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(72) Inventors:
• **Kropiwnicki, Jacek**
80-365 Gdansk (PL)
• **Skobylko, Marek**
81-194 Gdynia (PL)

(74) Representative: **Pomianek, Grazyna**
Kancelaria Patentowo-Prawna
Grazyna Pomianek
ul. Subisława 23 C lok. 7
80-354 Gdansk (PL)

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(71) Applicant: **Aic Spółka Akcyjna**
81-577 Gdynia (PL)

(54) **A METHOD OF THE FLOW OF A WORKING AGENT IN A HEAT MACHINE BASED ON THE STIRLING CYCLE, AND A HEAT MACHINE BASED ON THE STIRLING CYCLE**

(57) A method of flow of the working agent in a heat machine based on the Stirling cycle is characterized in that the working agent compression and decompression processes take place exclusively in the working chambers, and once the compression and decompression processes are complete, the entire working agent leaves the working chambers, where the transport between the said working chambers takes place at constant volume.

A heat machine based on the Stirling cycle comprising a cold chamber (2) and a hot chamber (1), placed inside of which are impellers (12, 21) fitted with vanes

(13, 20) guided along the inner surfaces of the chambers. The impellers (12, 21) are fitted on a common shaft (4) positioned in the chamber axis. The volumes of the working spaces (14, 19) formed between the said vanes (13, 20) change as the impeller rotates, and the total combined volume of the working spaces of the hot and cold chambers does not change when the spaces are combined, where the compression and decompression of the working agent takes place exclusively in the respective chamber.

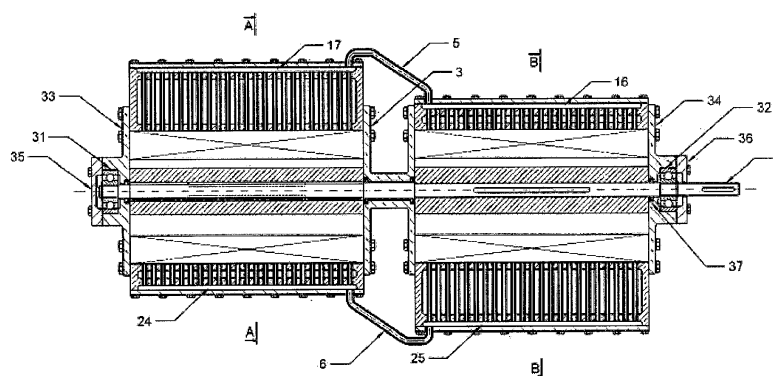


Fig. 3

Description

[0001] The invention concerns a method of the flow of a working agent in a heat machine based on the Stirling cycle, and a heat machine based on the Stirling cycle. In particular, the machine can work in the engine mode, i. e. it can generate mechanical energy, for example for the purpose of generating electrical energy, or it can work in the heat pump mode.

[0002] Known are various structural versions of heat engines working based on the Stirling cycle, which use gas, for example: helium, hydrogen, neon, or air as the working agent. Closed within the working space of the engine is constant volume of the working gas, which takes part in the subsequent engine work cycles. In order to achieve the heat flow the working gas needs to be alternately heated and cooled. The known heat engines based on the Stirling cycle include piston engines, pistonless engines, and vane-type engines. As an externally-powered engine, the Stirling engine can be supplied with heat energy from any source, including such which makes use of solar or geothermal energy.

[0003] Known from patent document US 2017/0045017 A1 is a Stirling engine with vane impeller. The impeller is placed in a casing which comprises the hot part and the cold part, and the two parts are connected to each other and can be arranged in a stack, one on top of the other. The impeller is eccentrically fitted on a power take-off output shaft. The impeller has slots where the vanes are fitted. Each space between the vanes in the hot part is connected to a single space between the vanes in the cold part, thus forming a joint working space. The connection between the cold part and the hot part is achieved by axial channels made in the impeller, the number of which corresponds to the number of vanes, and hence to the number of spaces between the vanes. The engine is fitted with elements for heating and cooling the working agent enclosed in the casing, where the working agent undergoes continuous isothermal decompression and compression at constant volume, thus generating power.

[0004] Known from patent document US 2013/0036732 A1 is a Stirling engine incorporating a casing, inside of which there is a working chamber with an eccentric impeller installed therein with blades guided along the inner surface of the chamber. The heat is supplied and discharged exclusively via the casing, one part of which is cooled and the other one heated.

[0005] It ensues from the working principle of the Stirling engine that the volume of the flow elements, primarily the heater and cooler, and of the elements which connect the space of compression and decompression should be as small as possible. Minimalization of these structural parameters translates to more intensive pressure buildup in the working space when the heat is supplied, and by analogy to more intensive pressure drop during the cooling, which is prerequisite for attaining high efficiency. In connection with the above, the known Stirling engines

described above must be supplied from a high temperature heat source to compensate for the small heat exchange area and at the same time ensure supply of the required amount of heat. The Stirling engine designed for being supplied with a low-temperature energy source, on the other hand, must have an extensive heat exchange area, which can be achieved by using external heat exchangers. Moreover, lower supply temperature can potentially translate to lower efficiency of the engine which means that the proportion of mechanical and hydraulic resistance versus energy production net grows substantially.

[0006] This invention solves the above problems related to the small area of heat exchange, the substantial mechanical resistance, and the adverse heat transfer via the casing, where these problems result in low efficiency of the known Stirling engines.

[0007] The purpose of this invention is achieved by developing a method of the flow of a working agent and a structure of a heat machine based on the Stirling cycle, in which the volume of the flow elements for the working agent is minimized.

