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(54) **DRIVE TRAIN, PARTICULARLY FOR TRUCKS AND RAIL VEHICLES**

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(57) **ABSTRACT**

The invention relates to a drive train, especially for a commercial vehicle,

- with an internal combustion engine which produces an exhaust gas stream;
- with an exhaust gas line which is connected to the internal combustion engine;
- with a supply air line system for supplying a supply air flow for combustion in the internal combustion engine, which supply air line system is connected to the internal combustion engine;
- with a steam cycle, comprising an expansion machine, at least one heat exchanger in order to evaporate the working medium of the steam cycle, and a condenser;
- the supply air line system comprises a fresh air line for supplying a fresh air flow for combustion in the internal combustion engine and a recirculating line for recirculating a part of the exhaust gas stream to the fresh air side for combustion in the internal combustion engine.

The invention is characterized in that

- a plurality of heat exchangers for evaporation of the working medium of the steam cycle is provided in the recirculating line, and a further heat exchanger for evaporation of the working medium of the steam cycle is provided in the exhaust gas line which is supplied with an exhaust gas stream intended for being conducted to the ambient environment, and the working medium of the steam cycle is first conducted through a second heat exchanger in the recirculating line, then through the further heat exchanger in the exhaust gas line and then through a first heat exchanger in the recirculating line, with the recirculated part of the exhaust gas stream first being conducted through the first heat exchanger and then through the second heat exchanger, and is then cooled.

