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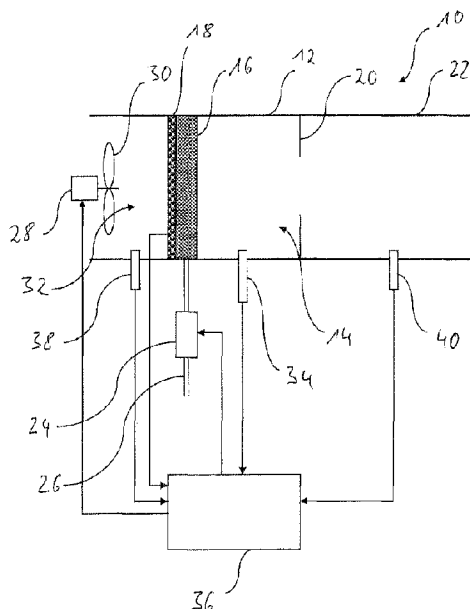
(72) Inventeurs/Inventors:
BLASCHKE, WALTER, DE;
HUMBURG, MICHAEL, DE;
PFISTER, WOLFGANG, DE;
JENSEN, HANS, DE

(73) Propriétaire/Owner:
EBERSPACHER CLIMATE CONTROL SYSTEMS
GMBH & CO. KG, DE

(74) Agent: NORTON ROSE FULBRIGHT CANADA
LLP/S.E.N.C.R.L., S.R.L.

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(54) Title: PROCESS FOR OPERATING A FUEL-OPERATED VEHICLE HEATER



(57) **Abrégé/Abstract:**

A fuel-operated vehicle heater includes a burner area with a combustion chamber, a fuel pump, and a combustion air blower. A pressure sensor detects a feed back pressure. An actuating unit actuates the fuel pump with a predefined value of a pump operating variable, and actuates the combustion air blower with a predefined value of a blower operating variable. A process for operating such a fuel-operated vehicle heater includes detecting the feed back pressure in case of a feed operating state set during the combustion operation and comparing the detected feed back pressure (P_e) with an expected feed back pressure (P_E) for the set feed operating state. If the detected feed back pressure deviates from the expected feed back pressure the pump operating variable is changed such that the feed back pressure changes toward the expected feed pressure and/or essentially corresponds to the expected feed back pressure.

Abstract

A fuel-operated vehicle heater includes a burner area with a combustion chamber, a fuel pump, and a combustion air blower. A pressure sensor detects a feed back pressure. An actuating unit actuates the fuel pump with a predefined value of a pump operating variable, and actuates the combustion air blower with a predefined value of a blower operating variable. A process for operating such a fuel-operated vehicle heater includes detecting the feed back pressure in case of a feed operating state set during the combustion operation and comparing the detected feed back pressure (P_e) with an expected feed back pressure (P_E) for the set feed operating state. If the detected feed back pressure deviates from the expected feed back pressure the pump operating variable is changed such that the feed back pressure changes toward the expected feed pressure and/or essentially corresponds to the expected feed back pressure.

PROCESS FOR OPERATING A FUEL-OPERATED VEHICLE HEATER

TECHNICAL FIELD

5 The present invention pertains to a process for operating a fuel-operated vehicle heater.

BACKGROUND

In connection with efforts to reduce crude oil consumption and to lower the emission of hazardous substances, attempts are increasingly being made to also use synthetically produced fuels to operate
10 fuel-operated vehicle heaters. Such a synthetic fuel is, for example, OME (oxymethylene ether).

One problem in using such fuels is that these have a different, generally lower calorific value than conventional fuels, for example, diesel. If such synthetic fuel is used or mixed with conventionally used fuel, for example, diesel, this may lead to the problem that the combustion carried out with a
15 mixture of combustion air and fuel produced at that time during an operation of a vehicle heater on the basis of operating parameters predefined for conventional fuels, for example, diesel, may lead to an excess emission of hazardous substances, on the one hand, and, on the other hand, cannot supply the heat output actually expected for the operation of the heater. The basis of this problem is that no direct information about the grade of the fuel being used is generally available or can be made
20 available for the heater. There is also generally no possibility of being able to evaluate the quality of the combustion taking place by the detection of the CO₂ content in the waste gas and to take compensatory actions based thereon in the actuation of a combustion air blower or of a fuel pump, especially in retrofit systems despite the possibility of being able to provide a sensor detecting the CO₂ content in the waste gas.

