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Technical Field

[0001] The invention relates to systems for supplying fuel to mobile and static drive devices.

State of the Art

[0002] In the course of increasing mobility and the environmental pollution thereby entailed, for a long time now, there has been a need for drive devices, in particular internal combustion engines, with reduced emission of pollutants, such as, for example, nitrogen oxides, carbon monoxide and volatile organic compounds. For this purpose, efforts have been made, first of all, to remove pollutants from exhaust gases using filters and catalytic converters, for example, and, second, to reduce the formation of these pollutants.

[0003] Carbon dioxide is an unavoidable end product of the combustion process when using hydrocarbon-based fuels, such as gasoline, diesel or natural gas. It has long been known that carbon dioxide has very negative effects on the climate equilibrium of the earth and makes a massive contribution to//toward man-made global warming. Preventing carbon dioxide emissions is therefore a very desirable goal.

[0004] Filtering carbon dioxide out of combustion exhaust is usually difficult to achieve at a reasonable cost in terms of energy. Systems in which carbon dioxide, for example, is captured in amine-based solvents, for example, are being tested for large-scale industrial use. However, such systems are complicated and expensive as well as being impractical for smaller installations. Furthermore, combustion engines that consume less fuel and therefore also have lower carbon dioxide emissions have been developed to reduce carbon dioxide emissions, and biomass-based fuels that are carbon dioxide neutral are used.

[0005] Electric vehicles are completely emission-free, at least locally. But the battery systems available today are still very heavy and/or their energy density is too low, which limits the maximum range that can be achieved. In addition, with regard to recharging time and refueling time, battery-operated vehicles are inferior to vehicles using chemical fuels.

[0006] Alternatively, methods and have fuel cell systems been developed for producing electric power for operating electric vehicles. Electricity is generated electrochemically from hydrocarbon-based fuels and atmospheric oxygen in such fuel cell systems. Here again, however, carbon dioxide is formed as the reaction product.

[0007] Emission of carbon dioxide can be prevented by using hydrogen as the fuel for internal combustion engines or fuel cells. However, hydrogen has a lower energy density than carbon-based liquid fuels and it also results in specific problems in production and storage.

[0008] Numerous technologies have become established over the years and are described in the prior art for internal combustion engines. Instead of having to develop completely new technologies, it would be desirable from the standpoint of efficiency to be able to modify these existing technologies in such a way that carbon dioxide emissions can be reduced or prevented entirely.

[0009] WO 00/70262 A1 discloses a refueling system for refueling vehicles with hydrogen gas. Hydrogen gas is produced by hydrolysis in an electrolysis cell, then is compressed by a compressor and made available at an outlet. Only a small supply of hydrogen is on hand, being

produced as needed from hydrogen, preferably using electricity outside of peak times. The production of hydrogen is regulated electrolytically.

[0010] EP 1167860 A2 discloses a modular design of a filling system for compressed gas cylinders. Liquid gas from a storage device for cryogenically liquefied gas is sent to an evaporator by a high-pressure pump and bottled in the compressed gas cylinders in a gaseous condition. The gas phase is sent back to the storage device in the high-pressure pump via a gas separator. In a first stage of the filling operation, the compressed gas cylinders are filled with gas from the gas phase of the storage device through a cut-off valve. When changing products, the filling system can also be flushed with gas from the gas phase of the storage device in this way.

Object of the Invention

[0011] The object of the invention is to provide an advantageous refueling system for mobile engines which obtain the energy required for operation by oxidation of carbon-based fuels.

[0012] These and other objects are achieved by a refueling system according to the invention as defined in the independent claim. Another advantageous embodiment is defined in the dependent claim.

Description of the Invention

[0013] With an advantageous device disclosed in the invention for performing mechanical work and/or generating electricity, the energy required for operation is obtained from the oxidation of carbon-based fuels to a product gas consisting essentially of carbon dioxide and water. A device for compression and/or condensation of the product gas is provided. A storage device receives the compressed and/or condensed product gas. Such an advantageous device disclosed according to the invention can be operated with pure oxygen as the oxidizing agent. A heat exchanger may be provided for cooling the product gas stream may be provided upstream and/or downstream from the device for compression and/or condensation of the product gas.

[0014] Another specific embodiment of an advantageous device according to the invention has a device for the condensation and/or separation of water out of the product gas.