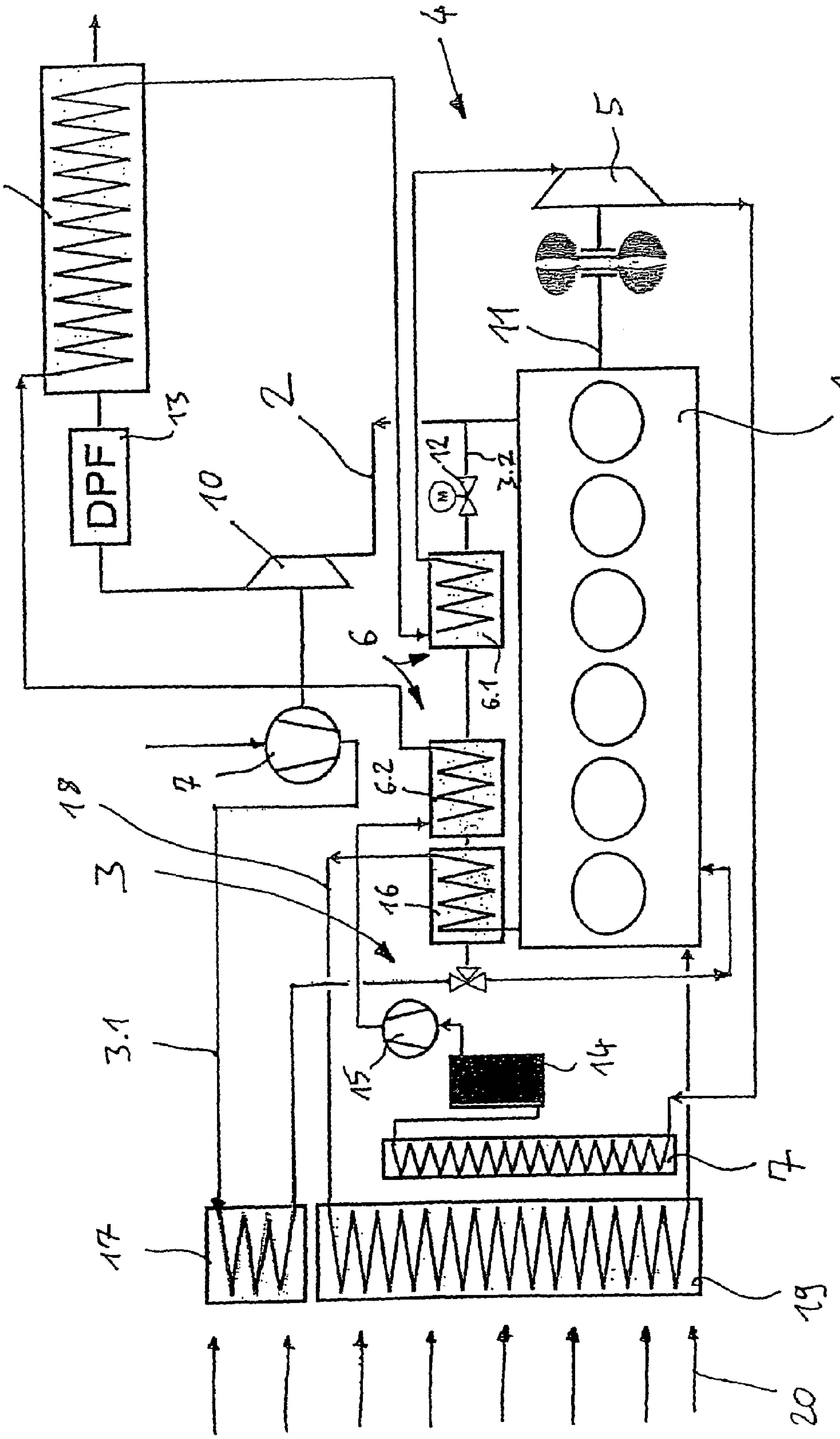

Fig. 1

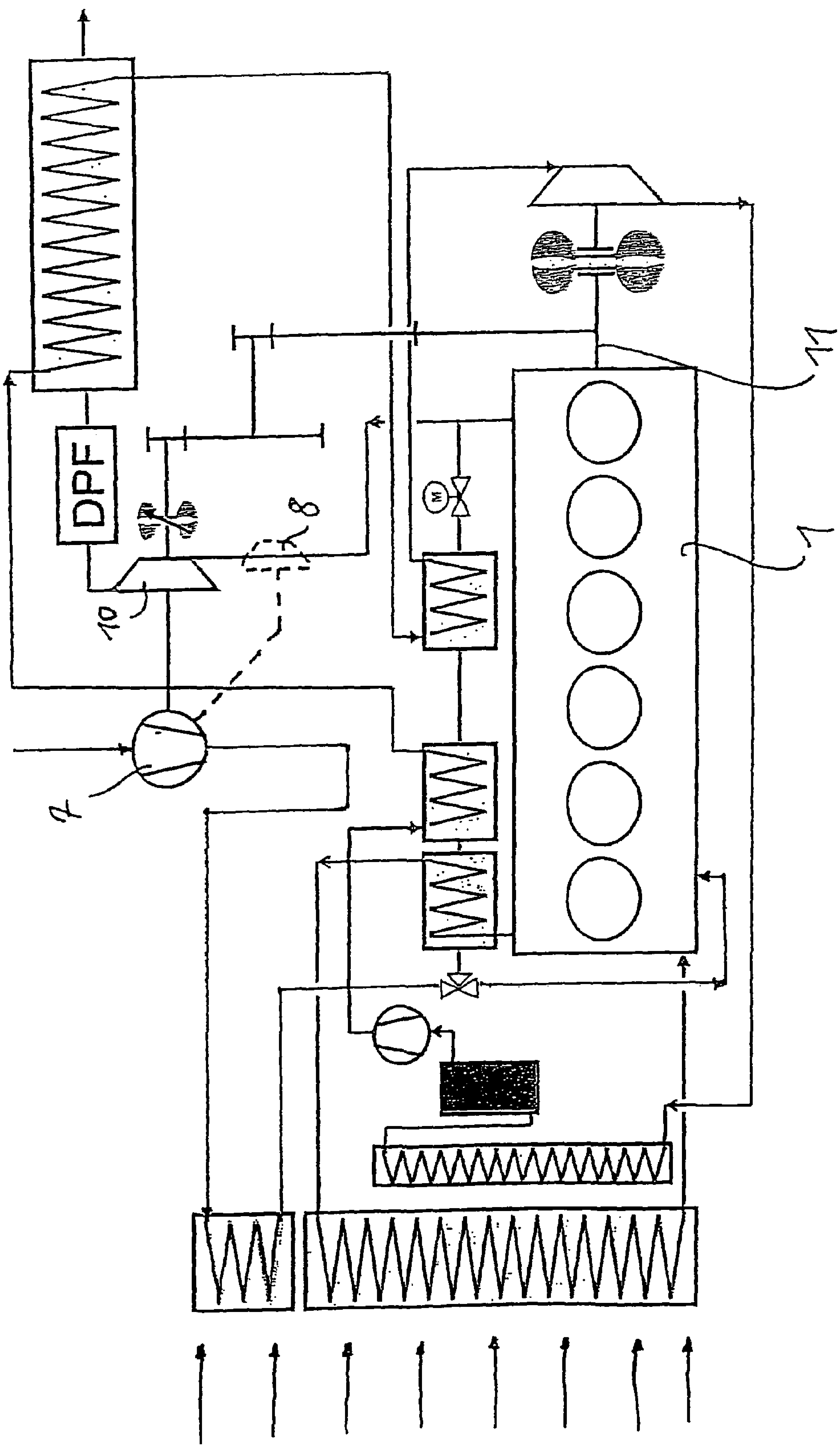

Fig. 2

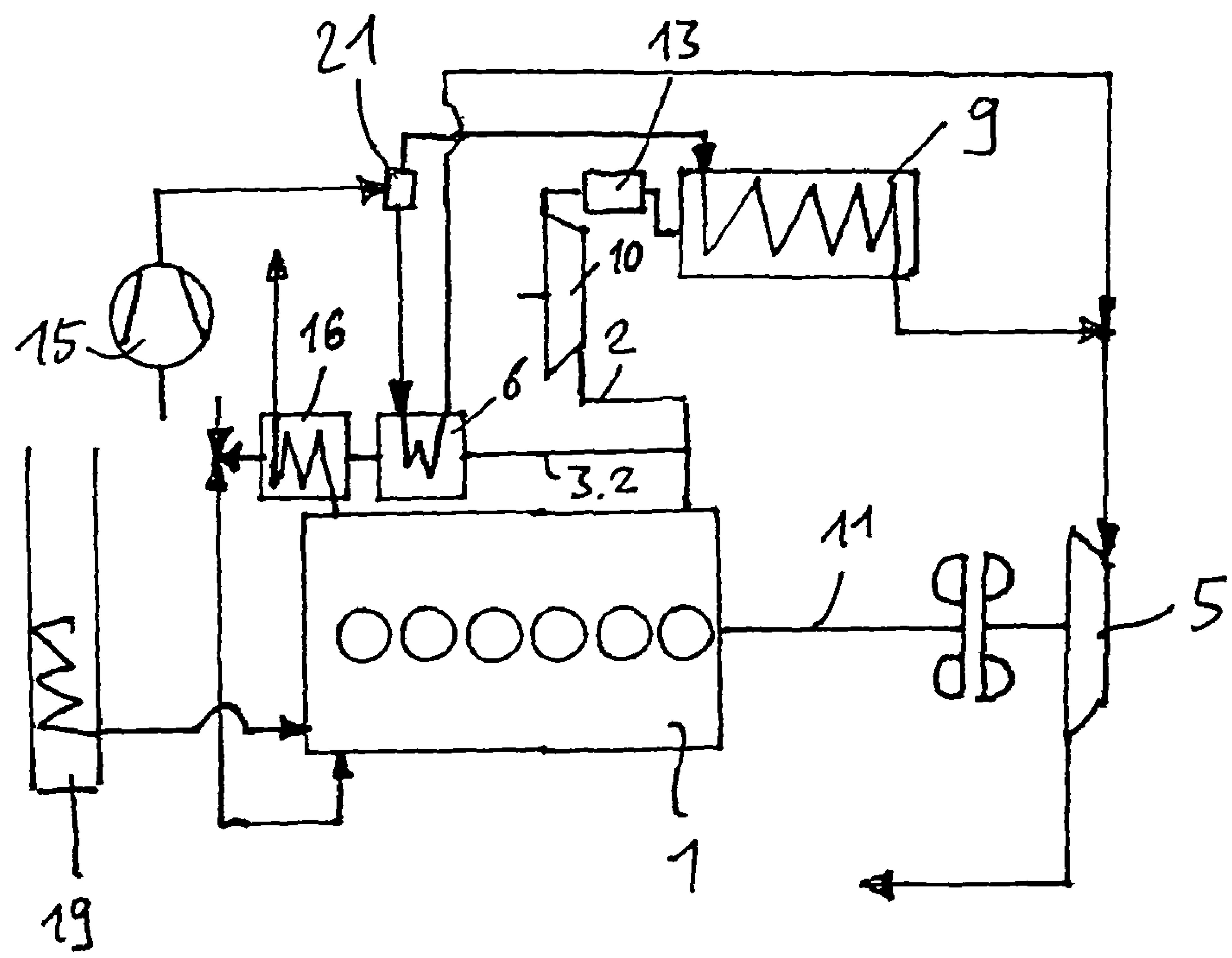

Fig. 3

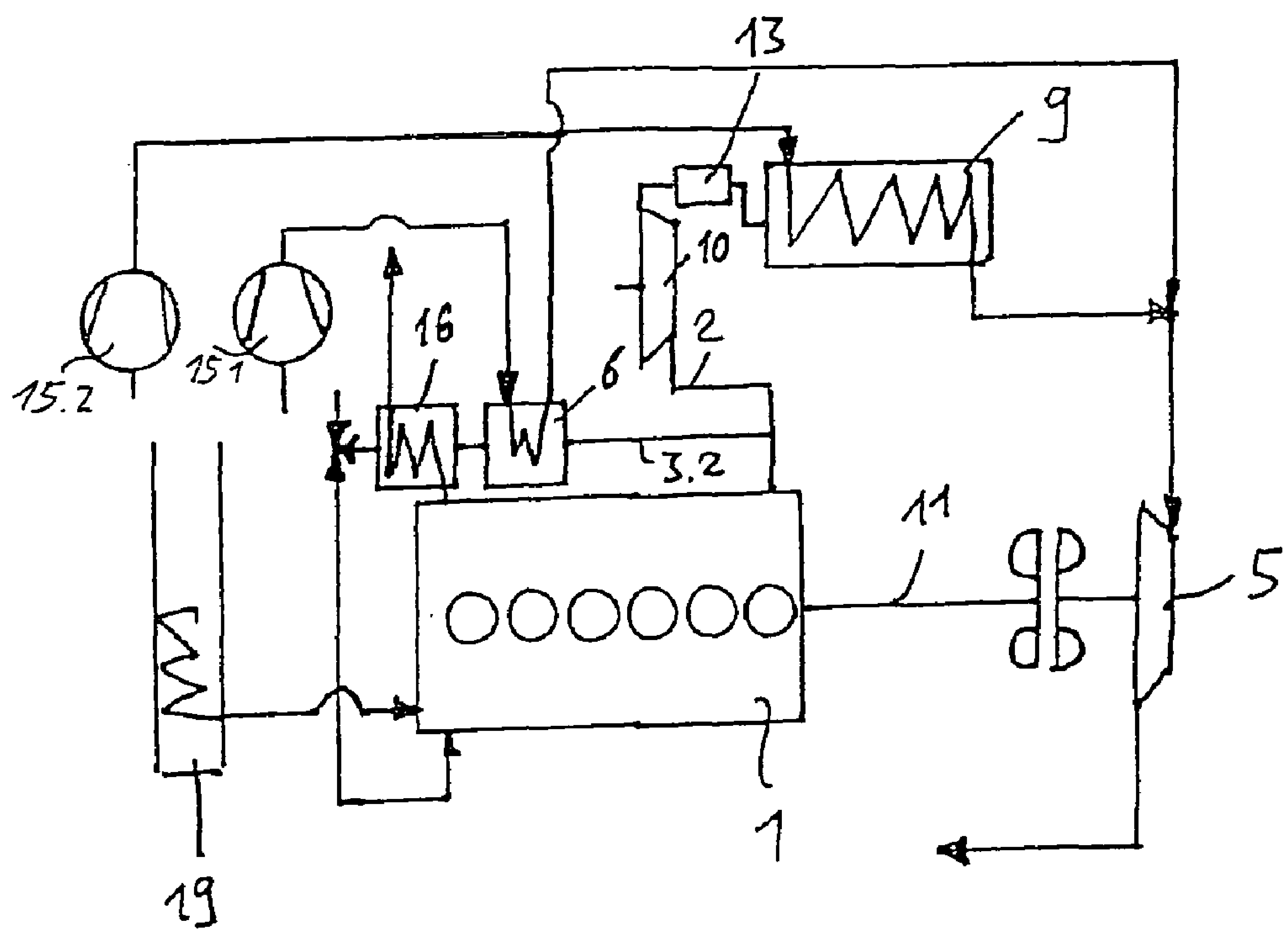

Fig. 4

DRIVE TRAIN, PARTICULARLY FOR TRUCKS AND RAIL VEHICLES

[0001] The present invention relates to a drive train, especially for commercial motor vehicles such as trucks, buses, construction machines, motor coaches of rail vehicles or locomotives, comprising an internal combustion engine and a steam cycle which is operated at least partly with heat obtained during the operation of the internal combustion engine. It can also be used in passenger cars or other mobile or stationary installations.

[0002] Drive trains are known in which an expansion machine in a steam cycle is provided as a second drive unit in addition to an internal combustion engine as the first drive unit. The internal combustion engine is used for driving the drive train or the vehicle. The expansion machine can also be used for driving the vehicle according to a first embodiment, which means feeding drive power to the drive train for transfer to the drive wheels of the vehicle, or driving a secondary unit, e.g. a generator, in the drive train. Conventional heat from the exhaust gas stream of the internal combustion engine is used for evaporating the working medium of the steam cycle, with a heat exchanger which guides the working medium of the steam cycle being arranged in the exhaust gas stream of the internal combustion engine and is energized by the exhaust gas in such a way that the heat from the exhaust gas is transferred to the working medium.

[0003] Heat which would be emitted via the exhaust to the ambient environment without providing the steam cycle and the utilization of the waste heat is used conventionally for steam generation. The generated steam is then guided through the expansion machine in which it expands under delivery of work. Thereafter, the expanded steam is guided through a condenser in which it condenses by supplying heat to the cooling system of the vehicle, in order to be supplied in the liquid state via a pump to the heat exchanger in the exhaust gas stream again, which is also known as the steam generator.

