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(54) INTERNAL COMBUSTION ENGINE AND GENERATOR FOR ELECTRICAL POWER SUPPLY

BRENNKRAFTMASCHINE UND GENERATOR FÜR VERSORGUNG MIT ELEKTRISCHEM STROM

MOTEUR À COMBUSTION INTERNE ET GÉNÉRATEUR POUR L'ALIMENTATION EN PUISSANCE ÉLECTRIQUE

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(73) Proprietor: **Liebherr-Components Colmar SAS**
68025 Colmar Cedex (FR)

(72) Inventors:
- **TISSOT, Jean-François**
  68750 Bergheim (FR)
- **KIEFFER, Julien**
  67500 Haguenau (FR)

(74) Representative: **Behr, Wolfgang**
Lorenz Seidler Gossel
Rechtsanwälte Patentanwälte
Partnerschaft mbB
Widenmayerstraße 23
80538 München (DE)

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Description

[0001] The present invention is directed to an electrical power supply comprising a generator and an internal combustion engine driving the generator.

[0002] In such systems, the engine usually comprises a turbo-charger with a turbine connected to an exhaust manifold of the engine and a compressor driven by the turbine and connected to an intake manifold of the engine for providing the engine with pressurized air, in order to improve the fuel efficiency and/or output power of the engine.

[0003] Such electrical power supplies may for example be used as an emergency power supply, for example for hospitals. In such a situation, once there is an emergency power out, the engine has to quickly start operating to provide the emergency power. In particular, the US standard NFPA 110 requires the engine to reach a synchronization speed of 1800 rpm within 10 seconds. Therefore, the engine has to start and has to overcome the inertia of its own crank shaft and of the rotor of the generator in order to reach this synchronization speed in a short time. After the synchronization speed has been reached, the electronics of the generator will have three seconds to achieve synchronization. After this, the emergency power is switched on. Before synchronization, there is no load on the engine, only the inertia and inner resistance of the engine and the generator are relevant. During synchronization, there is only a small additional load. After switch on of the power, there will be the full load on the system.

[0004] The nominal speed of the engine is 1800 rpm, corresponding to 60 Hz alternating current used in the US. After switch on, the actual speed will drop for about 100 rpm below the nominal speed, and the engine will need some time to reach again the nominal speed.

[0005] An electrical power supply according to the preamble of claim 1 is known from WO 2016/172748.

[0006] Documents US 2008/173017 A1, US 1 375 931 A, US 1 802 720 A, GB 2 129 056 A, US 4 154 060 A, US 4 760 703 A, JP S59 160025 A, EP 3 009 631 A1 and DE 10 2014 006019 A1 show engines.

[0007] The present invention is directed to improve the operation of the engine during full load and to achieve a quick increase of the rotation speed on start-up of the engine to synchronization speed and/or a quick recovery to nominal speed after switching on of the power.

[0008] This object is solved by an electrical power supply according to claim 1. Preferred embodiments of the present invention form the subject matter of the dependent claims.

[0009] The present invention comprises an electrical power supply comprising a generator and an internal combustion engine driving the generator, the engine comprising a turbo-charger with a turbine connected to an exhaust manifold of the engine and a compressor driven by the turbine and connected to an intake manifold of the engine for providing the engine with pressurized air. The invention is characterized in that the engine has an opening device for opening a high pressure side of the air intake system downstream of the compressor to atmosphere, such that the engine can breathe air at atmospheric pressure when the opening device is open. This makes it possible to operate the engine as a suction engine in operation phases where the compressor would otherwise act as a restriction.

[0010] The present invention thereby makes it possible to design the turbo charger such that it has optimal behavior during load conditions. In particular, the design of the turbo-charger does no longer have to take into account no-load conditions and/or the start-up phase of the engine. Therefore, a high specific power, i.e. a high power per liter of displacement volume, can be provided, because the turbocharger can be allowed to act during no-load conditions and/or during the startup phase as a restriction.

[0011] In particular, the opening device may be adapted to open during an operation phase where the compressor forms a restriction for the suction of the engine.

[0012] During start up, the piston engine does not yet provide sufficient exhaust gas energy to drive the turbine of the turbo charger at high speed, such that the compressor will not provide sufficient air, and therefore can form a restriction on the air intake in comparison with a suction engine. The present invention therefore opens the high pressure side of the engine to the atmosphere during the startup phase, to allow more air to go into the engine.

[0013] The electrical power supply of the present invention preferably is an emergency power supply and/or comprises an emergency startup-function.

[0014] The opening to the atmosphere will have the advantage that the synchronization speed is reached more quickly. Further, also after the high pressure side is again closed with respect to the atmosphere, there are advantages. In particular, the speed of the turbocharger will already be higher, because there was more exhaust gas power. This will lead to a quicker loading of the engine, i.e. it will be quicker to reach maximum boost pressure. Therefore, after switching on the electrical power generation, the drop in speed will be more quickly recovered and the initial load behavior of the engine will be improved.

[0015] According to the present invention, the opening device is adapted to open in reaction to a time condition, wherein the opening device is opened immediately on startup of the engine and kept open for a time interval sufficient for the engine to reach synchronization speed.

[0016] According to the present invention, the opening device is adapted to open during a specified time interval after start-up of the engine. For example, the time interval may have a length of between 2 seconds and 30 seconds.

[0017] The opening device is preferably closed before electrical power generation is switched on and/or before the full load is applied to the engine. This is because during a high load condition, the turbo charger will be

effective and necessary to recover nominal speed.

[0018] The main advantage of the time condition is that the intake manifold can be immediately opened to the atmosphere on start. With a pressure condition, in contrast, the opening will only take place after the engine has started sucking and received some resistance from the compressor of the turbo charger.

[0019] Because the behavior during start is known, since a time condition is used, it is not necessary to link the control of the opening device to the pressure in the intake manifold.

[0020] The opening device of the present invention may comprise a drive mechanism that is electronically controlled. The drive mechanism may for example be an electromagnetic drive.

[0021] The drive mechanism may be controlled in dependence on a time condition.

[0022] The opening device can for example be provided by a valve or flap. Preferably, the opening device is a one-way valve or a one-way flap.

[0023] The opening device may be adapted to be closed under high pressure conditions on the high pressure side of the air intake system and/or after start-up.

[0024] After the opening device has been closed, it will preferably stay closed for the entire operation of the engine, and only be opened again once there is a new start.

[0025] Preferably, the opening device is designed such that it is closed mechanically under high pressure conditions on the high pressure side.

[0026] Therefore, even in case that the opening device is controlled to open and close electronically, for example on a time basis, in case that there is a failure in the control, the mechanical construction will make sure that the high pressure side is closed at least under high pressure conditions, such that the turbocharger can work properly.

[0027] The opening device may comprise two stages for providing redundancy. In particular, there may be two stages that both have to open in order to open the high pressure side to atmosphere. This redundancy makes it more unlikely that the high pressure side will remain open during high load conditions.

[0028] In a first variant, the opening device may have a separate air inlet, preferably comprising an air filter.

[0029] In a second variant, the opening device may bypass the compressor, wherein the compressor and the opening device receive air from a main air inlet. Preferably, the main air inlet comprises an air filter.

[0030] In a preferred embodiment, the high pressure side of the intake air system of a turbocharged engine may be one or more of the following components:

- a duct between compressor and charge air cooler;
- a charge air cooler (which reduces the compressed air temperature to further increase its density);
- a duct between charge air cooler and intake receiver;
- an intake manifold.