[0015] An advantageous drive device according to the invention may be embodied as a fuel cell or as a heat engine, for example, as a piston engine or a turbine, or as a heating device. An embodiment of an advantageous device according to the invention, embodied as a heat engine, is advantageously an internal combustion engine with at least one combustion chamber for combustion of liquid or gaseous fuel with oxygen, with agents for converting the resulting gas pressure and/or gas volume into mechanical work, with a feed device for introducing oxygen into the combustion chamber, and with a ventilation device for removing combustion gases from the combustion chamber. A compressor for compressing the combustion gases and/or a condensation device for partial condensation of the combustion gases is provided downstream from the ventilation device. Another variant of such an advantageous device according to the invention has a feed device for introducing water into the combustion chamber and/or into the product gas stream downstream from the outlet from the combustion chamber.

[0016] A refueling system according to the invention for refueling a mobile engine or with a device according to the invention with gaseous or liquid fuels has means for the removing

compressed gases, in particular carbon dioxide, from a storage device of the mobile engine. Such a refueling system advantageously also has means for refueling the mobile engine or system with oxygen.

[0017] A supply system according to the invention for supplying one or more consumers with gaseous and/or liquid fuels comprises a first supply network for transporting fuels to consumers, from one or more production installations and/or from one or more first storage devices. A second recycling network serves for the return transport of exhaust gases, in particular carbon dioxide, from the consumers to one or more production installations and/or to one or more second storage devices.

[0018] In an advantageous method for performing mechanical work and/or for generating electrical or thermal energy, the energy necessary for operation is obtained by oxidation of carbon-based fuels to yield a product gas consisting essentially of carbon dioxide and water. The product gases formed with the oxidation reaction are compressed and/or condensed and captured in a storage device. Pure oxygen is advantageously used as the oxidizing agent. Such a method is advantageously carried out with a device disclosed according to the invention.

[0019] In another embodiment variant of such an advantageous method, the compressed product gases are cooled before and/or after compression and/or condensation. In another variant of such an advantageous method, water is condensed out and/or separated from the product gases.

[0020] In another advantageous embodiment variant of such a method, the fuels are produced by a method for thermo-chemical utilization of carbon-based starting materials, in which the carbon-based starting materials are pyrolyzed in a first stage, wherein pyrolysis coke and pyrolysis gas. In a second stage, the pyrolysis coke from the first stage is gasified, forming synthesis gas, while slag and other residual substances remain and are carried away. In a third stage, the synthesis gas from the second stage is converted into fuels, wherein excess recycled gas from the third stage is fed into the first stage and/or the second stage. The three stages form a closed circuit. European Patent Application No. 09176684.0 by the present applicant (EP 2325288 A1) discloses a method and a system for thermo-chemical processing and utilization of carbon-based substances.

[0021] In yet another advantageous variant of such a method, at least some of the product gases are utilized in a method for thermo-chemical utilization of carbon-based starting materials, in which the carbon-based starting materials are pyrolyzed in a first stage, resulting in and pyrolysis coke and pyrolytic gas result. In a second stage, the pyrolysis coke from the first stage is gasified, yielding synthesis gas, while slag and other residual substances remain and are discarded. In a third stage, synthesis gas from the second stage is converted into fuel, wherein excess recycled gas from the third stage is fed into the first stage and/or the second stage. These three stages form a closed circuit. Product gases are fed into the first stage and/or into the second stage and/or into the third stage.

Brief Description of the Drawings

[0022] For a better understanding of the present invention, reference is made below to the drawings. These drawings show only exemplary embodiments of the subject matter of the invention.

Figure 1 shows schematically an advantageous drive device in combination with a system for the thermo-chemical utilization of carbon-based substances, resulting in an essentially closed circuit of materials.

Figure 2 shows schematically one variant of an advantageous drive device.

Figure 3 shows schematically one embodiment of an advantageous drive device embodied as an internal combustion engine.

Figure 4 shows schematically another embodiment of an advantageous drive device embodied as an internal combustion engine.

Figure 5 shows schematically shows an advantageous drive device in a vehicle as well as a possible embodiment of a closed circuit for the fuel supply of such a vehicle with an advantageous drive device in combination with a recycling system for carbon dioxide.

Figure 6 shows schematically one possible embodiment of a supply network for gaseous fuels, in combination with a recycling system for carbon dioxide.

Embodiment of the Invention

[0023] The examples given below are presented to better illustrate the present invention but they are not suitable for restricting the invention to the features disclosed herein.