[0004] The provision of a steam cycle conventionally leads to the consequence that more heat needs to be carried off via the vehicle cooling system, and the vehicle cooling system needs to be configured to be more respectively powerful. For example, a cooling air flow needs to be guided by a fan of the vehicle cooling system through the condenser.

[0005] Recently, drive trains are equipped with so-called exhaust gas recirculation (EGR), especially motor vehicles, in order to adjust the emission values of the internal combustion engine to the requirements stipulated under the law. Exhaust gas is guided from the exhaust side of the internal combustion engine to the fresh air side of the internal combustion engine and mixed with fresh air. The mixture is then introduced for combustion together with the fuel into the various cylinders of the internal combustion engine, compressed and combusted under delivery of work. The share of exhaust gas acts virtually as an inert gas during the combustion.

[0006] The share of the exhaust gas stream which is guided in the exhaust gas recirculation to the fresh air side needs to be cooled as a result of its high temperature with which it exits from the internal combustion engine. This occurs conventionally via the vehicle cooling system, namely with cooling water in a heat exchanger which is disposed accordingly in the exhaust gas recirculation. The heat introduced via the exhaust gas recirculation into the cooling water needs to be passed to the ambient environment via the vehicle radiator, which consequently requires a large radiator surface or a strongly increased drive power for the cooler fan, and optionally a respectively strong cooling water pump in order to circulate a large cooling water flow in the cooling water cycle.

[0007] An especially large quantity of heat is introduced into the vehicle cooling system in drive trains, especially in motor vehicles, with exhaust gas recirculation and a steam cycle.