[0008] According to this invention, a method of flow of the working agent in a heat machine based on the Stirling cycle is characterized in that the working agent compression and decompression processes take place exclusively in the working chambers, and once the compression and decompression processes are complete, the entire working agent leaves the working chambers, where the transport between the said working chambers takes place at constant volume. Preferably, the flow of the working agent is a one-direction flow.

[0009] The thermodynamic cycle can be either clockwise or anti-clockwise. Preferably, the working agent is heated with low-temperature sources of energy, in particular the solar energy and/or geothermal energy and/or waste energy.

[0010] According to this invention, a heat machine based on the Stirling cycle comprising a cold chamber, placed inside of which is an impeller fitted with vanes which are guided along the inner surface of the cold chamber, and a hot chamber, placed inside of which is an impeller fitted with vanes which are guided along the inner surface of the hot chamber, where the number of vanes in both impellers referred to above is identical, and supplied from two (high and low) sources of heat, as well as featuring technical measures to achieve the flow of the working agent between the said chambers, is characterized in that the hot chamber impeller and the cold chamber impeller are fitted on a common shaft positioned in the axis of the said chambers, and the vanes of the said impellers divide the interiors of the said chambers into working spaces, where the inner surface of the chambers along which the vanes are guided is shaped so that the volumes of the said working spaces change as the impeller rotates, and the total combined volume of the working spaces of the hot and cold chambers does not change when the spaces are combined, where the com-

pression and decompression of the working agent takes place exclusively in the respective chamber.

[0011] Preferably, each of the impellers has four vanes.

[0012] Preferably, the hot and cold chambers are connected to each other with two conduits for the flow of the working agent between the said chambers so that one end of one conduit is connected via a manifold to the ducts for the flow of the working agent of the cold chamber, and the other end of the same conduit is connected via a manifold to the ducts for the flow of the working agent of the hot chamber, where the said ducts of the hot chamber constitute the pipes of a heat exchanger which features an inlet of the hot agent connected to an outlet via the ducts located in the casing of the hot chamber, whereas one end of the other conduit for the flow of the working agent between the said chambers is connected via a manifold to the ducts for the flow of the working agent of the hot chamber, and the other end of the same conduit is connected via a manifold to the ducts for the flow of the working agent of the cold chamber, where the said ducts of the cold chamber constitute the pipes of a heat exchanger which features an inlet of the cold agent connected to an outlet via the ducts located in the casing of the cold chamber.

[0013] Preferably, the cold chamber casing features an inspection flap of the ducts of the cold chamber for the flow of the cold agent, and preferably the hot chamber casing features an inspection flap of the ducts of the hot chamber for the flow of the hot agent.

[0014] The solution according to this invention meets the assumed purposes.

[0015] The invention is shown in embodiments on a drawings, where:

- Fig. 1 presents a heat machine in side view;
- Fig. 2 - a heat machine in front view from the side of the hot chamber;
- Fig. 3 - the heat machine as in Fig. 1, in cross section;
- Fig. 4 - the hot chamber in cross section along the A-A plane, as in Fig. 3, with the direction of the impeller rotations for the specific engine variant marked thereon;
- Fig. 5 - the cold chamber in cross section along the B-B plane, as in Fig. 3, with

the direction of the impeller rotations for the specific engine variant marked thereon.

[0016] An illustrative heat machine based on the Stirling cycle comprises a casing 11 with a cold chamber 2 inside, placed inside of which is an impeller 12 fitted with vanes 13 which are guided along the inner surface of the cold chamber, and a casing 22 with a hot chamber 1 inside, placed inside of which is an impeller 21 fitted with vanes 20 which are guided along the inner surface of the hot chamber. The casing 22 of the hot chamber 2 is connected to the casing 11 of the cold chamber 2 via a coupler 3. The number of vanes in both impellers referred to

above is the same. In the illustrative machine, each impeller has four vanes. The machine is supplied from two sources of heat: the high and low one. The impeller 21 of the hot chamber 1 and the impeller 12 of the cold chamber 2 are fitted on a common shaft 4 located in the axis of the said chambers 2, 1. The shaft sits on two bearings: bearing 31 on the side of the hot chamber, and bearing 32 on the side of the cold chamber, which are placed, correspondingly, in the lid 33 of the hot chamber 1 and the lid 34 of the cold chamber 2. The lid 33 of the hot chamber 1 is fitted with a closing element 35, and the lid 34 of the cold chamber 2 is fitted with a closing element 36. The hot chamber 1 and cold chamber 2 are sealed with the sealing elements 37 placed on the shaft 4. The vanes 13 of the impeller 12 divide the internal space of the cold chamber 2 into working spaces 14, and the vanes 20 of the impeller 21 divide the internal space of the hot chamber 1 into working spaces 19. The number of the working spaces 14, 19 is the same as the number of the vanes 13, 20. The internal surface of the cold chamber 2 along which the vanes 13 are guided when the impeller 12 rotates, and the internal surface of the hot chamber 1 along which the vanes 20 are guided when the impeller 21 rotates are shaped so that the said working spaces 14, 19 of both chambers 2, 1 change their volume as the impeller rotates, and the total combined volume of the working space 19 of the hot chamber 1 and of the working space 14 of the cold chamber 2 does not change when the spaces are combined, where the compression of the working agent and its decompression takes places exclusively in the respective chamber. The hot chamber 1 and cold chamber 2 are connected to each other with two conduits 5, 6 for the flow of the working agent between the said chambers. One end of the conduit 5 is connected via a manifold 16 to ducts 15 for the flow of the working agent of the cold chamber 2, and the other end of the said conduit 5 is connected via a manifold 17 to ducts 18 for the flow of the working agent of the hot chamber 1, where the said ducts 18 of the hot chamber 1 constitute pipes of a heat exchanger fitted with an inlet 7 of the hot agent connected to the outlet 8 of the agent via ducts 29 placed in the casing 22 of the hot chamber 1. On the other hand, one end of the other conduit 6 for the flow of the working agent between the said chambers is connected via a manifold 24 to ducts 23 for the flow of the working agent of the hot chamber 1, and the other end of the conduit 6 is connected via a manifold 25 to ducts 26 for the flow of the working agent of the cold chamber 2, where the said ducts 26 of the cold chamber 2 constitute the pipes of a heat exchanger which is fitted with an inlet 9 of the cold agent connected to an outlet 10 of the same agent via ducts 27 located in the casing 11 of the cold chamber 2.