[0031] The opening device may be arranged in any one of these components, and provide an opening of this component to atmosphere.

[0032] The opening to atmosphere may be provided directly, or by providing an opening to a component of the low pressure side of the air intake system downstream of the compressor.

[0033] For example, the opening device may provide an opening between

- directly atmosphere and intake manifold;
- upstream and directly downstream of the compressor;
- upstream of the compressor and intake manifold.

[0034] If there is an additional air inlet, it can be arranged in any position relative to the intake manifold. For example, it may be arranged at the opposite side of the intake manifold with respect to the inlet from the compressor of the turbo charger. Further, it could equally be arranged for example in the middle of the intake manifold. Further, if a V-engine with two separate intake manifolds is used, two additional air inlets, one for each intake manifold, can be used, or an additional air inlet can be arranged in a bridge between the two intake manifolds.

[0035] In a preferred embodiment, the engine has an output power of between 100 kW to 10 MW, preferably between 500 kW and 10 MW.

[0036] In a preferred embodiment, the engine has between 2 liters and 200 liters of total displacement, preferably between 15 liters and 200 liters of total displacement.

[0037] In a preferred embodiment, the rotor of the generator is directly coupled to the crank shaft of the engine.

[0038] In particular, the generator can be directly coupled to the crank shaft without an additional bearing for the rotor of the generator between the engine and the rotor.

[0039] Further, the present invention comprises a method for operating an internal combustion engine of an electrical power supply as described above, the engine comprising a turbo-charger with a turbine connected to an exhaust manifold of the engine and a compressor driven by the turbine and connected to an intake manifold of the engine for providing the engine with pressurized air. According to the invention, a high pressure side of the air intake system downstream of the compressor is opened to atmosphere, such that the engine can breath air at atmospheric pressure.

[0040] The method has the same advantages as described above. Preferably, the method is performed as discussed above with respect to the inventive engine and/or electrical power supply.

[0041] The present invention is now described with re-

spect to specific embodiments and figures.

[0042] The figures show:

Fig. 1a: a schematic drawing of an embodiment of an electrical power supply of the present invention,

Fig. 1b: a first embodiment of an internal combustion engine of the present invention, with the opening device arranged in the intake manifold at a middle position,

Fig. 2a/b: a first embodiment of an opening device not claimed in the present invention in an opened state (Fig. 2a) and a closed state (Fig. 2b),

Fig. 3: a first embodiment of an opening device of the present invention, which is electronically controlled,

Fig. 4: a further embodiment of an opening device not claimed in the present invention using a flap, in a closed state and an opened state,

Fig. 5: a second embodiment of an opening device of the present invention providing redundancy, in a closed state and an opened state,

Fig. 6: a second embodiment of an inventive engine, with the opening device arranged at end of the intake manifold opposite the connection to the compressor,

Fig. 7a: a third embodiment of an engine of the present invention where the opening device is arranged in a bypass of the compressor,

Fig. 7b: a fourth embodiment of an engine of the present invention where the opening device is arranged in a bypass between the main air inlet and the manifold, and

Fig. 8: a fifth embodiment of an engine of the present invention where the engine has a two-stage turbocharging arrangement.

[0043] Fig. 1 shows, in schematic form, an embodiment of an electric power supply according to the present invention. The power supply comprises an internal combustion engine 1 and an electrical generator 2, driven by the internal combustion engine 1. A rotor of the electrical generator 2 is connected to the shaft 3 of the engine 1 for this purpose. For example, the rotor may be directly coupled to the shaft 3 of the engine 1.

[0044] Fig. 2 shows an embodiment of an internal combustion engine 1 of the present invention in more detail. The internal combustion engine may for example be Diesel or a gas engine. The internal combustion engine 1 may be used in an electrical power supply of the present invention, or for other purposes.

[0045] The engine 1 comprises a number of cylinders 21, the cylinders being supplied with air by an intake manifold 11 connected to air inlets 20 of the cylinders. Exhaust gas from the cylinders 21 is discharged by exhaust outlets 22 of the cylinders 21 connected to an exhaust manifold 10.

[0046] The engine 1 is equipped with a turbocharger 4, comprising a turbine 5 and a compressor 6 driven by the turbine 5.

[0047] The inlet of the turbine 5 is connected to the exhaust manifold 10, and driven by the exhaust gas provided by the cylinders 21 of the engine 1. The turbine 5 has a turbine gas outlet 9 for discharging the exhaust gases.

[0048] The compressor 6 has a low pressure inlet connected to the main air inlet 7 of the engine, and a high pressure outlet connected to the intake manifold 11. The air intake system of the engine therefore comprises at least the main air inlet 7, the compressor 6, the intake manifold 11 and any component connecting these elements. The low pressure side of the air intake system comprises the air inlet 7 and the low pressure duct 28 connecting it to the low pressure inlet of the compressor 6. The high pressure side comprises at least any duct 27, 29 connecting the high pressure outlet of the compressor 6 with the intake manifold 11 and the intake manifold 11.

[0049] In the embodiment, the high pressure outlet of the compressor 6 is connected to the intake manifold 11 via the charged air cooler 8. In particular, the high pressure outlet of the compressor 6 is connected to the charged air cooler 8 by high pressure duct 27, and the charged air cooler 8 is connected to the intake manifold 11 by a high pressure duct 29. Therefore, the high pressure side of the air intake system comprises the ducts 27 and 29, the charged air cooler 8 and the intake manifold 11.

[0050] In a turbocharged engine, the exhaust gas of the engine will drive the turbine 5, which in turn drives the compressor 6 for providing charged high pressure air to the intake manifold 11. In a usual configuration, the shaft of the turbine 5 is mechanically linked to the shaft of the compressor 6. In particular, the turbine 5 and the compressor 6 may be arranged on the same shaft.

[0051] If the electric network is down, an electric generator powered by an engine has to start and reach a speed high enough to be synchronized with the network within a limited time. This time can be under 7s to make the engine able to fulfill the American standard "NFPA 110". To reach this target and during this sequence, the engine needs to breathe the biggest quantity of air so that it can burn the biggest quantity of fuel. The result will be a higher pressure on the pistons which will help to fight the engine and alternator inertia.

[0052] However if the engine is turbocharged, the compressor 6 of the turbocharger 4 positioned within the air intake system may become a restriction, when the engine 1 doesn't provide enough exhaust gas energy to its respective turbine 5 to drive it with a sufficient rotational speed. This consequently can reduce the delivered air quantity into the cylinders.

[0053] Vacuum values worse than 100 mbar under atmospheric pressure have been measured during some

tests of emergency start on electric generators powered by turbocharged Diesel engines. This is in particular the case if a high specific power is provided by a strong turbocharger.

[0054] The present invention therefore provides an opening device 12, , which can open the high pressure side of the air intake system of the turbocharged engine 1 to the atmosphere, to allow more air to go into the cylinders 21 if necessary.

[0055] The air can therefore bypass the turbocharger(s) 4 and the engine 1 doesn't have to fight the air restriction from the compressor(s) 6 when these are rotating too slowly. In particular, the engine has the possibility to breath directly into the atmosphere when
[Pressure intake manifold] < [Atmospheric Pressure],
for example.