[0008] The heat quantity introduced into the vehicle cooling system can be increased in such way that the drive train is provided with a so-called supercharged internal combustion engine. It is known that in such supercharging an exhaust gas turbine is arranged in the exhaust gas stream, which turbine drives a compressor which compresses the fresh air for combustion in the internal combustion engine. During the compression, the fresh air is heated and needs to be cooled again accordingly before it is introduced into the internal combustion engine. This conventionally also occurs via the vehicle radiator, usually via an air/air heat exchanger in contrast to the cooling of the cooling water in an air/water heat exchanger. The air/air heat exchanger also needs to be configured in a respectively powerful way.

[0009] The unexamined German application DE 10 2006 036 122 A1 describes a drive device with an internal combustion engine which generates an exhaust gas stream. A portion of the exhaust gas is recirculated by means of exhaust gas recirculation to the fresh air side of the internal combustion engine. A heat exchanger is arranged in the exhaust gas recirculation by means of which heat is transferred from the recirculated exhaust gas to a working medium cycle with an expansion machine. As a result, a part of the heat of the exhaust gas guidance in the expansion machine can be utilized. This utilization of the heat is not optimal however.

[0010] The present invention is based on the object of providing a drive train, especially for a motor vehicle, e.g. a rail vehicle or truck, but also a passenger car, which is optimized with respect to emission values of the internal combustion engine and fuel consumption and simultaneously reduces the load on the cooling system by a comparatively low introduction of heat into the same.

[0011] The object in accordance with the invention is achieved by a drive train with the features of claim **1**. Advantageous and especially appropriate embodiments of the invention are given in the dependent claims.