[0017] In addition, the casing 11 of the cold chamber 2 has an inspection lid 28 of the ducts 27 for the flow of the cold agent, and the casing 22 of the hot chamber 1 has an inspection lid 30 of the ducts 29 for the flow of the hot agent, which enable inspection and cleaning of the

said ducts.

[0018] In the described illustrative embodiment of the heat machine, the flow of the working agent is a one-direction flow, and the working agent compression and decompression processes take place exclusively in the working chambers 1, 2. Once the compression and decompression processes are complete, the entire working agent leaves the working chambers 1, 2, and its transport between the said working chambers takes place at a constant volume, i.e. any increase of the volume is equal to the decrease of the volume of the combined compression and decompression spaces. One of the working agents which can be used is air.

[0019] In illustrative embodiments of the invention the thermodynamic Stirling cycle may be either clockwise, in which case the heat machine plays the function of an engine, or anti-clockwise, in which case the heat machine plays the function of e.g. a heat pump.

[0020] Used to heat the working agent may be low-temperature sources of energy, especially the solar and/or geothermal and/or waste energy.

[0021] The flow of the working agent and the work of the heat machine in the engine function runs as follows.

[0022] The flow of the working agent between the chambers runs in one direction, from the cold chamber 2 to the hot chamber 1 via the conduit 5, and from the hot chamber 1 to the cold chamber 2 via the conduit 6. The engine is supplied from two heat sources: the high and low one. The hot agent which supplies heat from the high source of heat flows in through the inlet 7, and flows out through the outlet 8. The cold agent which releases heat to the low heat source flows in through the inlet 9, and flows out through the outlet 10. In the cold chamber 2, the four vanes 13 of the impeller 12 form four independent working spaces 14 where the working agent is compressed and then transported via the ducts 15 of the cold chamber 2 to the manifold 16 of the cold chamber, and then via the conduit 5 for the flow of the working agent between the chambers to the manifold 17 of the hot chamber 1. From the manifold 17 of the hot chamber 1 the working agent is transported via the ducts 18 of the hot chamber 1, where the ducts 18 play the role of a heater, into the working spaces 19 of the hot chamber 1, where the working spaces 19 are formed between the four vanes 20 of the hot chamber, fitted in the impeller 21, inside the casing 22 of the hot chamber 1. The working agent is cyclically decompressed in the working spaces of the hot chamber 1, and then pumped through the ducts 23 to the manifold 24. From the manifold 24 of the hot chamber 1 the working agent is transported via the conduit 6 for the flow of the working agent between the chambers to the manifold 25 of the cold chamber 2, and then to the working spaces of the cold chamber 2 via the ducts 26 of the cold chamber 2, which play the role of a cooler. The working agent supplied to the working spaces of the cold chamber is cooled with the cooling agent in the ducts 26 of the cold chamber 2, where at the same time the ducts play the role of a heat exchanger. The cold agent

is supplied via the inlet 9, following which it flows through the ducts 27 in the casing 11 of the cold chamber 2 and leaves the device via the outlet 10. Similarly, the working agent supplied to the working spaces of the hot chamber 1 is heated with the hot agent in the ducts 18 of the hot chamber for the flow of the working agent, where at the same time the ducts serve as a heat exchanger. The hot agent is supplied via the inlet 7, following which it flows through the ducts 29 in the casing 22 of the hot chamber 1 and leaves the device via the outlet 8.

[0023] As the result of the one-direction flow of the working agent between the cold chamber 2 and the hot chamber 1, the process of compression can only take place in the cold chamber 2, and the process of decompression in the hot chamber 1. The geometry of chambers 1, 2 is designed so as to ensure that the entire working agent leaves the cold chamber 2 once the compression process is complete. Similarly, the entire working agent leaves the hot chamber 1 once the decompression process is complete. The profiles of the surfaces guiding the vanes 20, 13 of the impellers 21, 12 used both in the hot chamber 1 and cold chamber 2 enable keeping the volume of the working agent constant when transporting the working agent from the working space of the cold chamber 2 to the working space of the hot chamber 1. This means that the cold space decreases in volume during the process at the same rate as the rate at which the hot space increases in volume. Similarly, when the working agent is transported from the working space of the hot chamber 1 to the working space of the cold chamber 2, the volume of the working agent remains constant. This means that the hot space decreases in volume during the process at the same rate as the rate at which the cold space increases in volume.