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SUMMARY

An object of the present invention is to provide a process for operating a fuel-operated vehicle heater, with which a heat output needed for the required operation of the heater can also be ensured in a reliable manner when using fuels of different grades.

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According to the present invention, this object is accomplished by a process for operating a fuel-operated vehicle heater, the vehicle heater comprising a burner area with a combustion chamber; a fuel pump for feeding fuel to the combustion chamber; and a combustion air blower for feeding combustion air to the combustion chamber, a pressure sensor being associated with the combustion air blower for detecting a feed back pressure downstream of the combustion air blower; further comprising an actuating unit for actuating the fuel pump such that the fuel pump is operated with a predefined value of a pump operating variable, and for actuating the combustion air blower such that the combustion air blower is operated with a predefined value of a blower operating variable, in which process associated with feed operating states and with a reference fuel defined by the pump operating variable and the blower operating variable, information on a feed back pressure to be expected in each case is provided, wherein the process further comprises the following steps:

- a) detection of the feed back pressure in case of a feed operating state set during the combustion operation,
- b) comparison of the detected feed back pressure with the feed back pressure to be expected for the set feed operating state, and
- c) if the detected feed back pressure deviates from the feed back pressure to be expected, changing of the pump operating variable such that the feed back pressure changes in the direction toward the expected feed pressure or/and essentially corresponds to the expected feed back pressure.

It is possible with the process according to the present invention to compensate for changes in the fuel to be burned, which changes occur in the state of combustion and become noticeable in the form of a changed feed back pressure, and thus to ensure that the heat output needed for a predefined heating operation can be ensured even when using fuels of different grades.

The combustion air blower may comprise a rotatable feed wheel, and the blower operating variable preferably corresponds to a speed of the feed wheel. Further, the fuel pump may comprise a pump piston with periodic reciprocating motion, and the pump operating variable may then correspond to a rate of motion of the pump piston.

A feed operating state may be defined as a ratio of the speed of the feed wheel to the rate of motion of the pump piston. It is in this pump piston that the expected feed back pressure (P_E) is predefined as a command variable in association with a predefined heating operation, and the detected feed back pressure (P_e) is changed in a pressure control as a control variable by changing the pump operating variable as manipulated variable in the direction toward the expected feed back pressure (P_E).

In this connection, it should be pointed out that regardless of how the information available is going to be processed, this ratio may be defined as speed/rate of motion or may be defined as rate of motion/speed.

The procedure to be carried out according to the present invention may run within the framework of a control of the feed back pressure, in which control the expected feed back pressure is used as command variable and the expected feed back pressure is the control variable to be adjusted in the direction toward the expected feed back pressure. The variable influenced by the control in this case, i.e., the manipulated variable, is the ratio of speed to rate, wherein, in principle, the speed of the combustion air blower, i.e., the fed quantity of air, remains unchanged and the rate, i.e., the fed quantity of fuel, is changed or adapted within the framework of a control loop.

As an alternative or in addition to such a control, for compensation of changes in the characteristic of the combustion being reflected in a change in the feed back pressure, a correction variable may be determined for the feed operating state associated with the expected feed back pressure be determined in step c) as a function of the deviation between the detected feed back pressure and the expected feed back pressure, and the pump operating variable be changed such that a feed operating state corrected by the correction variable is obtained. It can be ensured with such a step that the feed back pressure is very rapidly moved in the direction toward the desired value, i.e., the expected feed back pressure.

It may especially be possible to proceed such that a deviation between the ratio associated with the expected feed back pressure and the ratio associated with the detected feed back pressure is

determined, that a feed operating state deviating from the set feed operating state to the same extent as the deviation but in the opposite direction of deviation is determined as the corrected feed operating state, and that a pump operating variable associated with the corrected feed operating state with the blower operating variable being essentially unchanged is used as the changed pump operating variable to obtain the corrected feed operating state.

A change in the combustion characteristic in case of a feed operating state that is unchanged per se may, for example, also be induced by a change in the air pressure and thus a change in the quantity of oxygen fed by the blower. In order to be able to distinguish, for example, such a change in the ambient conditions, which change has an effect on the combustion characteristic, from a state, in which a change in the combustion characteristic is triggered due to the use of a different fuel, it is further proposed that the vehicle heater comprise a waste gas temperature sensor for providing waste gas temperature information, and that a reference waste gas temperature and a reference feed back pressure be determined in association with a reference feed operating state, and that step c) be carried out if the detected waste gas temperature and the detected feed back pressure deviate in a predefined manner from the reference waste gas temperature and from the reference feed back pressure in case of a set reference feed operating state.