[0012] The drive train in accordance with the invention comprises an internal combustion engine which generates an exhaust gas stream. The exhaust gas stream is guided to an exhaust gas line which is connected accordingly to the internal combustion engine. It is understood that several exhaust gas lines can be provided in parallel and/or in series with one another.

[0013] Furthermore, a supply air line system is provided which comprises at least one supply air line for supplying a supply air flow for combustion in the internal combustion engine. The supply air line system is connected accordingly to the internal combustion engine. The supplied air can concern fresh air or, as illustrated, a mixture of fresh air and exhaust gas which is mixed with exhaust gas, for which purpose a fresh air line is provided in the supply air line system and a recirculating line from the exhaust gas side to the fresh air side of the internal combustion engine.

[0014] The drive train in accordance with the invention further comprises a steam cycle which is operated with a working medium which evaporates in a heat exchanger, expands thereafter by an expansion machine by delivery of work and is condensed thereafter in a condenser. The working medium can be water or any other liquid that is capable of evaporation.

[0015] In accordance with the invention, the heat exchanger, or at least one heat exchanger by means of which the working medium in the steam cycle is evaporated at least in part, is provided in the recirculating line for the exhaust gas, so that heat from the exhaust gas recirculation can be used for evaporation of the working medium. Evaporation of the working medium shall be understood as being any kind of heat transfer into the working medium, irrespective of whether the working medium is present on the working medium side in the evaporated state or partly evaporated state at the end of the heat exchanger in which the heat transfer occurs, and if not yet it is completely evaporated especially in a further heat exchanger.

[0016] According to a first embodiment in accordance with the invention, at least two heat exchangers for evaporating the working medium of the steam cycle are provided in the exhaust gas recirculation, which means in the recirculating line as described initially. The exhaust gas in the recirculating line flows through the first heat exchanger at first and thereafter through the second heat exchanger, with the gas emitting heat to the working medium in each heat exchanger. The working medium of the steam cycle flows accordingly first through the second heat exchanger in the recirculating line, thereafter through a further heat exchanger which is provided in the exhaust gas line which is provided with an exhaust gas stream designated for further guidance to the ambient environment, and finally through the first heat exchanger in the recirculating line. As a result, two heat exchangers are provided in the recirculating line for evaporation of the working medium of the steam cycle with mutually different temperature levels. The interposed further heat exchanger in the exhaust gas line lies with respect to the temperature level at a level between the temperature level of the first and second heat exchanger in the recirculating line, usually as a result of an exhaust gas turbine provided upstream in the exhaust gas line and/or a diesel particle filter.

[0017] According to an alternative embodiment in accordance with the invention, a heat exchanger is provided in the recirculating line parallel to a further heat exchanger in the exhaust gas line with respect to the flow of the working medium in the steam cycle, with a control member provided before and/or after the heat exchangers in the direction of flow of the working medium being used to divided the working medium flow optionally in relation to both heat exchangers. The division can optionally occur in a variable manner according to an advantageous embodiment in such a way that the entire working medium flow flows through the heat exchanger in the recirculating line or through the further heat exchanger in the exhaust gas line, or that the entire flow is divided among both heat exchangers at a fixedly predetermined or variably adjustable ratio. It is also possible to provide a bypass for the working medium of the steam cycle, which is the heat exchanger in the recirculating line and the further heat exchanger in the exhaust gas line, by means of which the working medium can be guided partly or entirely past the two heat exchangers.

[0018] When a heat exchanger for evaporating the working medium of the steam cycle in the exhaust gas recirculation is provided in accordance with the invention, it is then especially possible to omit the conventional water/gas heat exchanger of the vehicle cooling system, by means of which the heat was guided into the cooling water from the share of the exhaust gas stream guided through the exhaust gas recirculation, or a respectively smaller dimensioned water/gas heat exchanger of the vehicle cooling system can be provided in addition, through which cooling water is guided. Since less heat is introduced into the cooling water as compared with conventional systems by utilizing heat from the exhaust gas recirculation for the steam cycle or for generating steam, it is possible to dimension the vehicle cooling system for a lower maximum cooling power, in that the radiator by means of which heat is carried off from the cooling water to the ambient environment is reduced in size, or the cooling water flow in the vehicle cooling system is reduced.

[0019] A further heat source which can be used alternatively or additionally for generating steam, which means for evaporating the working medium of the steam cycle, is arranged in a drive train with supercharged internal combustion engine behind a compressor in the direction of flow of the fresh air, which compressor compresses the fresh air and is driven especially via an exhaust gas turbine in the exhaust gas stream of the internal combustion engine. It is understood that it is also possible to compress a mixture of fresh air and exhaust gas with such a compressor and/or to drive the compressor differently than with an exhaust gas turbine, e.g. via the crankshaft of the internal combustion engine. It is further possible to provide a single compressor in the supply air line system, behind which the heat exchanger for steam generation is positioned in the direction of flow of the fresh air. It is alternatively possible to provide several compressors behind one another or a multi-stage compressor in the supply air line system and to then arrange a respective heat exchanger for steam generation between two compressors or between two compressor stages or behind several or all compressors or compressor stages. As a result, the heat produced during the compression of the supplied air can be used in a purposeful manner for operating the expansion machine and thus for generating drive power.