[0056] The opening device can be arranged at any desired position within the high pressure side of the air intake system. In the embodiment, the opening device can for example be arranged anywhere in the high pressure duct 27 connecting the high pressure outlet of the compressor 6 with the charge air cooler 8, the high pressure duct 29 connecting the charge air cooler 8 with the intake manifold 11, and the intake manifold 11.

[0057] Further, the opening device may either have a separate air inlet, and therefore open directly to the atmosphere, or may be connected to the low pressure side of the air intake system and therefore be connected to the atmosphere via the main air inlet 7 also used by the compressor 6.

[0058] The embodiment shown in Fig. 1b, the opening device 12 is arranged in the intake manifold 11 and has its own air inlet provided with an air filter 13. In the specific embodiment shown, the opening device 12 is arranged in a middle position of the intake manifold 11. Alternative configurations are possible, as will be described later on.

[0059] Fig. 2 shows a first embodiment not claimed in the present application. The opening device is arranged between the high pressure side 14 of the air intake system and a low pressure side 18, formed by a low pressure side of the air intake system or the atmosphere. In the embodiment, the opening device opens directly to atmosphere and comprises an air filter 13. However, in alternative arrangements, the opening device may also use the main air inlet 7.

[0060] In the embodiment shown in Fig. 2, the opening device is operated by the pressure difference between the low pressure side 18 and the high pressure side 14. In particular, due to its mechanical construction, if the pressure on the high pressure side 14 falls below the pressure on the low pressure side 18, the opening device will open to allow air to flow through the opening device from the low pressure side 18 to the high pressure side 14. This is shown in Fig. 2a. In contrast, if the pressure on the high pressure side 14 is higher than the pressure on the low pressure side 18, the opening device will close, to isolate the high pressure side from the pressure side 18, as shown in Fig. 2b.

[0061] In the embodiment, the opening device comprises a valve element 15 that is urged by spring 16 against a valve seat 17 for closing the opening device. Once the pressure difference between the low pressure side 18 and the high pressure side 14 is high enough to overcome the spring force of spring 16, the valve will open, allowing air from the low pressure side 18 to flow through the opening device to the high pressure side 14 of the air intake system.

[0062] In an alternative embodiment, the spring 16 could preload the valve 15 into an open position. This would guarantee that during start of the engine, the high pressure side 14 of the air intake system is already open to atmosphere. Once the turbo-charger starts to work properly, the increased pressure on the high pressure side will overcome the spring force of the spring and close the valve.

[0063] Fig. 3 shows a first embodiment of an inventive opening device. The opening device of Fig. 3 comprises a drive mechanism 19 for opening and closing the valve. The drive mechanism is preferably controlled electronically. In the embodiment shown in Fig. 3, the same construction using a valve 15 and a valve seat 17 is used as in Fig. 2, with the spring 16 being replaced by the drive 18 for operating the valve element 15.

[0064] Preferably, if the opening device is electronically controlled, the electronic control is performed on the basis of a time condition. In particular, the opening device can be opened immediately on startup of the engine, and be kept open for a time interval sufficient for the engine to reach synchronization speed. Preferably, the time interval in which the opening device is open is short enough that the opening device will be closed before the electrical power generation is switched on, and a high load is applied to the engine. This guarantees that during the high load condition, the turbocharger is effective to charge the engine with high pressure air. Because of the mechanical construction shown in Fig. 3, even if the drive mechanism 19 has a failure, the high pressure on the high pressure side 14 provided by the turbocharger will close the valve element 15 against the valve seat 17.

[0065] Fig. 4 shows a further embodiment of an opening device not claimed. In this opening device, the valve element 14 and the valve seat 17 are replaced by a flap 23 and a gasket 25. In particular, the flap 23 is pivotally arranged on a pivot axis 24. If the pressure on the high pressure side is higher than on the low pressure side, the flap 23 will be urged against the gasket 25, closing the high pressure side. If the pressure on the low pressure side 18 is higher than on the high pressure side 14, the flap 23 will open, allowing the engine to breathe through the opening device.

[0066] In the embodiment shown in Fig. 4, the opening device is arranged on the intake manifold, and has a separate air inlet with an air filter 13. The upper image shows the opening device in a closed state, i.e. when high pressure is provided by the turbocharger. The lower drawing in Fig. 4 shows the opening device in an open state,

where air enters into the air intake manifold 11 by the opening device to flow to the air inlets 20 of the cylinders 21.

[0067] In the embodiment shown in Fig. 4, the opening device is arranged on the intake manifold 11 at a position opposite to the duct 29 connecting the air intake manifold 11 with the compressor 6. Alternative arrangement of the open device are possible, as described above.

[0068] For safety reasons, knowing that in some cases the generators are an important power source, for example in hospitals, the opening device can be duplicated to be redundant. This optional feature is shown in Fig. 5, showing a first opening stage 23 and a second opening stage 23' arranged in series, such that the intake manifold is only open to atmosphere if both stages are open, as shown in the lower drawing. The embodiment in Fig. 5 provides such a redundant operation using two of the embodiments of the opening device shown in Fig. 4 in series, i.e. by using flaps 23 and 23' and gaskets 25 and 25'. Of course, redundancy could also be provided with the other embodiments, such as shown in Fig. 2 and 3.

[0069] The opening device in the present invention can be arranged at different positions within the high pressure side of the air intake system, and be either directly connected to atmosphere, or to a low pressure side of the air intake system.

[0070] As described above, Fig. 1b shows an opening device arranged in an air intake manifold at position between two cylinders 21. Fig. 4 to 6 show an opening device arranged in the intake manifold, at position opposite to duct 29 connecting the intake manifold 11 to compressor 6. In both configurations, the device has a separate air intake and preferably an air filter 13.

[0071] Fig. 7a and 7b show two configurations where the opening device is arranged between the high pressure side of the air intake system and the low pressure side of the air intake system, and therefore uses the main air inlet 7 also used by compressor 6.

[0072] In the embodiment shown in Fig. 7a, the opening device 12 is arranged in a bypass 26 between a duct 28 connecting the main air inlet 7 and the low pressure inlet of compressor 6, and the duct 27 connecting the high pressure outlet of the compressor 6 with the charge air cooler 8.

[0073] In the embodiment shown in Fig. 7b, the opening device 12 is arranged in a bypass 26 connecting the intake manifold 11 with duct 28 connecting the main inlet 7 with the low pressure inlet of the compressor 6.

[0074] Any one of the embodiments for an opening device described above can be used in any of the positions and configurations described above.

[0075] One or several opening devices according to the present invention can be provided in an engine, depending on its architecture and configuration.

[0076] For example, in a V-engine with two separated and independent air intake manifolds, each of the two intake manifolds may have its own opening device. Alternatively, the intake manifolds could be connected by a bridge, in which the opening device is provided.

[0077] The present invention can also be implemented on a multi-stage turbocharged engine, such as shown in Fig. 8. In such a configuration, the opening device is preferably arranged on the high pressure side of the compressor of the high pressure turbo charger.

[0078] An example of this is shown in Fig. 8. In addition to the components of the engine described above, the engine is provided with a low pressure turbo charger 4', the turbo charger 4 being configured as a high pressure turbo charger. In this configuration, the compressor 6' of the low pressure turbo charger 4' is connected to the main air inlet 7, and provides the compressor 6 of the high pressure turbo charger 4 with pressurized air. The turbine outlet 9 of the high pressure turbine 5 is connected to the low pressure turbine 5', which drives the low pressure compressor 6'. The low pressure turbine 5' has an exhaust gas outlet 9'.