Provisions may especially be made here for step c) to be carried out if the detected waste gas temperature is below the reference waste gas temperature and the detected feed back pressure is below the reference feed back pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described in detail below with reference to the attached figures. In the drawings,

Figure 1 shows a fuel-operated vehicle heater in a schematic diagram;

Figure 2 shows a diagram, which, plotted against a speed/rate ratio representing a feed operating state in association with different types of fuel, represents the CO₂ content

in the waste gas occurring during combustion as well as the feed back pressure occurring; and

Figure 3 shows a diagram, which shows the waste gas temperature to be expected and the feed back pressure to be expected for a reference feed operating state.

DETAILED DESCRIPTION

A fuel-operated vehicle heater is generally designated by 10 in Figure 1. The vehicle heater 10 comprises a burner area 12 with a combustion chamber 14 formed in it. A porous evaporator medium 16, for example, metal nonwoven, metal mesh, foamed ceramic or the like, is provided at a bottom area of the burner area 12. Further, an electrically energizable heating device 18 may be provided at the bottom area, which heating device may support an evaporation of fuel from the porous evaporator medium 16 especially during the start phase of the combustion operation. The combustion chamber 14 is essentially defined by a flame diaphragm 20. The combustion waste gases generated during combustion flow into a flame tube 22 in the direction toward a heat exchanger unit, in which heat transported in the combustion waste gases can be transferred to a medium to be heated, for example, air or water.

A fuel pump 24, for example, a feed pump, which is configured with a pump piston with periodic reciprocating motion, feeds the fuel needed for combustion from a fuel storage device, not shown, via a fuel line 26 into the porous evaporator medium 16. The liquid fuel is distributed in the evaporator medium 16 due to capillary feed action and is evaporated towards the combustion chamber 14 on the side of the evaporator medium facing the combustion chamber 14.

A combustion air blower, which is generally designated by 28, feeds the air needed for combustion by means of a feed wheel 30, which is driven to rotate, into a volume 32 upstream of the combustion chamber 14, which volume is also generally designated as plenum. The feed wheel 30 may include, but is not limited to, a fan. The combustion air fed by the combustion air blower 28 flows into the combustion chamber 14 and is mixed there with the fuel vapor via openings provided in a circumferential wall of the combustion chamber assembly unit 12 enclosing the combustion chamber 14 or/and in a combustion air inlet pipe provided at the bottom area, which openings are

provided or otherwise allow the entry of air into the combustion chamber 14. The mixture of combustion air and fuel vapor thus generated may be ignited at the beginning of the combustion operation by means of an ignition element 34, for example, a glow plug.

5 The fuel pump 24, the combustion air blower 28, the heating device 18 and the ignition element 34 are actuated by an actuating unit generally designated by 36. Corresponding to the combustion operation predefined for the heater 10 or the required heat output, the actuating unit 36 actuates the fuel pump 24 and the combustion air blower 28 such that a combustible mixture of combustion air and fuel is provided in the desired mixing ratio and with the quantity in the combustion chamber 14
10 needed for combustion. In this case, a feed operating state associated with a required heat output can be defined by using the speed of the feed wheel 30 as a blower operating variable and the rate of motion of a pump piston of the fuel pump 24 as a pump operating variable. In particular, such a feed operating state may be defined as the ratio of the speed to the rate of motion. For any heat output required during the heating operation or for a corresponding feed operating state, a
15 predefined speed and a correspondingly predefined rate of motion may thus be predefined or be stored, for example, in the form of a table or of a characteristic diagram in the actuating unit 36. If a defined heat output shall be selected, the fuel pump 24 and the combustion air blower 28 are actuated such that they are operated with the speed and rate of motion associated with this heat output and with the corresponding feed operating state. For example, a control of the speed and of
20 the rate of motion may take place here. A direct detection of the fed quantity of air or of the fed quantity of fuel does not generally take place. There is also generally no information available as to what type of fuel is used for the combustion.