[0024] An advantageous drive device 1 according to the invention provides mechanical energy from chemical energy sources 20, wherein the utilization of the chemical energy is accomplished thermo-chemically or electro-chemically. Such a drive device has a closed circuit. In other words, it does not release any emissions into the atmosphere. The residual substances, such as carbon dioxide in particular, that are formed while providing mechanical work are after-treated, compressed and stored in a space-saving manner, for example, in a pressure tank. The stored gas mixture essentially contains only carbon dioxide and optionally water. Carbon dioxide is usually transferred to a suitable, larger storage device for further utilization. This recycling of carbon dioxide advantageously takes place simultaneously with refueling of a vehicle.

[0025] In an advantageous variant of an advantageous drive device disclosed according to the invention, the stored carbon dioxide is partially or completely reused. Figure 1 shows schematically one such embodiment of an advantageous drive device 1 according to the invention. European Patent Application No. 09176684.0 by the present applicant discloses a method and a system 6 for thermo-chemical processing and utilization of carbon-based materials. However, Figure 1 shows the aforementioned system 6 in greatly simplified form for the sake of simplicity.

[0026] In an essentially closed circuit 26, 28, carbon-based starting material 27 is converted into hydrocarbons 20 and hydrocarbon derivatives in the system 6. To do so, the carbon-

based starting material 27 is converted into a synthesis gas mixture 26 in a first and second stage 61, and in a third stage 62, hydrocarbons and other valuable materials 20, which can be used for other purposes, e.g., as propellants and/or gaseous fuels 20, are produced from the synthesis gas mixture 26. The recycled gas mixture 28 that remains after the synthesis stage 62 essentially contains carbon dioxide and is fed back into the first stage as a gasifying agent.

[0027] An advantageous drive device 1 according to the invention advantageously uses gaseous or liquid hydrocarbons and hydrocarbon derivatives 20 from the system 6 as fuels. The oxidation reaction which generates thermal or electrical energy uses pure oxygen 22 instead of air. The oxygen is advantageously entrained in a pressure tank. An advantageous drive device 1 according to the invention may be, for example, an internal combustion engine, in which heat generated by the oxidation reaction is converted into mechanical work in a heat engine, or a fuel cell in combination with an electric motor, in which the oxidation reaction is utilized for generating electricity.

[0028] Using oxygen 22 instead of air, on the one hand, prevents the formation of nitrogen oxides due to the absence of atmospheric oxygen in a thermo-chemical reaction at high temperatures, but in particular, essentially only carbon dioxide 24 and water vapor 23 remain in the resulting reaction products 21. Depending on the stoichiometric ratios in the reaction, the resulting gases may also contain certain fractions of carbon monoxide and unreacted fuel, but these can be aftertreated subsequently in a manner similar to that used for carbon dioxide.

[0029] The reaction products 21 of the energy generating reaction are essentially gaseous. The corresponding gas mixture is then compressed to reduce the volume. The gas mixture 21 is cooled with the help of a heat exchanger before and/or after being compressed, so that the volume of the gas mixture is further reduced again and only carbon dioxide 24 remains in the gas mixture, optionally with fractions of carbon monoxide and unreacted fuel. The water 23 that condenses out is separated. Carbon dioxide 24 can be stored temporarily in a suitable reservoir, e.g., a pressure tank.

[0030] At regular intervals, carbon dioxide 24 is again fed to the first stage 61 of the system 6, resulting in a closed cycle of materials for the carbon dioxide. With the aforementioned method, it is thus possible to produce liquid or gaseous hydrocarbons and hydrocarbon derivatives from carbon-based substances and carbon dioxide, and to subsequently convert the resulting fuel mixture into mechanical work in an advantageous drive device 1 according to the invention. The captured and stored carbon dioxide is recycled and partly or completely converted back into fuels 20 in the system 6. In this way, the effective emission of carbon dioxide from an advantageous drive device according to the invention can be greatly reduced or even prevented entirely.

[0031] Alternatively or in addition to recycling, a portion of the stored carbon dioxide can be deposited in such a manner that it is never allowed to enter the atmosphere. Corresponding technologies for permanent, long-term storage of carbon dioxide are being developed throughout the world at the present time. For example, permanent disposal of carbon dioxide by pumping it into empty petroleum and natural gas fields is being tested.

[0032] Another generalized variant of an advantageous drive device 1 is diagrammed schematically in Figure 2. An advantageous internal combustion engine 1 according to the invention can be operated without any problem in a combination operation using hydrogen 25 as an additional fuel. In such a case, the hydrogen fraction results in a reduction in the resulting amount of residual gas downstream from the heat exchanger or compressor, because only water is formed by oxidation of hydrogen with oxygen.