[0024] The machine works in the engine mode in a cycle of subsequent processes. The working agent gets compressed exclusively in the working space of the cold chamber 2, between the vanes of the impeller 12. The applied solution guarantees minimalization of the workload when carrying out the process. Once the compression process is complete, the working agent is transported from the cold chamber 2 to the hot chamber 1 via the ducts 18 of the hot chamber 1 for the flow of the working agent, where the ducts play the role of a heater. The working agent is transported at constant volume, which, when combined with intensive heat supply in the heater, increases the pressure of the working agent. Thanks to the keeping of constant volume of the working agent the pressure of the working agent increases in the process at the expense of the heat supplied to the heater rather than at the expense of the supplied mechanical work. Once the transport of the working agent from the working space of the cold chamber 2 to the hot chamber 1 is complete, the working agent decompresses, where the entire decompression process takes place in the hot chamber 1, which guarantees maximalization of mechanical energy production in the process. The last process in the cycle consists in the transport of the working

agent from the hot chamber 1 to the cold chamber 2 via the ducts 26 of the cold chamber for the flow of the working agent, where the ducts play the role of a cooler. The working agent is transported at constant volume, which, when combined with intensive heat reception in the cooler, decreases the pressure of the working agent. Because of the fact that the compression process takes place in the range of pressures lower than those which occur in the decompression process, the work done in the cycle is positive. At the same time, thanks to the applied technical solutions the work cycle performed in the engine mode enables practical implementation of the Stirling work cycle, i.e. it is possible to compress the working agent exclusively in the cooled space, heat is supplied at constant volume, decompression is performed exclusively in the heated space, and the heat is discharged at constant volume, too. The listed factors enable the device to reach its highest possible efficiency. The impellers 12, 21 transfer the produced mechanical energy to the shaft 4, which here serves as the transmission shaft. The energy may be used for example to produce electric energy.

[0025] The heat machine may work in the function of a heat pump and then the flow of the working agent and the work of the machine runs as described below. The thermodynamic cycle is anti-clockwise. The direction of rotations of the shaft 4 is opposite to that which occurs when the machine works in the engine function, and the shaft 4 plays the driving function. The working agent flows between the chambers in one direction, from the cold chamber 2 to the hot chamber 1 via the conduit 6, and from the hot chamber 1 to the cold chamber 2 via the conduit 5. The pump is supplied from two sources of heat. The cold agent is supplied via the inlet 9 and discharged via the outlet 10 and represents the source of heat for the heat pump. The hot chamber 1, on the other hand, is cooled with the hot agent supplied via the inlet 7 and discharged via the outlet 8, and used for the purpose of heating. In the cold chamber 2, in the independent working spaces 14 formed between the four vanes 13 of the impeller 12, the working agent is decompressed and then transported via the ducts 26 of the cold chamber 2, where the ducts play the role of a heater by supplying the heat from the low source of heat to the manifold 25 of the cold chamber 2 and then via the conduit 6 to the manifold 24 of the hot chamber 1, from where, via the ducts 23, it flows into the working spaces 19 of the hot chamber 1, where the working spaces are formed between the four vanes 20 of the impeller 21 of the hot chamber 1. In the working spaces of the hot chamber 1 the working agent is cyclically compressed, and then pumped through the ducts 18 which play the role of a cooler into the manifold 17. From the manifold 17 of the hot chamber 1 the working agent is transported via the conduit 5 to the manifold 16 of the cold chamber 2, and then via the ducts 15 to the working spaces of the cold chamber 2. The cold agent, which serves as the source of heat for the heat pump, is supplied via the inlet 9, and then flows through the ducts 27 in the casing 11 of the cold chamber 2 and is dis-

charged via the outlet 10. The hot chamber 1, on the other hand, is cooled with the hot agent used for heating purposes, which is supplied via the inlet 7, then which it flows through the ducts 29 in the casing 22 of the hot chamber 1 and is discharged via the outlet 8. Thanks to the one-direction flow of the working agent between the hot chamber 1 and the cold chamber 2, the compression process can take place exclusively in the hot chamber 1, and the decompression process in the cold chamber 2. Once the compression process is complete, the entire working agent leaves the hot chamber 1. Similarly, once the decompression process is complete, the entire working agent leaves the cold chamber 2. The profiles guiding the vanes 13, 20 of the impellers 12, 21 used both in the cold chamber 2 and the hot chamber 1 enable keeping the volume of the working agent constant when transporting the working agent from the working space of the hot chamber 1 to the working space of the cold chamber 2. This means that the hot space decreases in volume during the process at the same rate as the rate at which the cold space increases in volume. Similarly, when the working agent is transported from the working space of the cold chamber 2 to the working space of the hot chamber 1, the volume of the working agent remains constant. This means that the cold space decreases in volume during the process at the same rate as the rate at which the hot space increases in volume.

[0026] The machine works in the heat pump mode in the following cycle of subsequent processes. The working agent gets decompressed exclusively in the cold chamber 2, between the vanes 13 of the impeller 12. The process is accompanied by a drop in the temperature of the working agent. Once the decompression process is complete, the working agent is transported from the cold chamber 2 to the hot chamber 1 (in the direction opposite to that which occurs in the engine mode) via the ducts 26 of the cold chamber 2, where in this case the ducts play the role of a heater and supply the heat from the low source of heat. The working agent is transported at constant volume, which, when combined with intensive heat supply, increases the pressure and temperature of the working agent. Thanks to the keeping of constant volume of the working agent the pressure of the working agent increases in the process at the expense of the heat supplied to the heater rather than at the cost of the supplied mechanical work. The mechanism enables reducing the mechanical work load required to perform the cycle. Once the transport of the working agent from the cold chamber 2 to the hot chamber 1 is complete, the working agent compresses, where the entire compression process takes place in the hot chamber 1. During the process, the temperature of the working agent increases further. The last process in the cycle consists in the transport of the working agent from the hot chamber 1 to the cold chamber 2 via the ducts 18 of the cold chamber 1, where the ducts play the role of a cooler (i.e. opposite to that in the engine mode). The working agent is transported at constant volume, which, when combined with intensive

heat reception in the cooler, decreases the pressure and temperature of the working agent. The heat received from the ducts 18 of the hot chamber 1 is transferred by the hot agent for heating purposes. Because of the fact that the compression process takes place in the range of pressures higher than those which occurs in the decompression process, the work done in the cycle is negative, and to operate, the device needs mechanical work supplied from the outside via the shaft 4 which in this case plays the driving function.

