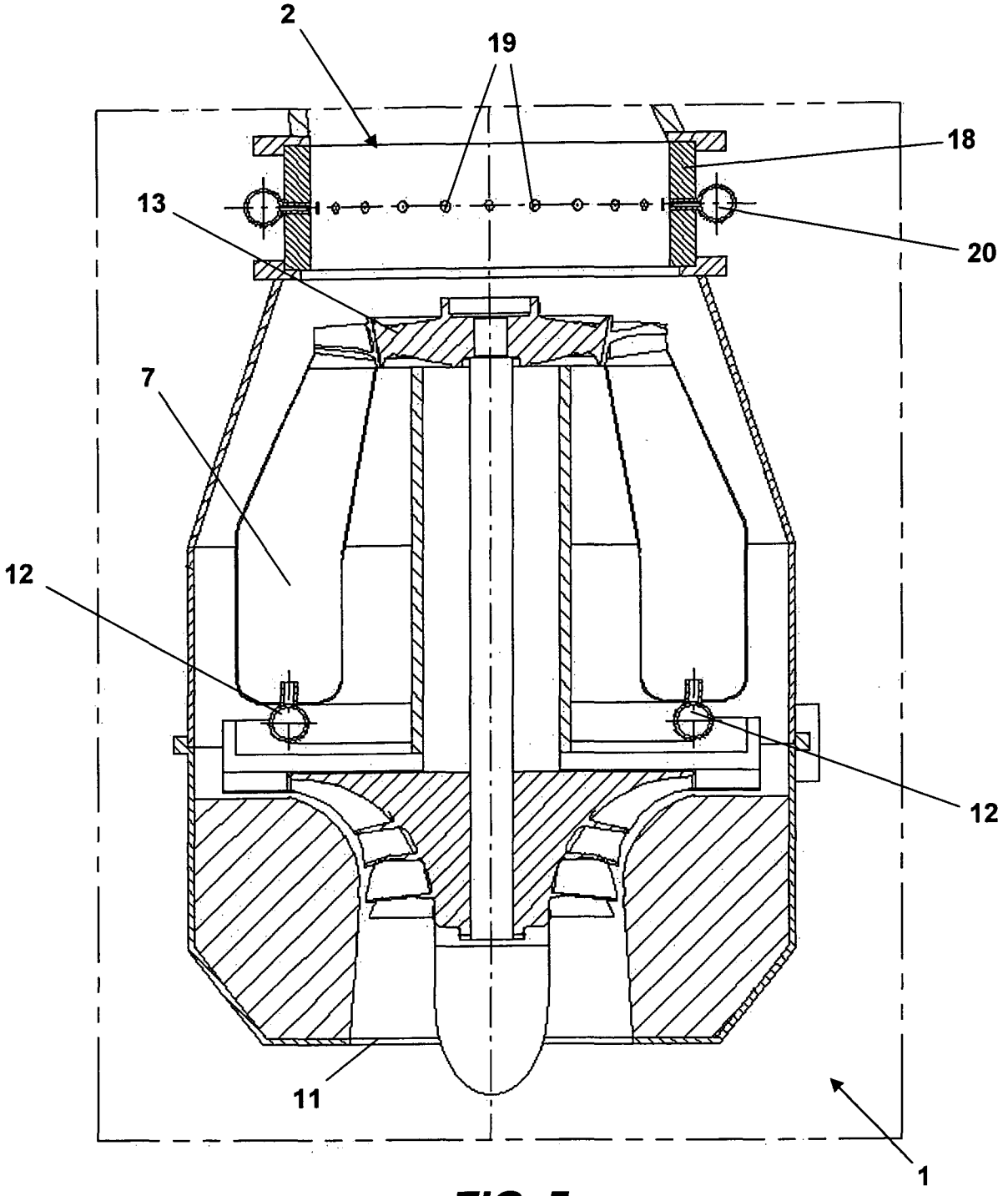

FIG. 5

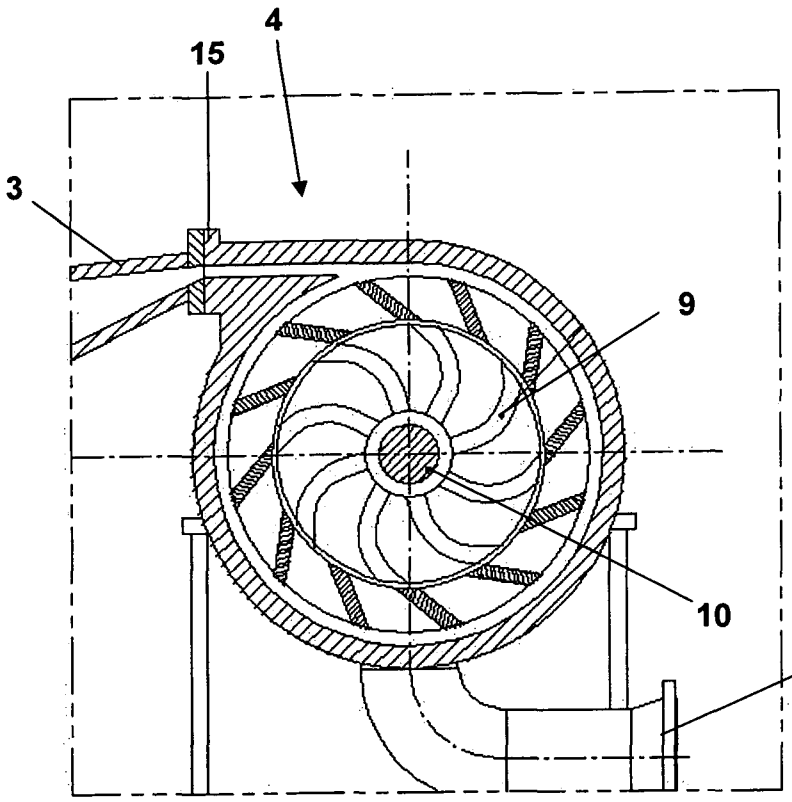

FIG. 6A

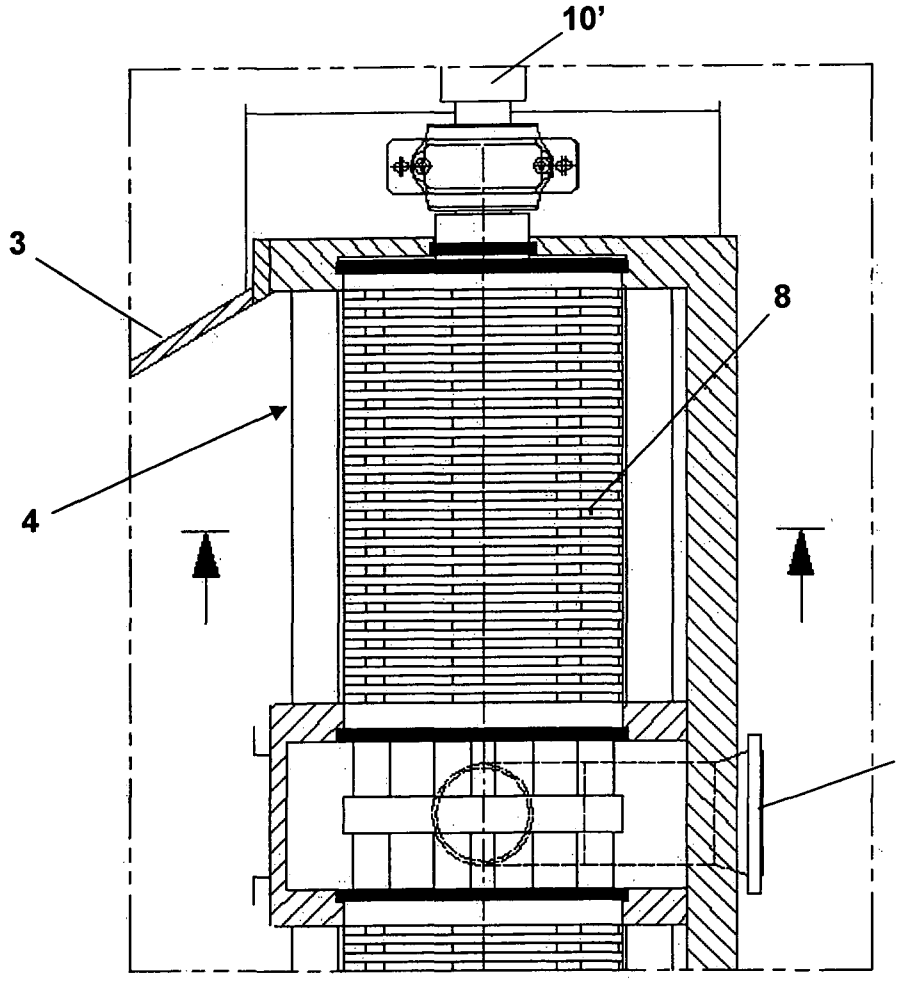

FIG. 6B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BR 2009/000199

A. CLASSIFICATION OF SUBJECT MATTER
IPC[8]: ***F02C 6/00*** (2006.01); ***F01K 21/04*** (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)
IPC[8]: F02C, F01K

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)
EPODOC,WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 3619661 A1 (GREUL) 17 December 1987 (17.12.1987) *Abstract; figure; column 3, lines 41-40; claim 1;* *figure; column 3, lines 41-40; claim 1;* --	1,2,11,15 4,7-10,16
Y	GB 186084 A (TESLA) 25 September 1922 (25.09.1922) *Fig. 1,2; page 2, line 56 - page 3, line 3;* --	4,7,8
Y	GB 186083 A (TESLA) 25 September 1922 (25.09.1922) *Fig. 1; page 4, line 6 - page 5, line 35;* ----	9,10,16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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)
"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
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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