[0033] If an advantageous drive device 1 according to the invention is designed as an internal combustion engine, then in an advantageous variant of such a drive device according to the invention, water 23 can be used as an additional expansion means. To this end, after ignition of the combustion process, for example, after spontaneous ignition of the compressed fuel-air mixture in a diesel engine, a certain amount of water is injected into the cylinder. This water, which is preferably finely atomized, is then evaporated due to the thermal energy of the exothermic oxidation reaction. The resulting increase in gas pressure increase and/or increase in gas volume due to the water vapor contributes to the generation of kinetic energy, but at the same time, the temperature of the entire mixture of combustion exhaust gases and water vapor drops. However, this is not a problem or may even be desirable, because substantially higher reaction temperatures occur due to the higher energy density of the reaction with pure oxygen, which improves thermodynamic efficiency but can also put a greater burden on parts of an advantageous drive device 1 according to the invention.

[0034] Alternatively, the water may also be introduced as steam. Furthermore, a certain amount of liquid water can also be supplied, mixed with the liquid fuel. At high reaction temperatures, superheated water vapor acts as an additional oxidizing agent in addition to oxygen.

[0035] The functioning of an advantageous drive device 1 according to the invention is described and explained in greater detail below on the example of an internal combustion engine in the form of a piston engine. Similarly, advantageous drive devices according to the invention embodied as internal combustion engines may also be embodied as turbines or as Wankel engines, etc. The hot combustion gases are used for performing mechanical work according to the function principle of the respective type of internal combustion engine, and are thereby partly depressurized. Next, the gas mixture leaves the combustion chamber. Thus, for example, with an advantageous internal combustion engine according to the invention, embodied as a four-stroke piston engine, the combustion gas mixture is ejected from the cylinder in the third stoke and then compressed, cooled and stored temporarily.

[0036] One possible embodiment of an advantageous drive device 1 according to the invention embodied as an internal combustion engine is diagrammed schematically in Figure 3 on the example of a piston engine with one cylinder. The internal combustion engine 1 shown her has a cylinder 111 and a piston 112 arranged movably therein, together forming a closed combustion chamber 11. Oxygen 22 is introduced in a first stroke into the expanding combustion chamber 11 with a feed device 16, which is only diagrammed schematically. Then in a second stroke, oxygen 22 is compressed, and at the end of the second stroke, the fuel 20 is introduced into the combustion chamber 11 with a feed device 18 and is combusted. With the subsequent third stroke, the expanding combustion gases 21 perform mechanical work, and with the fourth stroke, the party expanded exhaust gases 21 are removed from the combustion chamber 11 by a ventilation device 12 (not shown in detail).

[0037] The hot combustion gases 21, consist essentially only of carbon dioxide and water vapor, are then cooled in a downstream heat exchanger 13. Therefore, the volume of these product gases 21 is reduced. A portion of the water 23 is condensed out by cooling and separated. The residual gas, now consisting only of carbon dioxide 24 and optionally residual fractions of carbon monoxide and unreacted fuels, is compressed in a series-connected compressor 14 and pumped into a storage device 15, which is a pressure tank in the simplest case. The condensation stage 13 upstream from the compression 14 reduces unwanted formation of condensed water droplets in the compressor 14.

[0038] The advantageous internal combustion engine 1 according to the invention presented here has no emissions. Since the advantageous device according to the invention is not

operated with air or similar mixtures, no air-specific pollutants, such as nitrogen oxides, can be formed. The water formed by combustion is not a problem and can be separated. Carbon dioxide and other residual gases are captured in the storage device 15 and stored for further use. Unburned fuel fractions are either condensed out with the water and separated or are compressed together with the carbon dioxide.

[0039] Sulfur and phosphorus may also be present in the fuels for an advantageous drive device according to the invention, in addition to the basic building blocks C, H, O, depending on the quality level. For example, sulfur can react in the oxidation reaction to form sulfur dioxide and sulfur trioxide, which in turn react with water to form sulfurous acid and sulfuric acid, respectively. These corrosive pollutants, together with water, can be condensed out, separated and discarded. The same also applies to phosphorus pollutants and fine dust particles that may be formed.

[0040] A further possible embodiment of an advantageous drive device 1 according to the invention, embodied as an internal combustion engine, is diagrammed schematically in Figure 4. In this variant, water is introduced into the combustion chamber 11 through a feed device 17, which is diagrammed only schematically. This preferably takes place in such a way that during or after the combustion reaction, a certain amount of water 23 in liquid or vapor form is injected into the combustion chamber and finely distributed. This water is heated by the heat of combustion, so that the entire gas volume increases in the combustion chamber 11, and therefore the gas pressure and/or gas volume available for providing mechanical work also increases. Accordingly, the amount of fuel can then be reduced while maintaining the same power level.