A pressure sensor 38 is associated with the heater 10. This pressure sensor is arranged downstream
25 of the combustion air blower 28, for example, in the volume 32, and consequently detects the feed back pressure, i.e., the pressure against which the combustion air blower 28 feeds. However, a temperature sensor 40, which may be provided, for example, in the area of the flame tube 22 or even further downstream, may, in principle, also be provided in the area of the combustion chamber 14, detects the temperature of waste gas leaving the combustion chamber 14. Both the waste gas
30 temperature and the feed back pressure are parameters, which are connected with the proceeding combustion. The more fuel is burned, the greater is the quantity of waste gas generated during the

combustion and the greater is the pressure, against which the combustion air blower 28 must feed. The more fuel is burned, the greater is the quantity of energy released during the combustion and the higher is the waste gas temperature.

- 5 The grade of the fuel to be burned also has an effect on the parameters detected by the sensors 38, 40. When burning a high-grade fuel, for example, diesel, a greater quantity of energy is released per burned unit quantity of the fuel, which leads to a correspondingly greater waste gas volume and feed back pressure and also to a correspondingly higher waste gas temperature. A fuel of lower grade, for example, OME, results in the release of a lower quantity of energy and accordingly a
- 10 lower waste gas temperature as well as a lower feed back pressure in case of the same fed quantity of fuel. The present invention utilizes this to carry out corrective measures during the combustion operation in the manner described below, which guarantee that the use of fuels of different grades does not result in a heat output required for a combustion operation to be set not being reached, even though the quantity of fuel predefined in association with this heat output and the
- 15 correspondingly associated quantity of combustion air are fed into the combustion chamber 14.

Figure 2 shows the connection between a feed operating state and the CO₂ content in the waste gas on the basis of the curve K₁ for a reference fuel, i.e., for example, diesel. The feed operating state is defined by the ratio between a blower operating variable represented by the speed of the feed wheel

20 30 and a pump operating variable represented by the rate of motion of a pump piston of the fuel pump 24. In particular, the feed operating state is defined by a speed/rate ratio. In order to reach a CO₂ content of about 9.5% to 9.6%, a feed operating state is set, in which the speed/rate ratio is about 1670. Assuming that the operation is carried out with this feed operating state F_E, using diesel as fuel, it can be expected that a feed back pressure P_E of about 2135 Pa is set during the then

25 proceeding combustion. It should be pointed out that in association with curve K₁, the curve K₂ represents the feed back pressure to be expected for a corresponding feed operating state.

Curve K₃ represents for different feed operating states, i.e., different speed/rate ratios, the CO₂ content respectively contained in the waste gas for an alternative fuel, for example, OME. Since

30 this alternative fuel has a markedly lower calorific value than diesel, the combustion of the same quantity of fuel, i.e., operating with the same speed/rate ratio, leads to a lower CO₂ content in the

waste gas. In order to reach the same state of combustion, i.e., to be able to release the same heat output as well, which ultimately means that the CO₂ content is also in the same range, for example, about 9.5% to 9.6%, the operation would have to be carried out with a markedly higher fuel content in the mixture when using OME as fuel, which ultimately would mean a feed operating state represented by a markedly lower speed/rate ratio of about 890.

It should now be assumed that the vehicle heater 10 is operated with a fuel of unknown grade in a feed operating state corresponding to the feed operating state F_E . As has already been explained, the expected feed back pressure P_E would be about 2135 Pa for the reference fuel diesel. It was, however, actually found that the detected feed back pressure P_e is only about 2030 Pa. In case of unchanged blower operating variable, i.e., speed, and unchanged pump operating variable, i.e., rate of motion, it can, in principle, be assumed that such a feed back pressure P_e being below the expected feed back pressure P_E can be attributed to the use of a fuel with a lower calorific value.

Without having detailed knowledge about the grade of the fuel actually used, in order to be able to ensure that the combustion is again taking place such that the heat output needed for a defined operating state to be set is produced, the deviation A between the feed operating state associated with the expected feed back pressure P_E and the feed operating state associated with the detected feed back pressure P_e is determined. Based on the set feed operating state F_E , a corrected feed operating state F_K is then determined by a deviation from the feed operating state F_E with the prior determined deviation A but in the opposite direction, i.e., while the detected feed back pressure P_e implies the presence of a fictitious feed operating state being above the set feed operating state F_E by the deviation A , the corrected feed operating state F_K corrected in the sense described above means operating with a fuel content in the air/fuel mixture, which fuel content is increased to a corresponding extent. This leads to a CO₂ content of about 9.5% to 9.6% in turn being reached when using a fuel, whose feed operating state-CO₂ content relationship is represented by curve K_4 , based on the increased quantity of fuel and with the quantity of air left unchanged, which ultimately means that the heater 10 can again be operated with the heat output predefined for a defined operating state. The correction explained above is thereby based on the assumption that the different curves shown in Figure 2 can each be approximately interpreted as linear curves at least for smaller deviations.