[0020] The invention will be explained below in an exemplary manner by reference to embodiments, wherein:

[0021] FIG. **1** shows a drive train in accordance with the invention with a plurality of heat exchangers used for steam generation in the exhaust gas recirculation and a further heat exchanger in the exhaust gas stream of the internal combustion engine;

[0022] FIG. **2** shows an embodiment according to FIG. **1**, but with an additionally integrated turbocompound system;

[0023] FIG. **3** shows an alternative arrangement of the invention with a division of the flow of the working medium of the steam cycle to parallel switched heat exchangers in the exhaust gas recirculation and the exhaust gas line;

[0024] FIG. **4** shows a modification of FIG. **3**;

[0025] FIG. **1** shows an internal combustion engine **1** with an exhaust gas line **2** and a supply air line system **3**. The supply air line system **3** comprises a fresh air line **3.1** in which a compressor **7** is arranged. The compressed fresh air is mixed with a proportion of the exhaust gas which is recirculated via a recirculating line **3.2** to the fresh air side of the internal combustion engine **1** and supplied to the internal combustion engine **1** for combustion. In the present case, the quantity of the recirculated share which flows through the recirculating line **3.2** can be adjusted via a control valve **12**.

[0026] The compressor **7** for compressing fresh air is driven via an exhaust gas turbine **10** which is arranged in the exhaust gas stream of the internal combustion engine **1**. A particle filter **13** for filtering particles, especially exhaust particulates, from the exhaust gas stream is arranged in the direction of flow behind the exhaust gas turbine **10**.

[0027] A steam cycle **4** is provided in accordance with the invention in which steam is generated which expands in the expansion machine **5** and is condensed in a condenser **7**. In the present case, the expansion machine **5**, e.g. in the form of a steam turbine or a piston engine, is used for introducing drive power into the crankshaft **11** of the internal combustion engine. It would alternatively also be possible to drive an auxiliary unit of the drive train with the expansion machine **5**, or to introduce drive power to the drive wheels via another drive connection when used in a motor vehicle.

[0028] In the illustrated embodiment, the condensed steam is guided into a collecting vessel **14** and thereafter through a pump **15** in order to circulate the working medium of the steam cycle **4** in the steam cycle or to bring the working medium to the required pressure.

[0029] In the embodiment as shown in FIG. **1**, three heat exchangers **6**.**1**, **6**.**2** and **16** are arranged in the recirculating line **3**.**2** of the supply air line system **3**, which heat exchangers are flowed through successively in the direction of flow of the recirculated exhaust gases in the mentioned sequence before the exhaust gas is mixed with fresh air from the fresh air line **3**.**1**. Accordingly, the first heat exchanger **6**.**1** is provided with the recirculated share of the exhaust gas stream at a higher temperature than the second heat exchanger **6**.**2**, the third heat exchanger **16** will only be provided or a cooling of the recirculated exhaust gas will only occur when this is necessary as a result of a too high outlet temperature of the recirculated exhaust gas stream from the second heat exchanger **6**.**2**.

[0030] The working medium of the steam cycle **4** is guided at first through the second heat exchanger **6**.**2** in the recirculating line **3**.**2** before it enters the first heat exchanger **6**.**1** in the recirculating line **3**.**2**. Furthermore, a further heat exchanger **9** is provided in the steam cycle between the second heat exchanger **6**.**2** and the first heat exchanger **6**.**1** in order to heat or evaporate the working medium of the steam cycle **4**. Said further heat exchanger **9** is arranged in the exhaust gas stream of the proportion of exhaust gas which is passed to the ambient environment after flowing through the further heat exchanger **9**. In this case, the further heat exchanger **9** is provided in the direction of flow of the exhaust gas behind the particle filter **13**.

[0031] The illustrated number of heat exchangers and the presently described specific sequence of through-flow of the same with exhaust gas and working medium of the steam cycle **4** optimizes the introduction of heat into the working medium by means of the temperature level at which the heat transfer occurs. It is possible to deviate from the illustrated embodiment, e.g. the further heat exchanger **9** can be provided at a different position in the exhaust gas stream. Alternatively or in addition, three or more heat exchangers which are flowed through by working medium could be provided in the recirculating line **3**.**2**. Finally, as it is illustrated, the heat exchanger **16** which is flowed through by cooling water could be saved or be replaced for example by an exhaust gas/cooling air heat exchanger or other heat exchanger.

[0032] It is naturally also possible to save the particle filter **13** or to position the same at another position in the exhaust gas stream. Alternatively or additionally, the use of an SCR system for selective catalytic reduction of nitrogen oxides in the exhaust gas is possible, e.g. at the position of the particle filter **13** or behind the same, or naturally at another position. It is also possible to provide an SCRT® system (selective catalytic reduction trap), or a combination of CRT® and SCR system. A CRT® combines the effect of a particle filter with that of an oxidation catalytic converter.

[0033] In the embodiment as shown in FIG. **1**, the fresh air (charge air) which is compressed in the compressor **7** in the fresh air line **3**.**1** is cooled in an air-cooled heat exchanger **17** of the cooling system in an application in a motor vehicle, especially a motor vehicle cooling system, before it is mixed with the recirculated exhaust gas. A respective cooling could be provided in addition or alternatively even after the mixture. Especially advantageously, a respective heat exchanger or several heat exchangers for cooling this compressed fresh air, before or after its mixture with the recirculated exhaust gas, could be "cooled" by the working medium of the steam cycle **4**, so that this occurring heat could also be used for steam generation.

[0034] FIG. **1** shows a cooling water cycle with reference numeral **18** in which a radiator **19** (water/air radiator) is arranged, as is known. Reference numeral **20** indicates the respective cooling air which is guided through the radiator **19** or the heat exchanger **17**. As is shown, the cooling water in the cooling cycle, especially the vehicle cooling cycle, is used for cooling the internal combustion engine **1** and, in the specially illustrated embodiment, for additionally cooling down the recirculated exhaust gas stream, when the maximum possible heat was extracted from the same by means of the steam cycle **4**.