[0041] Alternatively or additionally, water can also be introduced into the product gas stream 21 when the latter has left the combustion chamber 11. Such a variant has the advantage that the combustion reaction in the combustion chamber can take place efficiently at the highest possible temperature, and at the same time, the resulting temperature of the product gas stream is so low that the downstream devices 14, 13 are not polluted excessively.

[0042] The amount of water and the point in time of injection are thus coordinated with the supply of fuel 21 and oxygen 22, so that the combustion reaction can take place efficiently. The resulting temperature during the oxidation reaction is advantageously essentially such that the resulting thermodynamic efficiency of the heat engine is as high as possible. The greater the amount of water used, the lower is also the relative amount of carbon dioxide in the reaction gases, thereby reducing the amount of gas which remains after the water has condensed out and which is to be compressed.

[0043] In the embodiment illustrated in Figure 4, the combustion gases 21 are first compressed in a compressor 14 before subsequently being cooled in the heat exchanger 13. The water 23 remains in the gas mixture 21 and collects in liquid form in the pressure tank 15. The water 23 can also be discharged at the same time as the regular discharge of carbon dioxide 24. The variant shown in Figure 4 can also be combined with the internal combustion engine 1 without the injection of water as illustrated in Figure 3, and vice versa, and can be used in general for an advantageous drive device 1 according to the invention.

[0044] The energy required for operation of the compressor of an advantageous drive device 1 according to the invention is advantageously generated by the advantageous drive device itself. This result in a decline in the achievable efficiency of the advantageous drive device according to the invention, but at the same time, the aforementioned drive device according to the invention achieves emission-free exhaust. Furthermore, the power output that is achievable is greater at the same engine dimensions, which compensates for the loss of power. For

example, the compressor can be operated directly with the crankshaft of an internal combustion piston engine by means of a suitable transmission.

[0045] If the advantageous drive device 1 according to the invention is embodied as a turbine, the compressor can sit directly on the same shaft. The product gases can then be condensed directly following the expansion process, and the remaining residual stream can be compressed.

[0046] In another variant of an advantageous drive device according to the invention, embodied as a piston engine, the product gases are precompressed in the combustion chamber during the third stroke, and only then are they discharged through the ventilation device 12. The downstream compressor 14 may optionally be omitted.

[0047] Such an embodiment is also possible as a two-stroke variant because charging of the combustion chamber with a reaction mixture (fuel 20, oxygen 22, water 23) in an advantageous drive device according to the invention can be accomplished very rapidly. In a second upstroke, the combustion gases are precompressed and discharged from the combustion chamber at the end of the stroke. The oxygen gas can be injected into the combustion chamber under high pressure at the end of the upstroke, because comparatively little oxygen is required for a complete combustion reaction, and water is present as an additional expansion medium. The liquid fuel 20 and the water 23 as the expansion medium can be injected into the combustion chamber very rapidly under a high pressure.

[0048] Energy consumption for the compressor can be optimized by a suitable combination with one or more heat exchangers and/or cooling elements, in which the gas volume can be reduced by way releasing the thermal energy of the reaction gases to an internal or external heat sink.

[0049] It is also possible to achieve an advantageous drive device 1 according to the invention as a heat engine with external combustion, for example, as a steam engine and/or steam turbine or as a Stirling engine.

[0050] A vehicle driven by an advantageous drive device 1 according to the invention is diagrammed schematically in Figure 5 as an example of an advantageous mobile engine 3 according to the invention. An advantageous drive device 1 according to the invention, which is embodied as an internal combustion engine, is either used directly as a drive assembly, or alternatively, is operated constantly in an ideal engine speed range, wherein electric power for an electrical drive assembly is generated by a generator. If the advantageous drive device 1 according to the invention is embodied as a fuel cell system, an electric motor also serves as a drive assembly.

[0051] The vehicle 3 has a tank 31 for the liquid or gaseous fuel 20 as well as a pressure tank 32 for the oxygen 22. The gas storage tank 15 for carbon dioxide is advantageously also embodied as a pressure tank 15. An advantageous drive device 1 according to the invention is suitable in particular for less weight-sensitive vehicles, such as land and water vehicles, for example, in particular vehicles for urban traffic or ships and larger boats. It is also possible to generate oxygen on site, depending on the size of the vehicle, so that the pressure tank 32 serves only as a temporary storage device and may be designed to be smaller accordingly.