With the procedure described above, the feed back pressure can be moved, in the manner of a control, very rapidly in the direction toward the expected feed back pressure, when a different fuel is used as the reference fuel. Since there is a clear connection between the feed back pressure and the quality of the proceeding combustion and thus of the heat output, it is thus guaranteed that, even though there is no direct knowledge about the fuel actually used, the required heat output for a predefined heating operation is reached. As an alternative or in addition, this required heat output, i.e., the setting of the feed back pressure associated with this heat output, may also be provided within the framework of a control loop. The feed back pressure to be expected for a heat output to be set forms the command variable as a desired value in the control loop, while the detected feed back pressure forms the control variable as an actual value. As manipulated variable, the quantity of the fed fuel, i.e., e.g., the rate, at which a pump piston of the fuel pump is moved, is influenced. By means of such a control, taking place, for example, as proportional control, it can equally be ensured that, without having detailed knowledge about the fuel actually used, the required heat output can also be provided by adjusting the feed back pressure to the expected feed back pressure. Such a control of the feed back pressure may also take place, for example, in connection with the procedure described above with reference to Figure 2. In this case, using the procedure described above, the feed operating state can at first be changed with a single correction step such that it can be assumed that the feed back pressure occurring at that time already corresponds to the expected feed back pressure or is very close to it. If this correction has been carried out once, it can then be ensured within the framework of a precise control loop that a deviation between the detected feed back pressure, i.e., the control variable, and the expected feed back pressure, i.e., the command variable, which deviation is also possibly still present, is essentially entirely eliminated.

As explained above, the described correction is especially carried out if it is detected that the feed back pressure detected in association with a set feed operating state does not correspond to the feed back pressure to be expected for this feed operating state. This does not have to be triggered by the use of a fuel of different grade, although may in some circumstances. Figure 3 shows values for the feed back pressure and the waste gas temperature to be expected, which are represented by a pressure point D and a temperature point T, for a defined operating state of the heater 10, in which this heater is operated with a feed operating state associated with this operating state such that a

CO₂ content somewhat above 9.6% can be expected. For this defined operating state and for the feed operating state associated with same, the feed back pressure to be expected is about 2135 Pa, and the waste gas temperature to be expected is about 340°C. If, based on this defined operating state, a different fuel is used, i.e., for example, a fuel with higher OME content and thus

5 correspondingly lower calorific value, the feed back pressure with the combustion air feed quantity unchanged decreases along a curve K₅. Based on the grade decreasing with increasing OME content in the fuel or accordingly decreasing calorific value, the combustion will lead to a lower CO₂ content in the waste gas. Correspondingly, the waste gas temperature decreases along a curve K₆ based on the temperature point T. This means that if the feed back pressure and the temperature
10 decrease based on the reference feed back pressure predefined for a reference feed operating state, which corresponds to the pressure point D and to a reference waste gas temperature, which corresponds to the temperature point T, this is a clear indication that fuel with a lower calorific value than the reference fuel, i.e., for example, diesel, is used and the correction described above with reference to Figure 2 can be carried out accordingly. For example, both in association with the
15 waste gas temperature and in association with the feed back pressure, a corresponding threshold can be set here, the exceeding or falling short of which in the case shown is used as a criterion for the correction of the feed operating state shown in Figure 2 being carried out.