[0035] In the illustrated embodiment, the condenser **7** is also supplied with the cooling air **20**.

[0036] In the embodiment as shown in FIG. **2**, in connection of which the description of FIG. **1** also applies accordingly, the drive power of the exhaust gas turbine **10** is additionally transferred to the crankshaft **11** of the internal combustion engine **1**, which occurs here via a respective transmission. When the direction of power is reversed, the compressor **7** can thus be driven for compressing the fresh air by means of the internal combustion engine **1**, which advantageously always occurs when an only comparatively low exhaust gas stream is available. The so-called turbo lag can thus be reduced or avoided.

[0037] As is indicated with the broken line, the compressor **7** can also be driven via an exhaust gas turbine **8** (turbo-supercharger turbine) which is provided in addition to the exhaust gas turbine **10** in the exhaust gas stream or the exhaust line **2** and is usually provided upstream with respect to the direction of the exhaust gas stream of the exhaust gas turbine **10**, and the exhaust gas turbine **10** (which is then designated as an exhaust gas power turbine) is used exclusively for introducing drive power into the crankshaft **11** of the internal combustion engine **1** in order to form a turbocompound system.

[0038] FIG. **3** shows an embodiment in which the respective components are marked with respective reference numerals. FIG. **3** does not show all components that were explained in detail in FIGS. **1** and **2**. The internal combustion engine **1** is shown in which crankshaft **11** is in a drive connection with the expansion machine **5** via a hydrodynamic coupling which can be arranged to be controllable or non-controllable as in the previously illustrated embodiments, or can be switched into such a drive connection. Instead of a hydrodynamic coupling it is also possible to provide any other non-hydrodynamic coupling, especially one that is controllable. The internal combustion engine **1** is cooled by means of a cooling medium (usually cooling water) which is circulated in a cooling cycle (see the indicated radiator **19**). In this respect, reference can be made to the description in FIG. **1**. A recirculating line **3**.**2** for recirculated exhaust gas is provided here again, and an exhaust gas line **2** with an exhaust gas turbine **10** and diesel particulate filter **13**. It is understood that the exhaust gas turbine **10** and/or the diesel particulate filter **13** could be omitted if so desired. The statements made above apply to the further exhaust gas treatment.

[0039] The working medium of the steam cycle flows from the pump **15** to a control member **21**. It would principally be possible that the working medium flows through one or several further heat exchangers (not shown) before it enters the control member **21**, e.g. a heat exchanger in a vehicle cooling cycle and/or a heat exchanger for intermediate cooling of compressed fresh air (charge air cooler). The control member **21** causes a division of the working medium flow of the steam cycle in the direction towards a heat exchanger **6** in the recirculating line **3**.**2** in the direction to a further heat exchanger **9** in the exhaust gas line **2**. The working medium flow of the steam cycle is combined again after these two heat exchangers **6**, **9** and supplied to the expansion machine **5**. It is obvious that here further heat exchangers could be provided.

[0040] The control member **21** is usually triggered by means of a control apparatus in such a way that the division of the working medium flow in the steam cycle to the two heat exchangers **6** and **9** occurs depending on one or several predetermined input quantities which can be detected or calculated. Such an input quantity can be a temperature at a certain point in the exhaust gas stream, the drive train or the steam cycle for example. The speed, the torque and/or the power output of the internal combustion engine **1** could be used as an input quantity. Further input quantities are possible.

[0041] FIG. **4** shows a modification of FIG. **3**, in which the division of the working medium flow in the steam cycle to the two parallel heat exchangers **6** and **9** is not achieved by means of a control member dividing the working medium flow but by two pumps **15**.**1** and **15**.**2** which are switched in parallel with respect to one another. As a result, pump **15**.**1** conveys the working medium flow in the steam cycle through the heat exchanger **6** in the recirculating line **3**.**2**, and pump **15**.**2** conveys the working medium flow of the steam cycle through the further heat exchanger **9** in the exhaust gas line **2**. When the pumps **15**.**1** and **15**.**2** are arranged to be controllable or adjustable with respect to their conveying performance and are arranged especially to be speed-controlled or speed-adjusted, the working medium volume flow or the working medium mass flow in each of the parallel branches of the steam cycle, which is in the branch with heat exchanger **6** and in the branch with heat exchanger **9**, can be controlled or adjusted individually. The pumps **15**.**1** and **15**.**2** can be arranged like pump **15** in the preceding embodiments as a displacement machine for example. Other arrangements are also possible, e.g. as a turbo machine. The two pumps **15**.**1** and **15**.**2** which are thus especially individually speed-controlled or speed-adjusted convey for example from a common collecting vessel for working medium, e.g. as was shown with reference to FIG. **1**.

[0042] The described invention is preferably used in a motor vehicle. An application in a stationary drive train, e.g. in a block heating station, is possible for example. In the case of an application in a vehicle, the internal combustion engine (optionally in addition to the expansion machine **5** used for driving the car) may be the only drive unit for driving the vehicle, or further drive units for driving the vehicle can be provided, e.g. an electric motor.