[0079] The invention can be used in such a two stage turbo charged configuration in exactly the same way as described above, with the opening device arranged at any position downstream of the high pressure turbo charger 6, and may connect the high pressure side either directly with the atmosphere, or with the low pressure side, preferably with the low pressure side of the low pressure turbocharger 4'.

Claims

1. Electrical power supply comprising a generator (2) and an internal combustion engine (1) driving the generator (2), the engine comprising a turbo-charger (4) with a turbine (5) connected to an exhaust manifold (10) of the engine and a compressor (6) driven by the turbine (5) and connected to an intake manifold (11) of the engine for providing the engine (1) with pressurized air, wherein the engine has an opening device (12) for opening a high pressure side (14) of the air intake system downstream of the compressor (6) to atmosphere, such that the engine (1) can breath air at atmospheric pressure when the opening device (12) is open,
   characterized in that
   the opening device (12) is adapted to open in reaction to a time condition, wherein the opening device is adapted to open during a specified time interval after start-up of the engine, wherein the opening device (12) is opened immediately on startup of the engine and kept open for a time interval sufficient for the engine to reach synchronization speed.

2. Electrical power supply according to claim 1, wherein the electrical power supply is an emergency power supply and/or comprises an emergency startup-function.

3. Electrical power supply according to any of the pre-

ceding claims, wherein the time interval has a length of between 2 seconds and 30 seconds.

4. Electrical power supply according to claim 3, wherein the opening device is closed before electrical power generation is switched on and/or before the full load is applied to the engine.

5. Electrical power supply according to any of the preceding claims, wherein the opening device (12) comprises a drive mechanism (19) that is electronically controlled in dependence on a time condition.

6. Electrical power supply according to any of the preceding claims, wherein the opening device (12) is a valve or flap, wherein the opening device is preferably a one-way valve or a one-way flap.

7. Electrical power supply according to any of the preceding claims, wherein the opening device (12) comprises two stages for providing redundancy.

8. Electrical power supply according to any of the preceding claims, wherein the opening device (12) has a separate air inlet, preferably comprising an air filter (13).

9. Electrical power supply according to any of the preceding claims, wherein the opening device (12) bypasses the compressor (6), wherein the compressor (6) and the opening device (12) receive air from a main air inlet (7), the main air inlet preferably comprising an air filter.

10. Electrical power supply according to any of the preceding claims, wherein the engine has an output power of between 100 kW to 10 MW, preferably between 500 kW and 10 MW.

11. Electrical power supply according to any of the preceding claims, wherein the engine has between 2 liters and 200 liters of total displacement, preferably between 15 liters and 200 liters of total displacement.

12. Electrical power supply according to any of the preceding claims, wherein the rotor of the generator (2) is directly coupled to the crank shaft of the engine (1).

13. A method for operating an internal combustion engine (1) of an electrical power supply according to any of the claims 1 to 12, wherein a high pressure side (14) of the air intake system downstream of the compressor (6) is opened to atmosphere, such that the engine (1) can breath air at atmospheric pressure.

Patentansprüche

1. Stromversorgungseinrichtung mit einem Generator (2) und einem Verbrennungsmotor (1), der den Generator (2) antreibt, wobei der Motor einen Turbolader (4) mit einer Turbine (5), die mit einem Auslasskrümmer (10) des Motors verbunden ist, und einen Verdichter (6) aufweist, der von der Turbine (5) angetrieben wird und mit einem Ansaugkrümmer (11) des Motors verbunden ist, um den Motor (1) mit Druckluft zu versorgen, wobei der Motor eine Öffnungsvorrichtung (12) zum Öffnen einer Hochdruckseite (14) des Luftansaugsystems stromabwärts des Verdichters (6) zur Atmosphäre aufweist, so dass der Motor (1) bei atmosphärischem Druck Luft ansaugen kann, wenn die Öffnungsvorrichtung (12) geöffnet ist,
dadurch gekennzeichnet, dass
die Öffnungsvorrichtung (12) eingerichtet ist, um sich als Reaktion auf eine Zeitbedingung zu öffnen, wobei die Öffnungsvorrichtung eingerichtet ist, um sich während einer bestimmten Zeitspanne nach dem Anlassen des Motors zu öffnen, wobei die Öffnungsvorrichtung (12) unmittelbar beim Anlassen des Motors geöffnet wird und für eine Zeitspanne offen gehalten wird, die ausreicht, damit der Motor die Synchronisierungsdrehzahl erreicht.

2. Stromversorgungseinrichtung nach Anspruch 1, wobei die Stromversorgungseinrichtung eine Notstromversorgungseinrichtung ist und/oder eine Notstartfunktion aufweist.

3. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei die Zeitspanne eine Länge zwischen 2 Sekunden und 30 Sekunden hat.

4. Stromversorgungseinrichtung nach Anspruch 3, wobei die Öffnungsvorrichtung geschlossen wird, bevor die elektrische Energieerzeugung eingeschaltet wird und/oder bevor der Motor unter Volllast läuft.

5. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei die Öffnungsvorrichtung (12) einen Antriebsmechanismus (19) aufweist, der in Abhängigkeit von einer Zeitbedingung elektronisch gesteuert wird.

6. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei die Öffnungsvorrichtung (12) ein Ventil oder eine Klappe ist, wobei die Öffnungsvorrichtung bevorzugt ein Einwegventil oder eine Einwegklappe ist.

7. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei die Öffnungsvorrichtung (12) zwei Stufen zur Bereitstellung von Redundanz umfasst.

8. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei die Öffnungsvorrichtung (12) einen separaten Lufteinlass, bevorzugt mit einem Luftfilter (13), aufweist.

9. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei die Öffnungsvorrichtung (12) den Verdichter (6) umgeht, wobei der Verdichter (6) und die Öffnungsvorrichtung (12) Luft von einem Hauptlufteinlass (7) aufnehmen, wobei der Hauptlufteinlass bevorzugt einen Luftfilter aufweist.

10. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei der Motor eine Ausgangsleistung zwischen 100 kW und 10 MW, bevorzugt zwischen 500 kW und 10 MW hat.

11. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei der Motor zwischen 2 Liter und 200 Liter Gesamthubraum, bevorzugt zwischen 15 Liter und 200 Liter Gesamthubraum hat.

12. Stromversorgungseinrichtung nach einem der vorstehenden Ansprüche, wobei der Rotor des Generators (2) direkt mit der Kurbelwelle des Motors (1) gekoppelt ist.

13. Verfahren zum Betreiben eines Verbrennungsmotors (1) einer Stromversorgungseinrichtung nach einem der Ansprüche 1 bis 12, wobei eine Hochdruckseite (14) des Luftansaugsystems stromabwärts des Verdichters (6) zur Atmosphäre offen ist, so dass der Motor (1) Luft bei atmosphärischem Druck ansaugen kann.