[0052] Figure 5 does not show a possible storage tank for the water 23. However, such a storage tank may also be relatively small. The condensed water formed in the aftertreatment of

the combustion gases can be recycled, so that the effective water consumption and thus the size of the required storage tank is even smaller.

[0053] Figure 5 also shows a possible embodiment of a closed circuit for the fuel supply for such an advantageous vehicle 3 according to the invention. To this end, the vehicle 3 is filled with liquid or gaseous fuel 20 as well as compressed oxygen 22 at a suitably equipped refueling system 41. At the same time, carbon dioxide 24 collected in the gas storage device 15 is recycled to a suitable gas storage device of refueling system 41.

[0054] The refueling system 41 forms a closed circuit with the fuel production system 6, as is disclosed in European Patent Application No. 09176684.0 (EP 2325288 A1) by the present applicant. The system 6 produces liquid or gaseous hydrocarbon fuels 20 from carbon-based starting materials 27. These fuels are transported to the refueling system 41 by suitable means. The carbon dioxide 24 is in turn transported by suitable means to the system 6, where it is fed into the closed circuit of the system 6, optionally with carbon monoxide and unreacted fuel, which has been recycled from the vehicle 3 into refueling system 41.

[0055] A refueling system 41 is particularly suitable for example for municipal public bus transport operations. In general, such buses are refuelled only in the operation's refueling systems. Therefore, numerous vehicles 3 can be reached with a comparatively low number of refueling systems 41 to be retrofitted. This results in lower investment costs in a corresponding overall system.

[0056] In clearly defined areas of a city, for example, the recycling of carbon dioxide and/or the supply of fuel can also be accomplished by a suitable supply network 5. Figure 6 shows one possible embodiment of such a supply network. The system has two ring-shaped networks in the example shown here.

[0057] Gaseous fuel 20 is fed from a production system 6 with a closed circuit into a first supply network 51. Different refueling systems 41 receive gaseous or liquid fuels from this network 51. An electric power plant 43, where an electric generator is operated by an advantageous drive device according to the invention, is also connected to the network 51 along with a first temporary storage device 71.

[0058] In addition, there is a second recycling network 52, into which the refueling systems 41 and the electric power plant 43 feed the resulting carbon dioxide 24, which is in turn fed back into the production system 6. A second temporary storage device 72 serves to increase the capacity of the second network. In addition, a final storage 44 for carbon dioxide is also provided in the variant shown here. Carbon dioxide is diverted from the second network and pumped under pressure into a depleted oil field, where it will then remain permanently.

[0059] If an advantageous drive device according to the invention is connected directly to such an advantageous supply system 5 according to the invention, a fuel tank 31 and/or gas storage device 15 for carbon dioxide can be omitted entirely, because the fixed line system takes over this function. This is the case with the electric power generating plant 43 shown in Figure 6, for example.

List of Reference Numerals

[0060]

1	drive device
11	combustion chamber
111	cylinder
112	piston
12	exhaust device
13	heat exchanger
14	device for compression, compressor
15	gas storage device
16	feed device for oxygen
17	feed device for water
18	feed device for fuel
20	fuel, propellant
21	reaction products, product gases, combustion gases, exhaust gases
22	oxygen
23	water
24	carbon dioxide
25	hydrogen
27	carbon-based starting materials
28	recycled gases with carbon dioxide
3	vehicle, mobile or stationary engine
31	fuel tank
32	oxygen tank
41	refueling system
43	system for generating electric power
44	final storage for carbon dioxide
5	supply system
51	supply network for fuel
52	recycling network for carbon dioxide
6	system for the thermo-chemical utilization of carbon-based substances
61	first and second stage for producing a synthesis gas mixture
62	third stage for producing hydrocarbon derivatives and other valuable substances
71	first storage device, storage device for fuels
72	second storage device, storage device for product gases

Patentkrav

1. Optankningsanlæg (41) til optankning af en mobil maskine (3) med gasformige eller flydende drivstoffer (20), hvor den mobile maskine har en indretning (1) til at udrette mekanisk arbejde og/eller til generering af elektrisk energi, hvilken tilvejebringer den energi, der er nødvendig til driften, ud fra oxidationen af carbonholdige drivstoffer (20) til en produktgas (21) i det væsentlige bestående af kuldioxid (24) og vand (23), **kendetegnet ved** midler til udtagning af komprimerede produktgasser (21), især kuldioxid (24), fra et lager (15) af den mobile maskine (3).