List of numerical references

[0027]

- 1 - hot chamber
- 2 - cold chamber
- 3 - coupler between the chambers
- 4 - shaft
- 5, 6 - conduits for the flow of the working agent between the chambers
- 7 - inlet of the hot agent
- 8 - outlet of the hot agent
- 9 - inlet of the cold agent
- 10 - outlet of the cold agent
- 11 - casing of the cold chamber
- 12 - impeller of the cold chamber
- 13 - vane of the cold chamber
- 14 - working space of the cold chamber
- 15, 26 - ducts of the cold chamber for the flow of the working agent
- 16, 25 - manifolds of the cold chamber for the flow of the working agent
- 17, 24 - manifolds of the hot chamber for the flow of the working agent
- 18, 23 - ducts of the hot chamber for the flow of the working agent
- 19 - working space of the hot chamber
- 20 - vane of the hot chamber
- 21 - impeller of the hot chamber
- 22 - casing of the hot chamber
- 27 - ducts of the cold chamber for the flow of the cold agent
- 28 - inspection flap of the cold chamber
- 29 - ducts of the hot chamber for the flow of the hot agent
- 30 - inspection flap of the hot chamber
- 31, 32 - shaft bearings
- 33 - lid of the hot chamber
- 34 - lid of the cold chamber
- 35 - closing element of the hot chamber
- 36 - closing element of the cold chamber
- 37 - sealing element of the chambers

Claims

1. A method of flow of the working agent in a heat machine based on the Stirling cycle **characterized in**

that the working agent compression and decompression processes take place exclusively in the working chambers, and once the compression and decompression processes are complete, the entire working agent leaves the working chambers, where the transport between the said working chambers takes place at constant volume.

2. The method according to Claim 1, **characterized in that** the flow of the working agent is a one-direction flow.

3. The method according to Claims 1 or 2, **characterized in that** the thermodynamic cycle is clockwise.

4. The method according to Claims 1 or 2, **characterized in that** the thermodynamic cycle is anti-clockwise.

5. The method according to any of the Claims 1 to 4, **characterized in that** the working agent is heated with low-temperature sources of energy, in particular the solar energy and/or geothermal energy and/or waste energy.

6. A heat machine based on the Stirling cycle comprising a cold chamber, placed inside of which is an impeller fitted with vanes which are guided along the inner surface of the cold chamber, and a hot chamber, placed inside of which is an impeller fitted with vanes which are guided along the inner surface of the hot chamber, where the number of vanes in both impellers referred to above is identical, and supplied from two (high and low) sources of heat, as well as featuring technical measures to achieve the flow of the working agent between the said chambers, **characterized in that** the impeller (21) of the hot chamber (1) and the impeller (12) of the cold chamber (2) are fitted on a common shaft (4) positioned in the axis of the said chambers (2, 1), and the vanes (13, 20) of the said impellers (12, 21) divide the interiors of the said chambers (2, 1) into working spaces (14, 19), where the inner surface of the chambers (2, 1) along which the vanes (13, 20) are guided is shaped so that the volumes of the said working spaces (14, 19) change as the impeller rotates, and the total combined volume of the working spaces of the hot and cold chambers does not change when the spaces are combined, where the compression and decompression of the working agent takes place exclusively in the respective chamber.

7. The machine according to Claim 6, **characterized in that** each of the impellers (12, 21) has four vanes (13, 20).

8. The machine according to Claim 6, **characterized in that** the hot chamber (1) and the cold chamber

(2) are connected to each other with two conduits (5, 6) for the flow of the working agent between the said chambers so that one end of one conduit (5) is connected via a manifold (16) to the ducts (15) for the flow of the working agent of the cold chamber (2), and the other end of the same conduit (5) is connected via a manifold (17) to the ducts (18) for the flow of the working agent of the hot chamber (1), where the said ducts (18) of the hot chamber (1) constitute the pipes of a heat exchanger which features an inlet (7) of the hot agent connected to an outlet (8) via the ducts (29) located in the casing (22) of the hot chamber (1), whereas one end of the other conduit (6) for the flow of the working agent between the said chambers is connected via a manifold (24) to the ducts (23) for the flow of the working agent of the hot chamber (1), and the other end of the same conduit (6) is connected via a manifold (25) to the ducts (26) for the flow of the working agent of the cold chamber (2), where the said ducts (26) of the cold chamber (2) constitute the pipes of a heat exchanger which features an inlet (9) of the cold agent connected to an outlet (10) via the ducts (27) located in the casing (11) of the cold chamber (2).

9. The machine according to Claim 8, **characterized in that** the casing (11) of the cold chamber (2) features an inspection flap (28) of the ducts (27) of the cold chamber for the flow of the cold agent.

10. The machine according to Claim 8, **characterized in that** the casing (22) of the hot chamber (1) features an inspection flap (30) of the ducts (29) of the hot chamber (1) for the flow of the hot agent.