Revendications

1. Alimentation en énergie électrique comprenant un générateur (2) et un moteur à combustion interne (1) servant à entraîner le générateur (2), le moteur comprenant un turbocompresseur (4) doté d'une turbine (5) reliée à un collecteur d'échappement (10) du moteur et d'un compresseur (6) entraîné par la turbine (5) et relié à un collecteur d'admission (11) du moteur afin d'alimenter le moteur (1) en air sous pression, le moteur comportant un dispositif d'ouverture (12) permettant d'ouvrir un côté à haute pression (14) du système d'admission d'air en aval du compresseur (6) vers l'atmosphère, de sorte que le moteur (1) puisse aspirer de l'air à pression atmosphérique lorsque le dispositif d'ouverture (12) est ouvert,
caractérisée en ce que
le dispositif d'ouverture (12) est conçu pour s'ouvrir en réponse à une condition de temps, le dispositif d'ouverture étant conçu pour s'ouvrir pendant un intervalle de temps spécifié après le démarrage du moteur, le dispositif d'ouverture (12) étant ouvert immédiatement lors du démarrage du moteur et maintenu ouvert pendant un intervalle de temps suffisant pour que le moteur atteigne une vitesse de synchronisation.

2. Alimentation en énergie électrique selon la revendication 1, dans laquelle l'alimentation en énergie électrique est une alimentation électrique d'urgence et/ou comprend une fonction de démarrage d'urgence.

3. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle l'intervalle de temps présente une longueur comprise entre 2 secondes et 30 secondes.

4. Alimentation en énergie électrique selon la revendication 3, dans laquelle le dispositif d'ouverture est fermé avant la mise en service de la génération d'énergie électrique et/ou avant l'application d'une pleine charge au moteur.

5. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'ouverture (12) comprend un mécanisme d'entraînement (19) qui est commandé électroniquement en fonction d'une condition de temps.

6. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'ouverture (12) est un clapet ou un battant, le dispositif d'ouverture étant de préférence un clapet anti-retour ou un battant anti-retour.

7. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'ouverture (12) comprend deux étages permettant d'obtenir une redondance.

8. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'ouverture (12) comporte une entrée d'air séparée, comprenant de préférence un filtre à air (13).

9. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'ouverture (12) contourne le compresseur (6), et dans laquelle le compresseur (6) et le dispositif d'ouverture (12) reçoivent de l'air à partir d'une entrée d'air principale (7), l'entrée d'air principale comprenant de préférence un filtre à air.

10. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le moteur présente une puissance de sortie comprise entre 100 kW et 10 MW, de préférence

entre 500 kW et 10 MW.

11. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le moteur présente entre 2 litres et 200 litres de cylindrée totale, de préférence entre 15 litres et 200 litres de cylindrée totale.

12. Alimentation en énergie électrique selon l'une quelconque des revendications précédentes, dans laquelle le rotor du générateur (2) est accouplé directement au vilebrequin du moteur (1).

13. Procédé permettant de faire fonctionner un moteur à combustion interne (1) d'une alimentation en énergie électrique selon l'une quelconque des revendications 1 à 12, dans lequel un côté à haute pression (14) du système d'admission d'air en aval du compresseur (6) est ouvert à l'atmosphère, de sorte que le moteur (1) puisse aspirer de l'air à pression atmosphérique.