2. Optankningsanlæg ifølge krav 1, **kendetegnet ved** midler til optankning af den mobile maskine (3) med oxygen (22).

Fig. 1

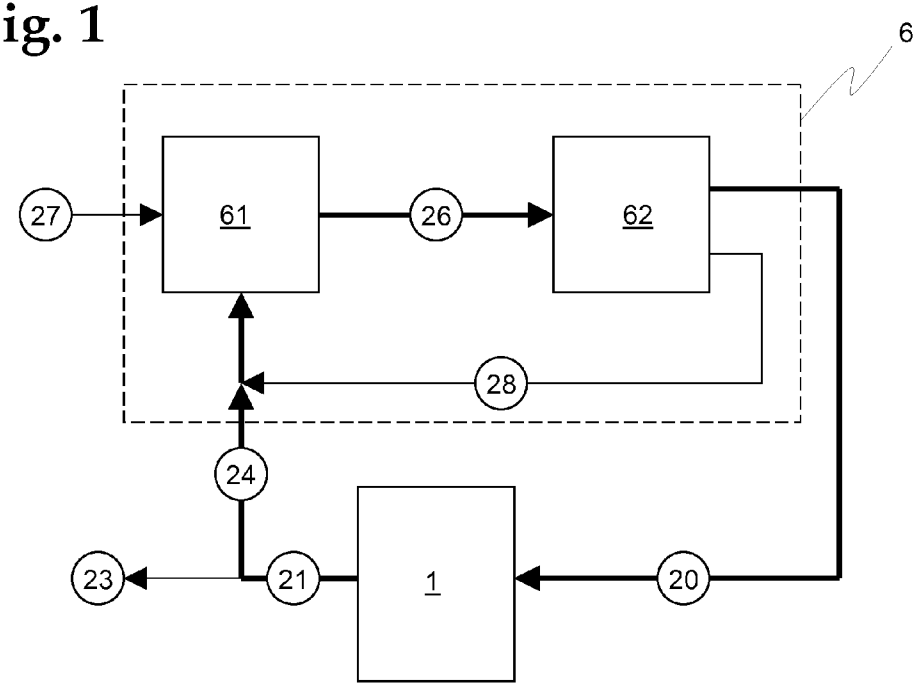

Fig. 2

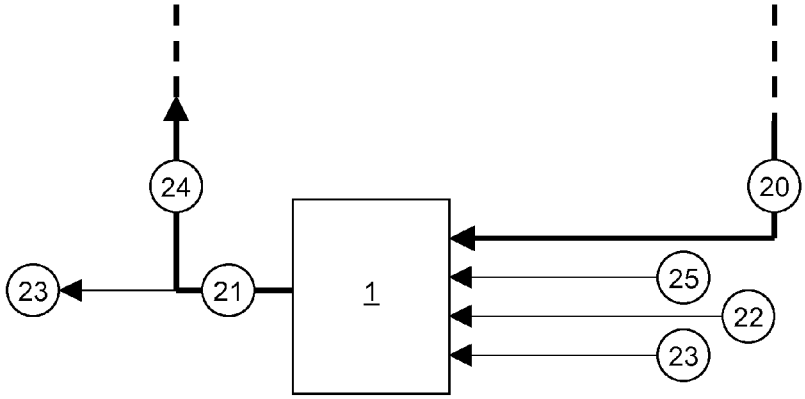

Fig. 3

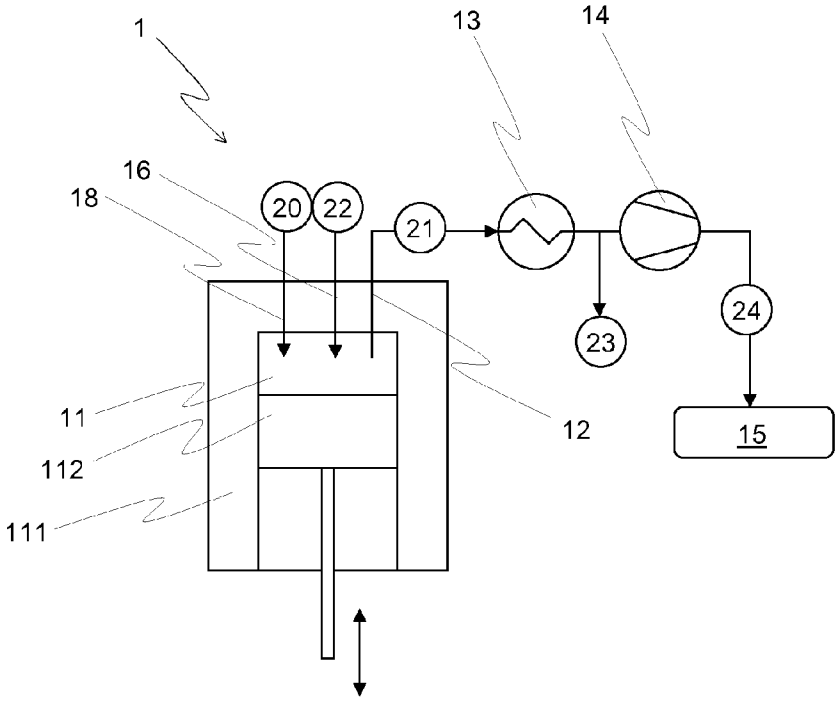
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Fig. 4