The decrease of the feed back pressure may, however, also be indicated by a decreasing air pressure
20 and thus by a lower oxygen content per fed air unit quantity. This may, for example, be the case if weather changes lead to a change in air pressure or a vehicle is operated at different heights. The change in the feed back pressure occurring in case of such a change in the oxygen content in the air is represented by the curve K₇. Curve K₇ shows that the feed back pressure drops sharply in case of decreasing oxygen content and correspondingly shifting of the mixture to be burned in the direction
25 of a richer mixture and thus increasing CO₂ content in the waste gas. At the same time, however, the change in the temperature represented by curve K₈ remains low for this case. A change in the oxygen content in the air thus leads to almost no change in the waste gas temperature, or only to a slight increase of the waste gas temperature, while the feed back pressure drops sharply. Thus, if the falling below of a threshold for the waste gas temperature and the falling below of a threshold
30 for the feed back pressure are predefined as criteria for the decision explained above, then in this case the feed back pressure would fall below the associated threshold; however, in case of the waste

gas temperature, such a falling below could not be observed, since the waste gas temperature remains almost the same or increases slightly. In this case, it can be concluded that a decreasing feed back pressure is not induced by a changed composition of the fuel and in this respect the correction of the feed operating state described with reference to Figure 2 does not have to be carried out. In this case, other corrective measures compensating the changed air pressure may be introduced.

In principle, as an alternative or in addition to the evaluation of the pressure and temperature values, the respective gradient of occurring deviations from the pressure point D and the temperature point T could be taken into consideration from the relationship shown in Figure 3.

CLAIMS:

1. A process for operating a fuel-operated vehicle heater, the vehicle heater (10) comprising a burner area (12) with a combustion chamber (14); a fuel pump (24) for feeding fuel to the combustion chamber (14); and a combustion air blower (28) for feeding combustion air to the combustion chamber (14), a pressure sensor (38) being associated with the combustion air blower (28) for detecting a feed back pressure downstream of the combustion air blower (28); further comprising an actuating unit (36) for actuating the fuel pump (24) such that the fuel pump (24) is operated with a predefined value of a pump operating variable, and for actuating the combustion air blower (28) such that the combustion air blower (28) is operated with a predefined value of a blower operating variable for operating the vehicle heater (10) with a required heat output, a feed operating state being associated with each one of a plurality of required heat outputs of the vehicle heater (10) and being defined by the predefined value of the pump operating variable and the predefined value of the blower operating variable associated with a respective one of the required heat outputs, the process comprising the step of providing, in association with each one of feed operating states and with a reference fuel, information on the feed back pressure to be expected in each one of the feed operating states, wherein the process further comprises the following steps:
 - a) in association with the feed operating state set during the combustion operation, detecting the feed back pressure (P_e),
 - b) comparing the feed back pressure (P_e) detected in step a) with an expected feed back pressure (P_E) to be expected for the feed operating state set in step a), and
 - c) if the feed back pressure (P_e) deviates from the expected feed back pressure (P_E), changing the pump operating variable such that the feed back pressure changes in the direction toward the expected feed back pressure (P_E) or/and corresponds to the expected feed back pressure (P_E).
2. The process in accordance with claim 1, characterized in that the combustion air blower (28) comprises a rotatable feed wheel (30), wherein the blower operating variable corresponds to a speed of the feed wheel (30), or/and that the fuel pump (24) comprises a pump piston with periodic reciprocating motion, wherein the pump operating variable corresponds to a rate of motion of the pump piston.

3. The process in accordance with claim 2, characterized in that the feed operating state is defined as a ratio of the speed of the feed wheel (30) to the rate of motion of the pump piston.

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4. The process in accordance with any one of claims 1 to 3, characterized in that a correction variable for the feed operating state (F_E) associated with the expected feed back pressure (P_E) is determined in step c) as a function of the deviation between the feed back pressure (P_e) that is detected and the expected feed back pressure (P_E), and the pump operating variable is changed such that the feed operating state (F_E) is corrected by the correction variable for obtaining a corrected feed operating state (F_K).

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5. The process in accordance with claim 3, characterized in that a correction variable for the feed operating state (F_E) associated with the expected feed back pressure (P_E) is determined in step c) as a function of the deviation between the feed back pressure (P_e) that is detected and the expected feed back pressure (P_E), and the pump operating variable is changed such that the feed operating state (F_E) is corrected by the correction variable for obtaining a corrected feed operating state (F_K), and a deviation (A) between the ratio associated with the expected feed back pressure (P_E) and the ratio associated with the feed back pressure (P_e) is determined, that the feed operating state deviating from the feed operating state (F_E) in step a) to the same extent as the deviation (A) but in the opposite direction of deviation is determined as the corrected feed operating state (F_K), and that the pump operating variable associated with the corrected feed operating state with the blower operating variable being unchanged is used as the changed pump operating variable to obtain the corrected feed operating state (F_K).