Fig. 1a

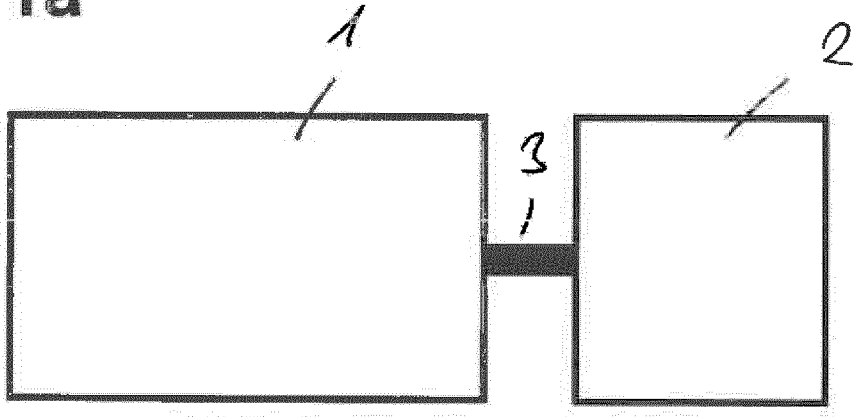


Fig. 1b

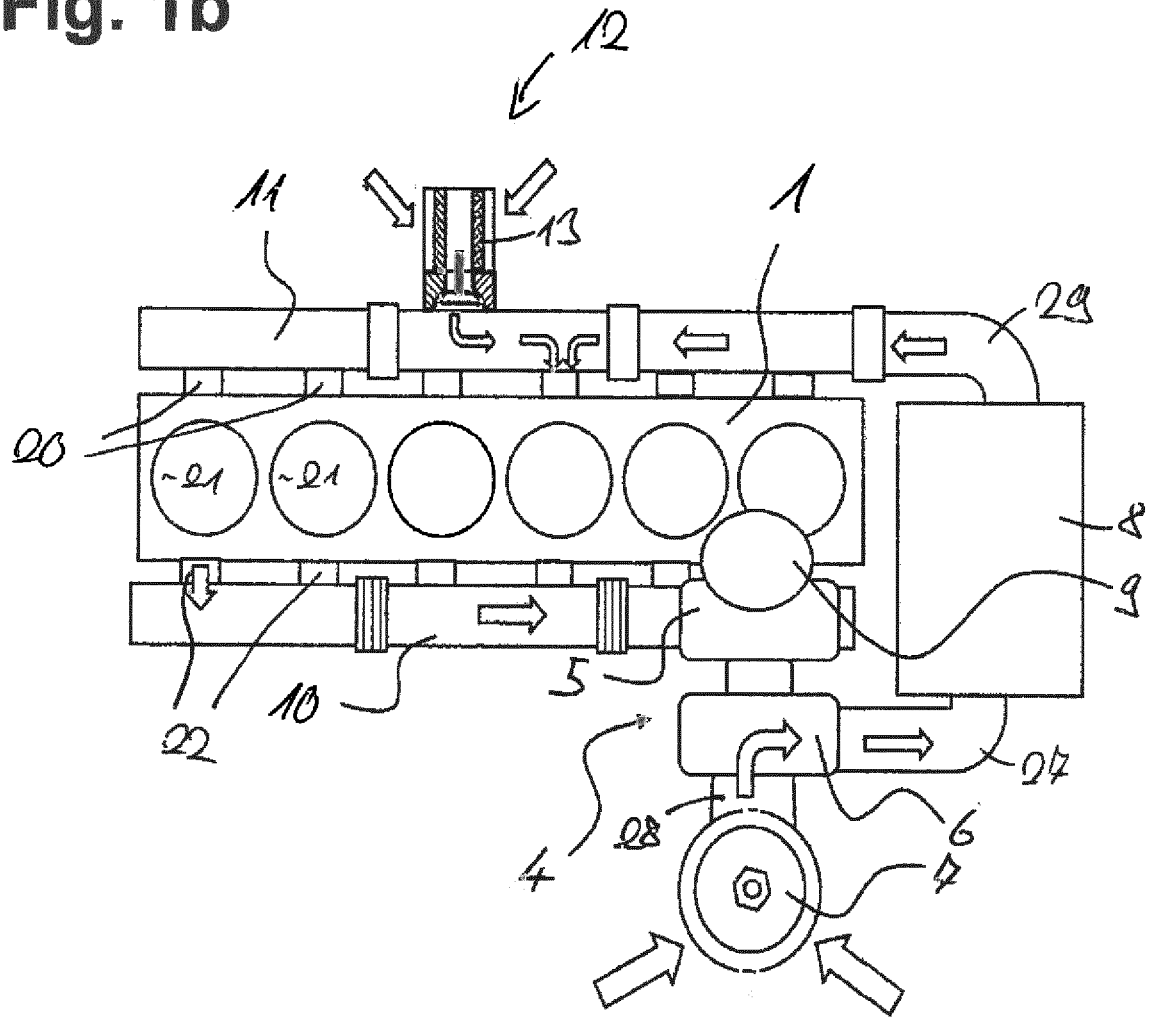


Fig. 2a

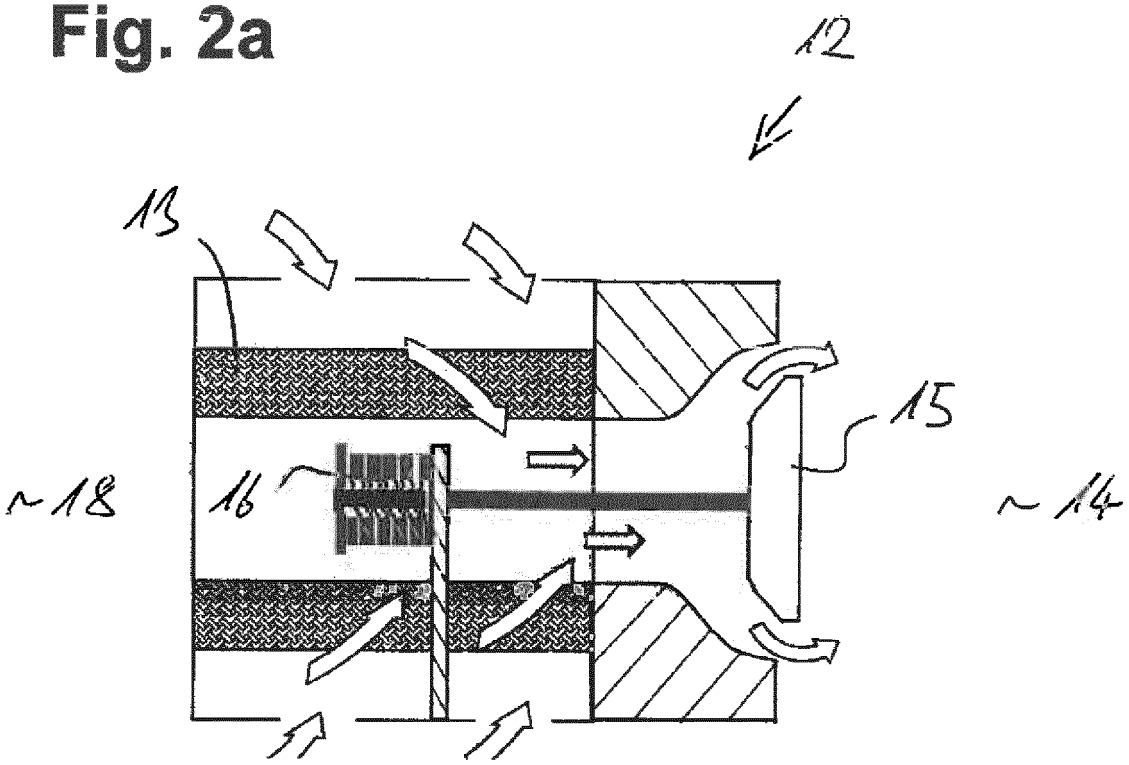


Fig. 2b

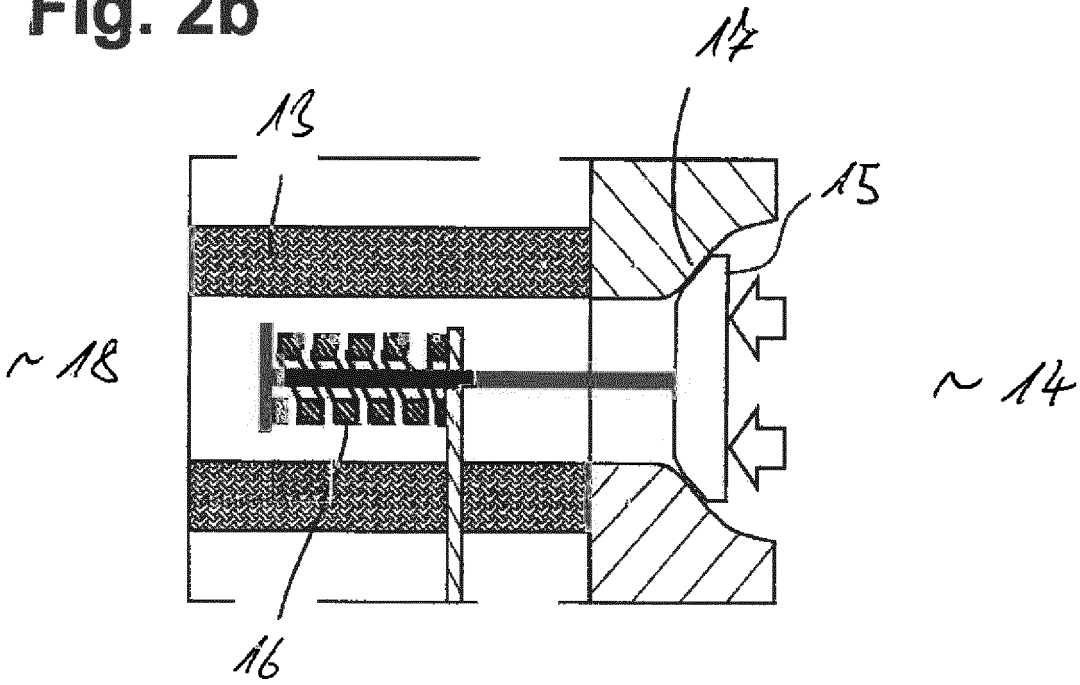


Fig. 3