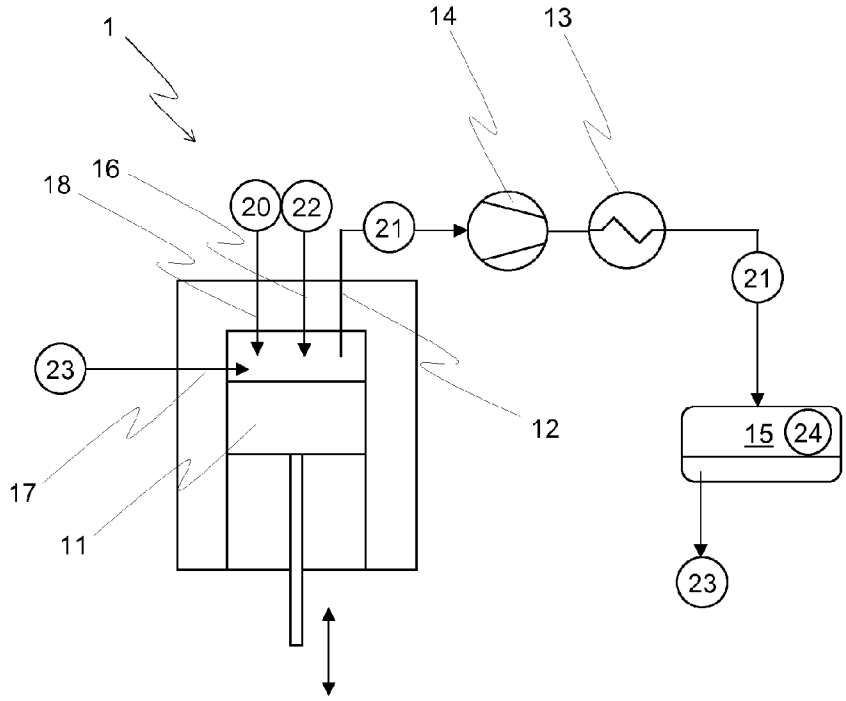
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Fig. 5

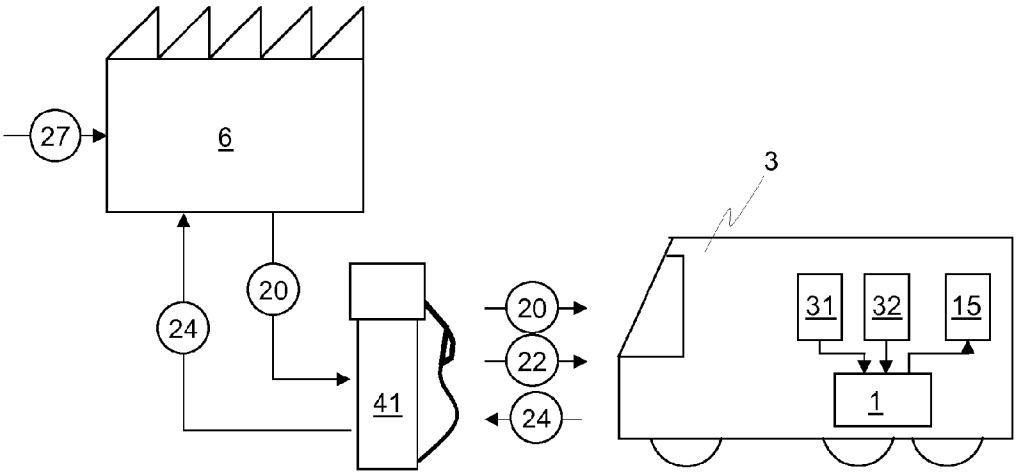

Fig. 6