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6. The process in accordance with any one of claims 1 to 5, characterized in that the expected feed back pressure (P_E) is defined as a command variable in association with a defined heating operation, and the detected feed back pressure (P_e) is changed in a pressure control as a control variable by changing the pump operating variable as manipulated variable in the direction toward the expected feed back pressure (P_E).

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7. The process in accordance with any one of claims 1 to 6, characterized in that the vehicle heater (10) comprises a waste gas temperature sensor (40) for providing information about the waste gas temperature, and that a reference waste gas temperature (T) and a reference feed back pressure (D) are determined in association with a reference feed operating state, and that step c) is carried out if the detected waste gas temperature and the detected feed back pressure deviate in a defined manner from the reference waste gas temperature (T) and from the reference feed back pressure (D) in case of a set reference feed operating state.
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8. The process in accordance with claim 7, characterized in that step c) is carried out if the detected waste gas temperature is below the reference waste gas temperature (T) and the detected feed back pressure is below the reference feed back pressure (D).
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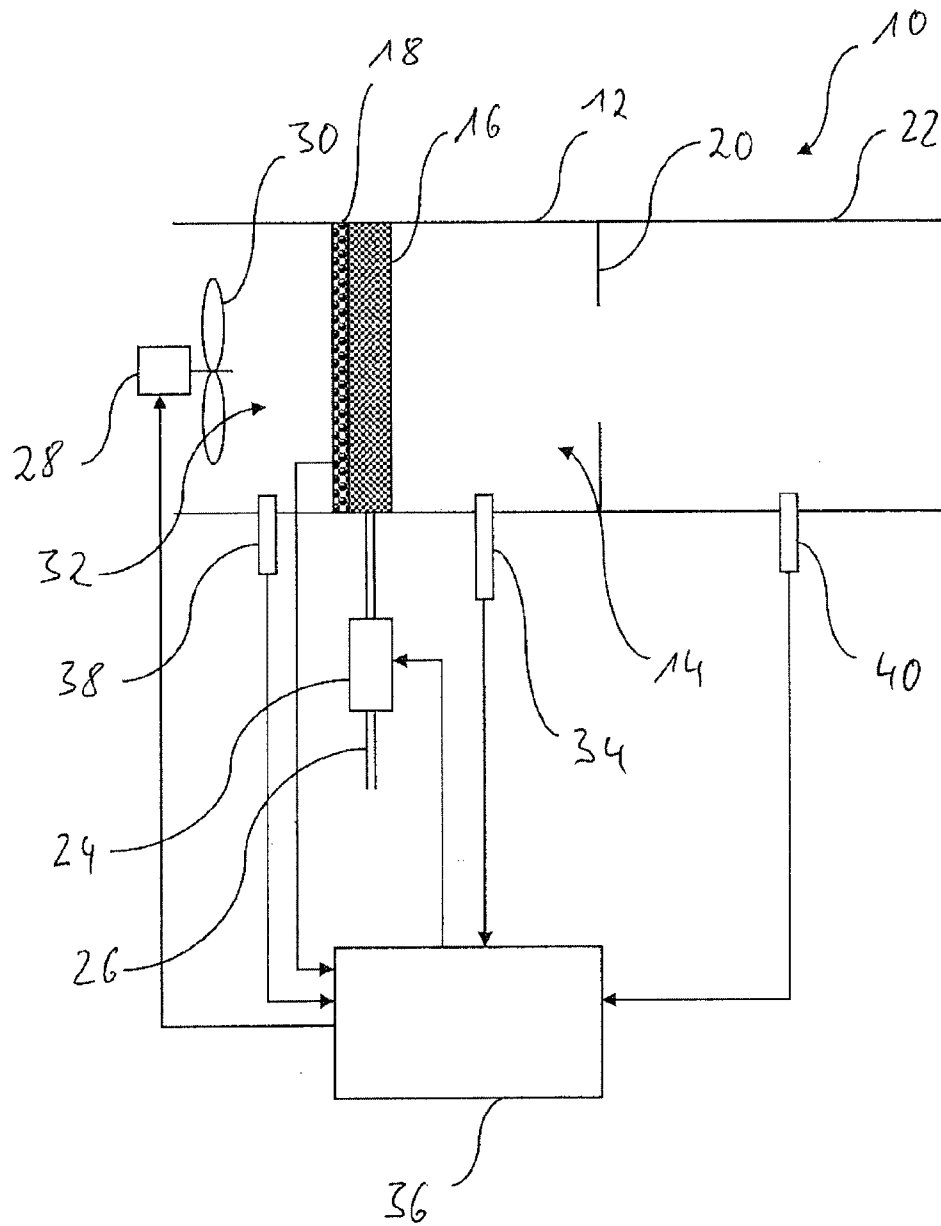