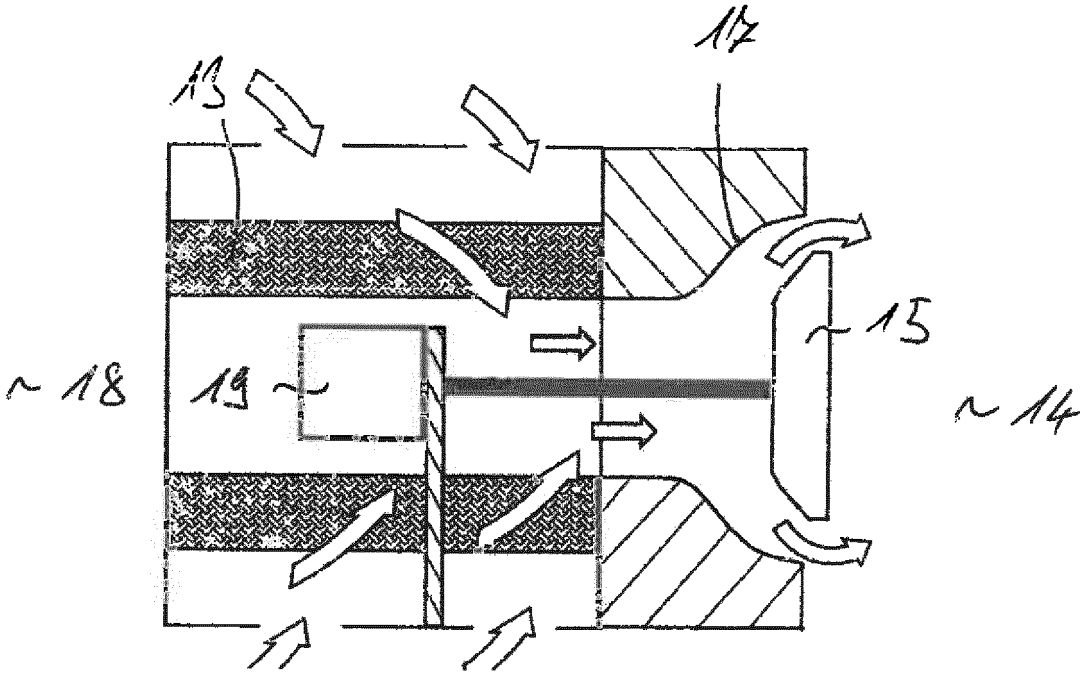


Fig. 4

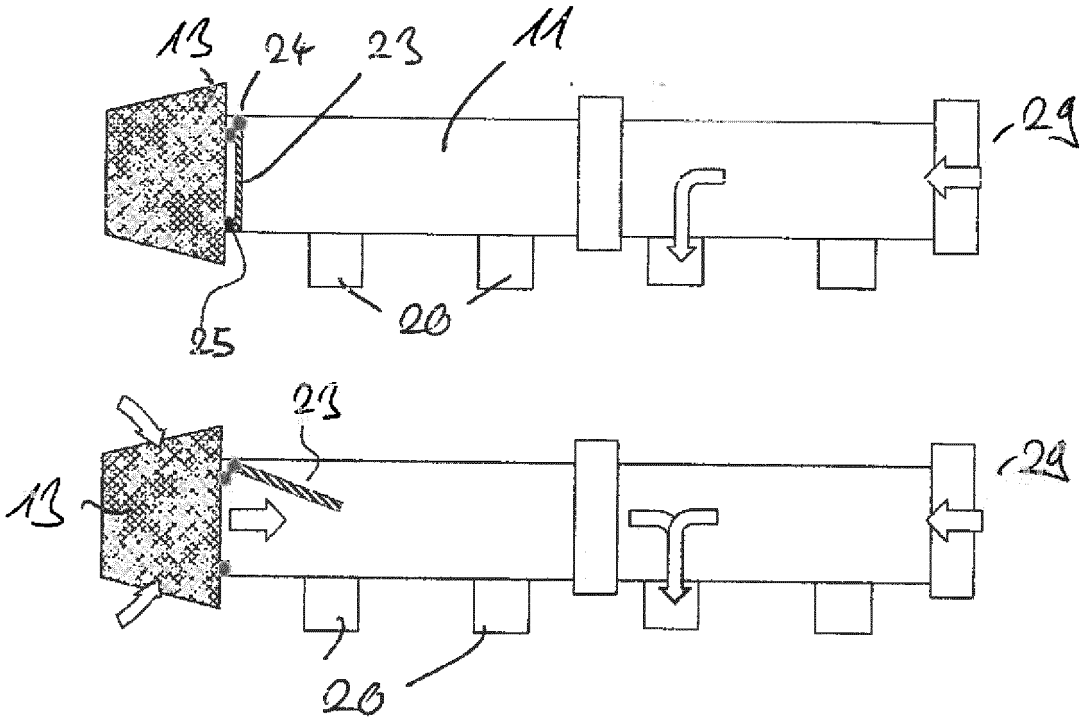


Fig. 5

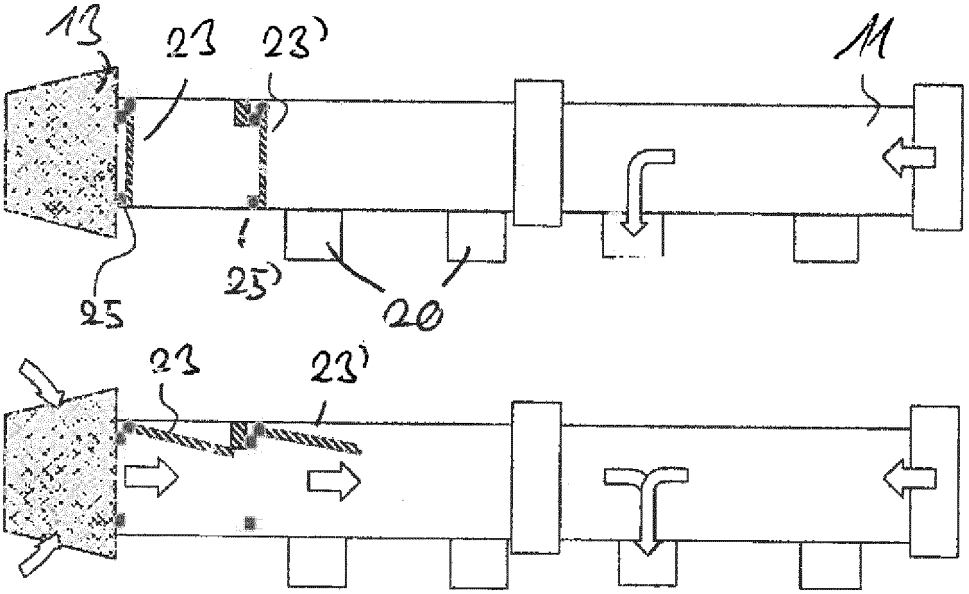


Fig. 6

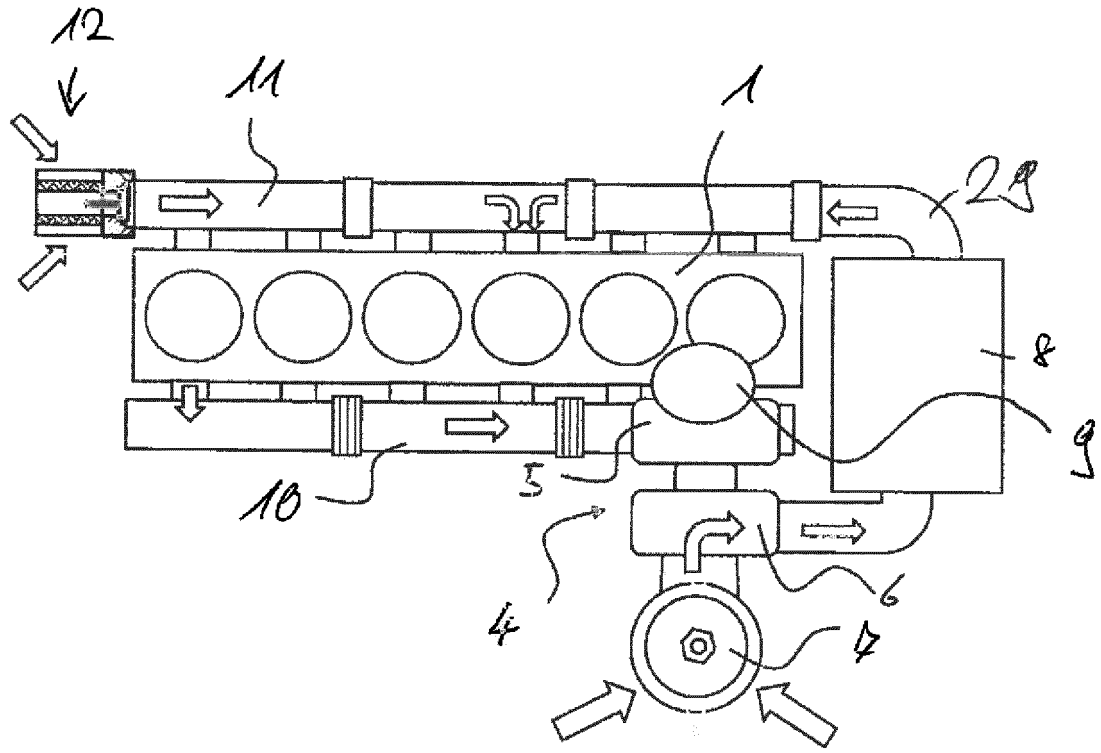


Fig. 7a