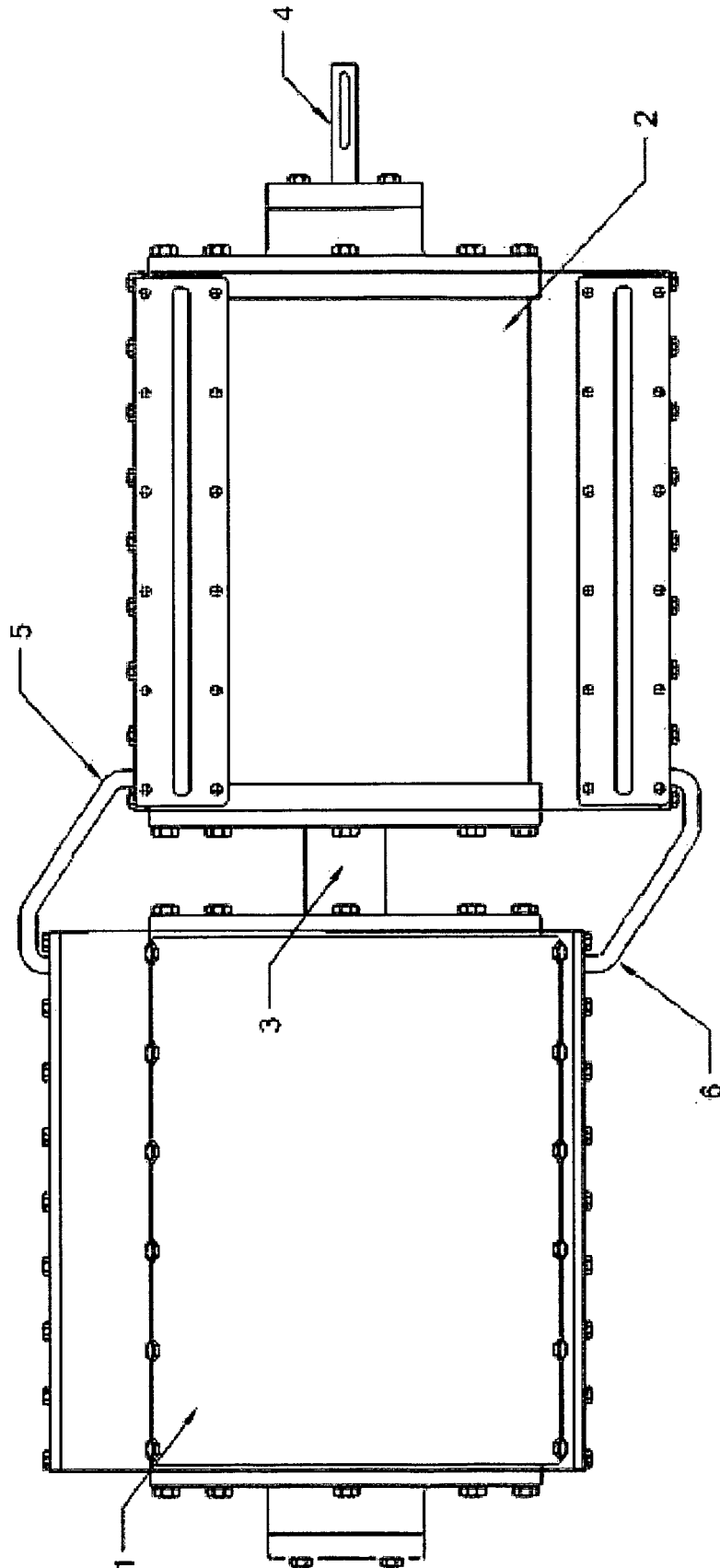


Fig. 1