1-**9**. (canceled)

10. A drive train, especially for a commercial vehicle,
with an internal combustion engine which produces an exhaust gas stream;
with an exhaust gas line which is connected to the internal combustion engine;
with a supply air line system for supplying a supply air flow for combustion in the internal combustion engine, which supply air line system is connected to the internal combustion engine;
with a steam cycle, comprising an expansion machine, at least one heat exchanger in order to evaporate the working medium of the steam cycle, and a condenser;
the supply air line system comprises a fresh air line for supplying a fresh air flow for combustion in the internal combustion engine and a recirculating line for recirculating a part of the exhaust gas stream to the fresh air side for combustion in the internal combustion engine; characterized in that
a plurality of heat exchangers for evaporation of the working medium of the steam cycle is provided in the recirculating line, and a further heat exchanger for evaporation of the working medium of the steam cycle in the exhaust gas line which is supplied with an exhaust gas stream intended for being conducted to the ambient environment, and the working medium of the steam cycle is first conducted through a second heat exchanger in the recirculating line, then through the further heat exchanger in the exhaust gas line and then through a first heat exchanger in the recirculating line, with the recirculated part of the exhaust gas stream first being conducted through the first heat exchanger and then through the second heat exchanger, and is thereby cooled.

11. A drive train according to claim **10**, characterized in that in the supply air line system a compressor is arranged which is especially driven by an exhaust gas turbine, in the exhaust gas stream and which especially compresses fresh air supplied to the internal combustion engine for combustion, and a heat exchanger is arranged in the supply air line system in the direction of flow behind the compressor and is supplied with the compressed supply air or a mixture of compressed supply air and recirculated exhaust gas stream and extracts heat from the same for evaporating the working medium of the steam cycle.

12. A drive train according to claim **11**, characterized in that several compressors or a multi-stage compressor is provided in the supply air line system, and the heat exchanger is arranged in the direction of flow between the compressors or compressor stages, or one heat exchanger each is arranged in the direction of flow behind one and especially behind each compressor.

13. A drive train according to claim **10**, characterized in that following the heat exchanger in the recirculating line or the second heat exchanger the recirculated part of the exhaust gas stream is conducted and cooled by a heat exchanger embedded in a cooling cycle, especially a vehicle cooling cycle.

14. A drive train according to claim **11**, characterized in that following the heat exchanger in the recirculating line or the second heat exchanger the recirculated part of the exhaust gas stream is conducted and cooled by a heat exchanger embedded in a cooling cycle, especially a vehicle cooling cycle.

15. A drive train according to claim **12**, characterized in that following the heat exchanger in the recirculating line or the second heat exchanger the recirculated part of the exhaust gas stream is conducted and cooled by a heat exchanger embedded in a cooling cycle, especially a vehicle cooling cycle.

16. A drive train according to claim **10**, characterized in that an exhaust gas turbine is arranged in the exhaust gas stream, by means of which drive power can be transferred to a crankshaft of the internal combustion engine, and the part of the exhaust gas stream which is conducted through the recirculating line is branched off from the exhaust gas stream before the exhaust gas turbine in the direction of flow.

17. A drive train according to claim **11**, characterized in that an exhaust gas turbine is arranged in the exhaust gas stream, by means of which drive power can be transferred to a crankshaft of the internal combustion engine, and the part of the exhaust gas stream which is conducted through the recirculating line is branched off from the exhaust gas stream before the exhaust gas turbine in the direction of flow.

18. A drive train according to claim **12**, characterized in that an exhaust gas turbine is arranged in the exhaust gas stream, by means of which drive power can be transferred to a crankshaft of the internal combustion engine, and the part of the exhaust gas stream which is conducted through the recirculating line is branched off from the exhaust gas stream before the exhaust gas turbine in the direction of flow.

19. A drive train according to claim **13**, characterized in that an exhaust gas turbine is arranged in the exhaust gas stream, by means of which drive power can be transferred to a crankshaft of the internal combustion engine, and the part of the exhaust gas stream which is conducted through the recirculating line is branched off from the exhaust gas stream before the exhaust gas turbine in the direction of flow.

20. A drive train according to claim **14**, characterized in that an exhaust gas turbine is arranged in the exhaust gas stream, by means of which drive power can be transferred to a crankshaft of the internal combustion engine, and the part of the exhaust gas stream which is conducted through the recirculating line is branched off from the exhaust gas stream before the exhaust gas turbine in the direction of flow.

21. A drive train according to claim **15**, characterized in that an exhaust gas turbine is arranged in the exhaust gas stream, by means of which drive power can be transferred to a crankshaft of the internal combustion engine, and the part of the exhaust gas stream which is conducted through the recirculating line is branched off from the exhaust gas stream before the exhaust gas turbine in the direction of flow.

22. A drive train according to claim **16**, characterized in that the further heat exchanger is arranged in the direction of flow behind the exhaust gas turbine in the exhaust gas stream.

23. A drive train according to claim **17**, characterized in that the further heat exchanger is arranged in the direction of flow behind the exhaust gas turbine in the exhaust gas stream.

24. A drive train according to claim **18**, characterized in that the further heat exchanger is arranged in the direction of flow behind the exhaust gas turbine in the exhaust gas stream.

25. A drive train according to claim **19**, characterized in that the further heat exchanger is arranged in the direction of flow behind the exhaust gas turbine in the exhaust gas stream.

26. A drive train according to claim **20**, characterized in that the further heat exchanger is arranged in the direction of flow behind the exhaust gas turbine in the exhaust gas stream.

27. A drive train according to claim **21**, characterized in that the further heat exchanger is arranged in the direction of flow behind the exhaust gas turbine in the exhaust gas stream.

* * * * *