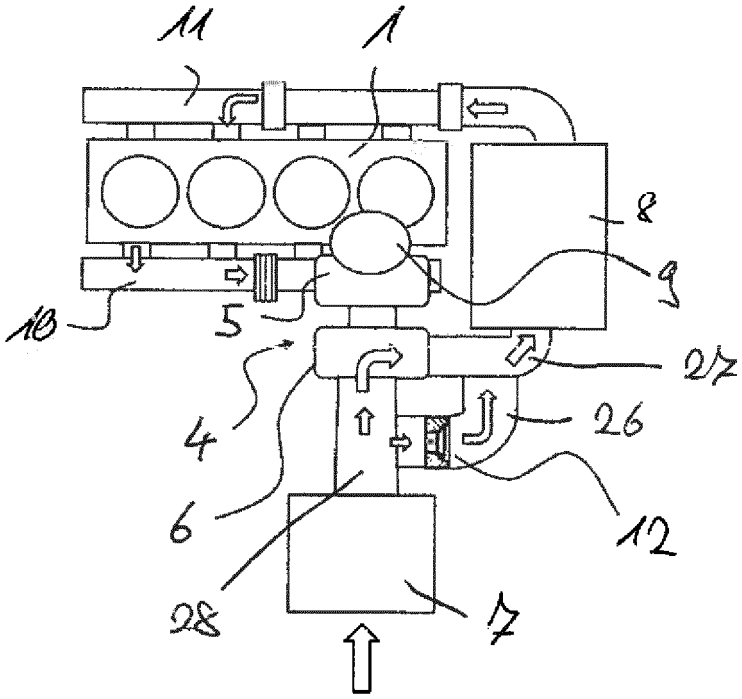


Fig. 7b

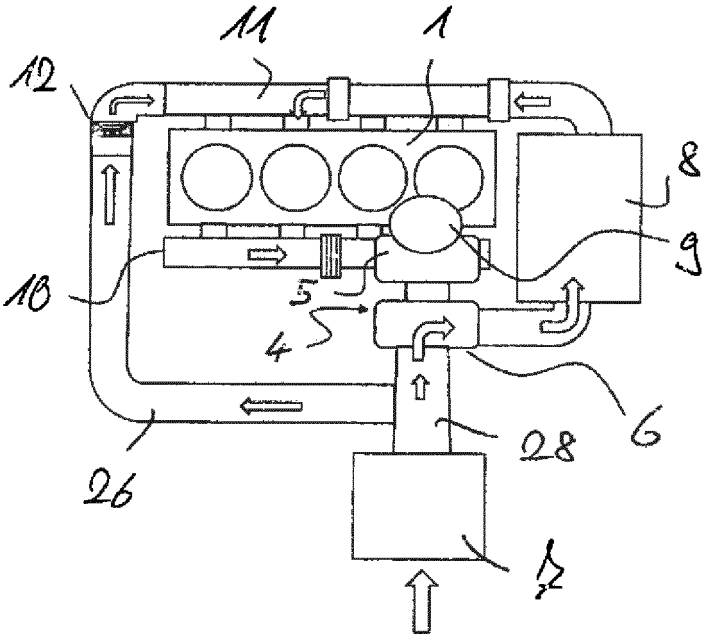
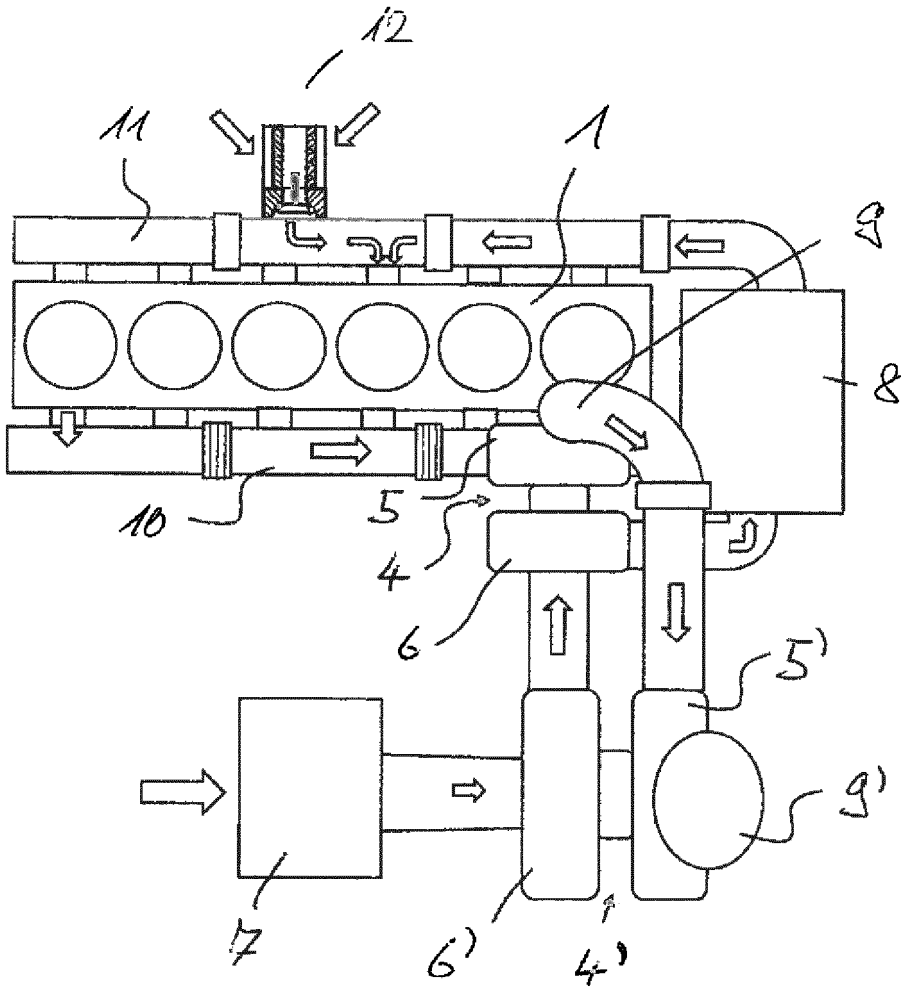


Fig. 8



REFERENCES CITED IN THE DESCRIPTION

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