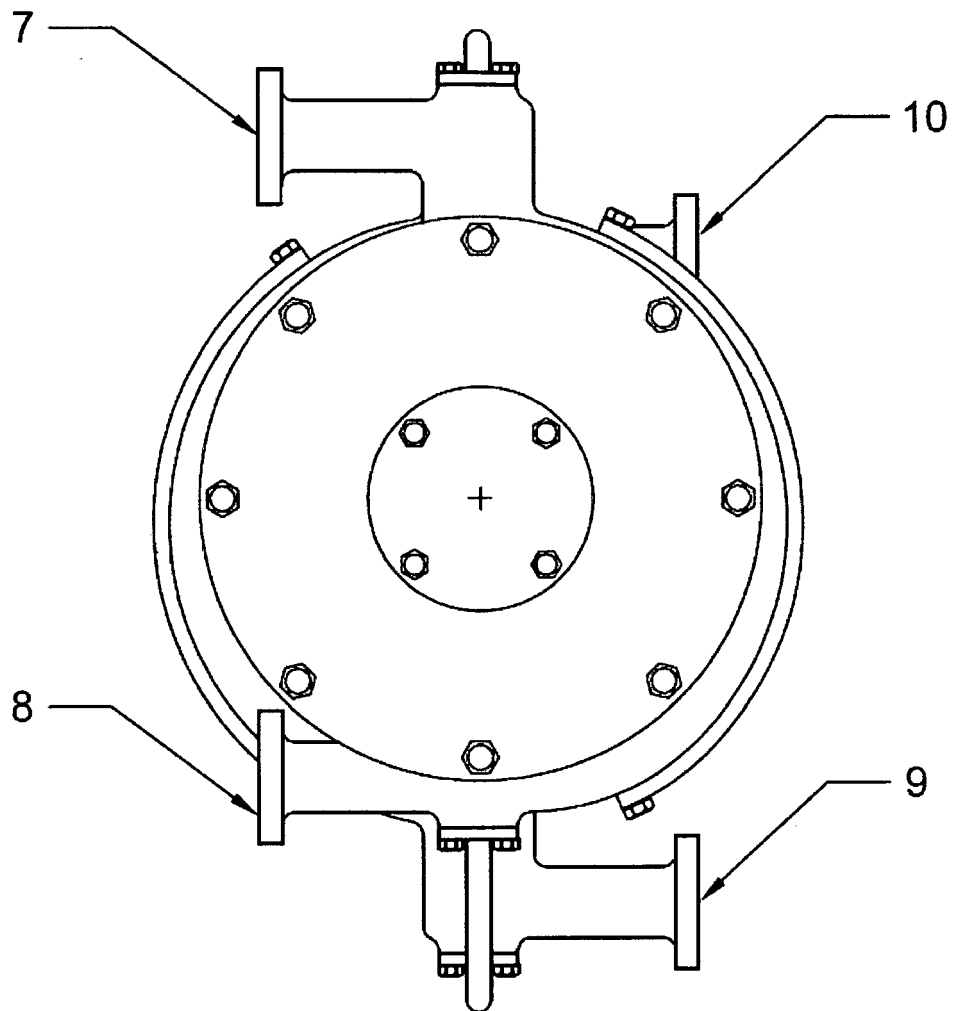
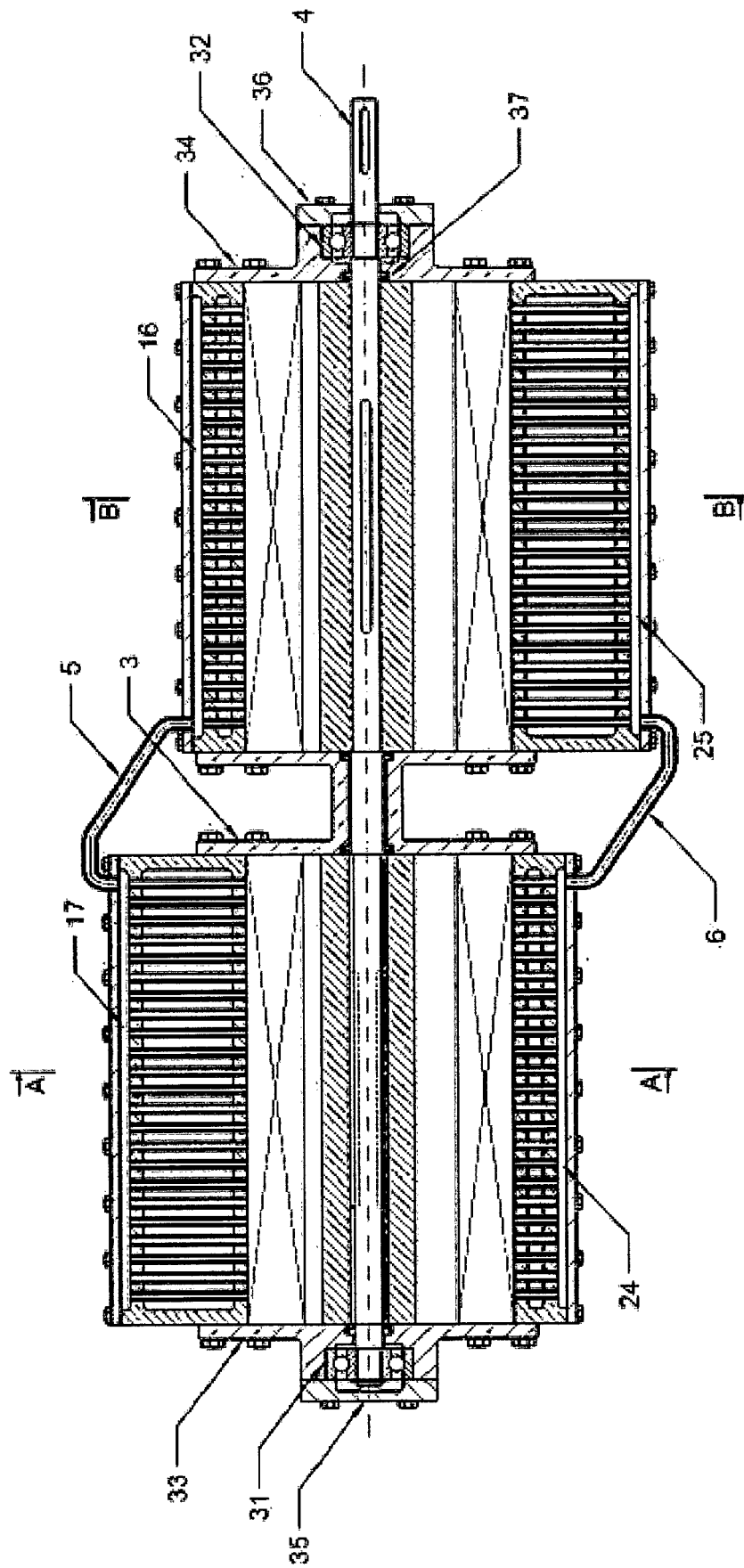


Fig. 2



File

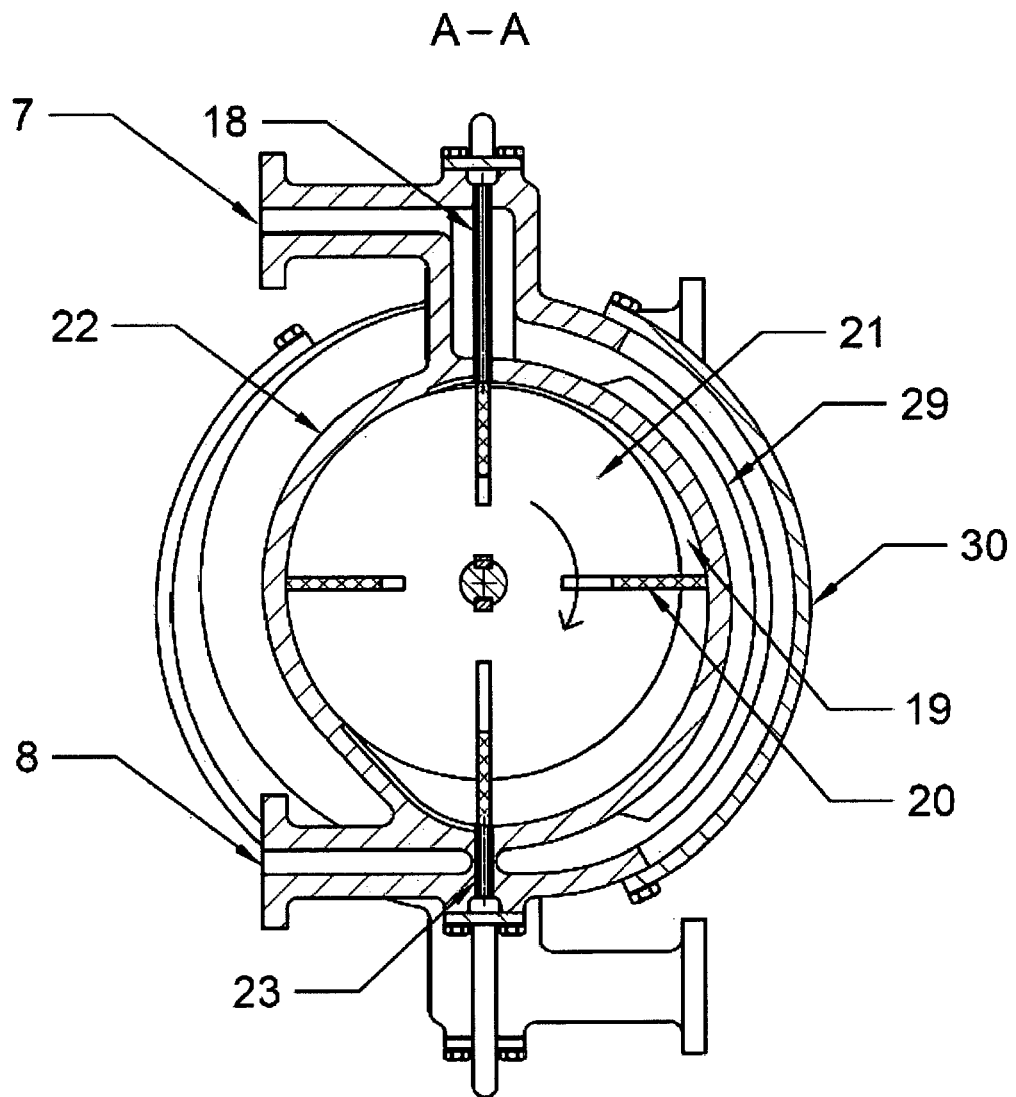


Fig. 4

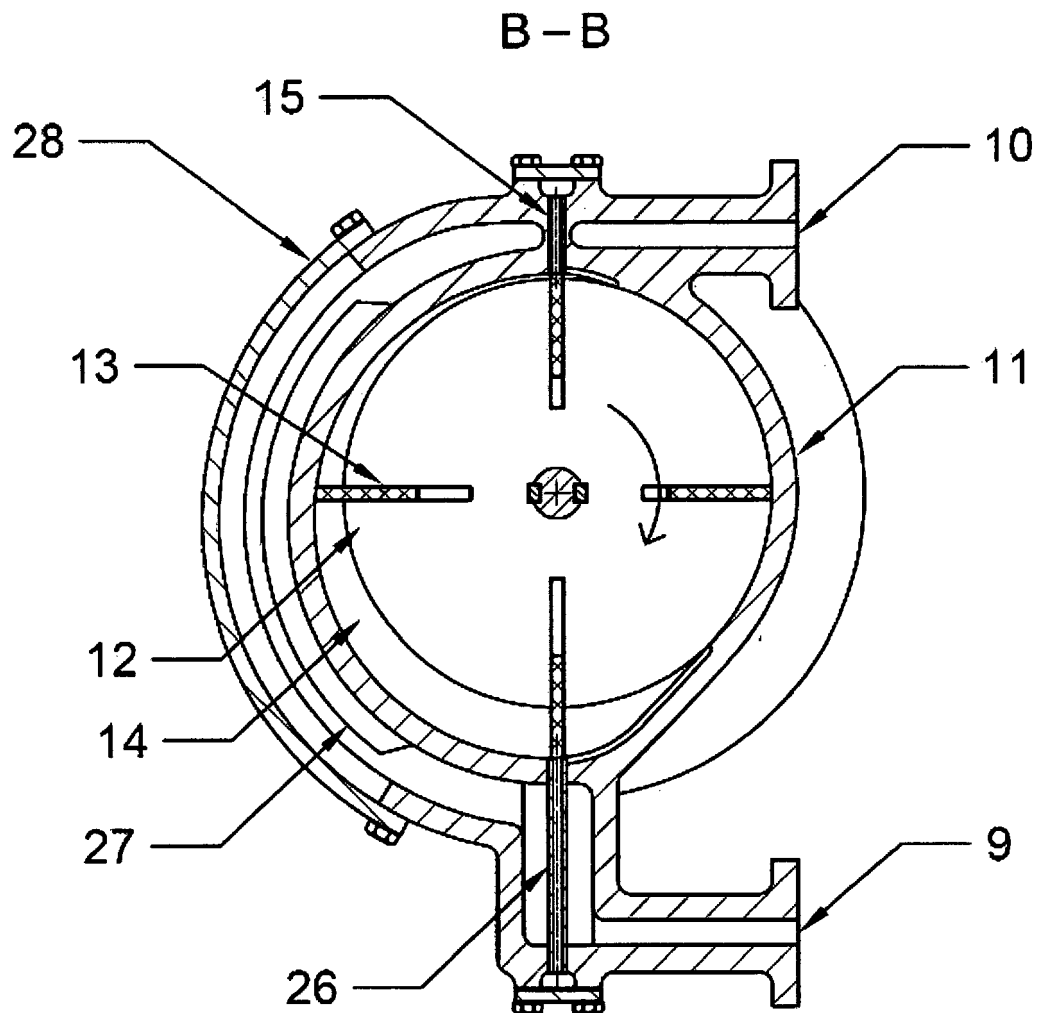


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 22 46 0073

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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