Fig. 1

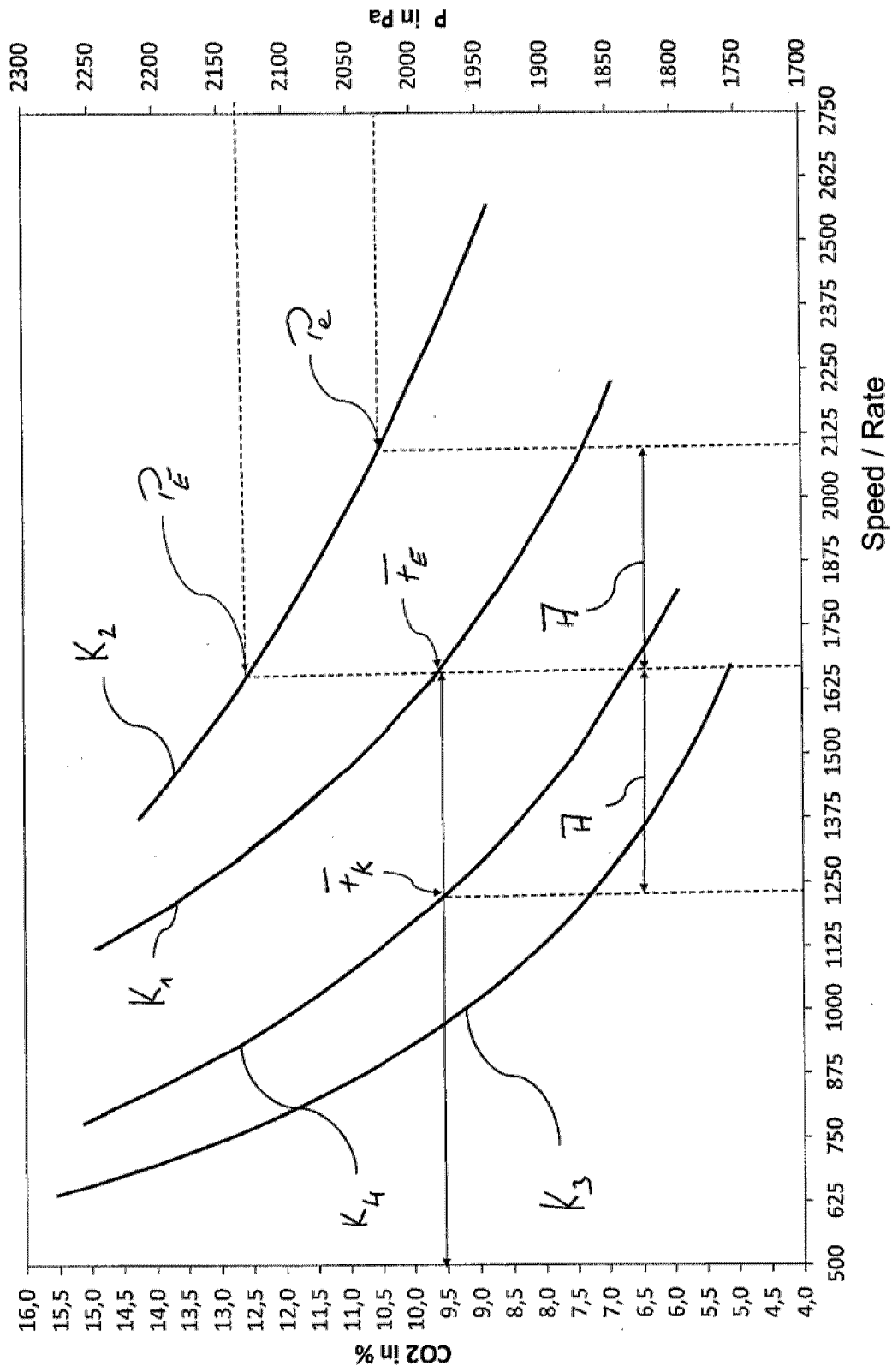


Fig. 2

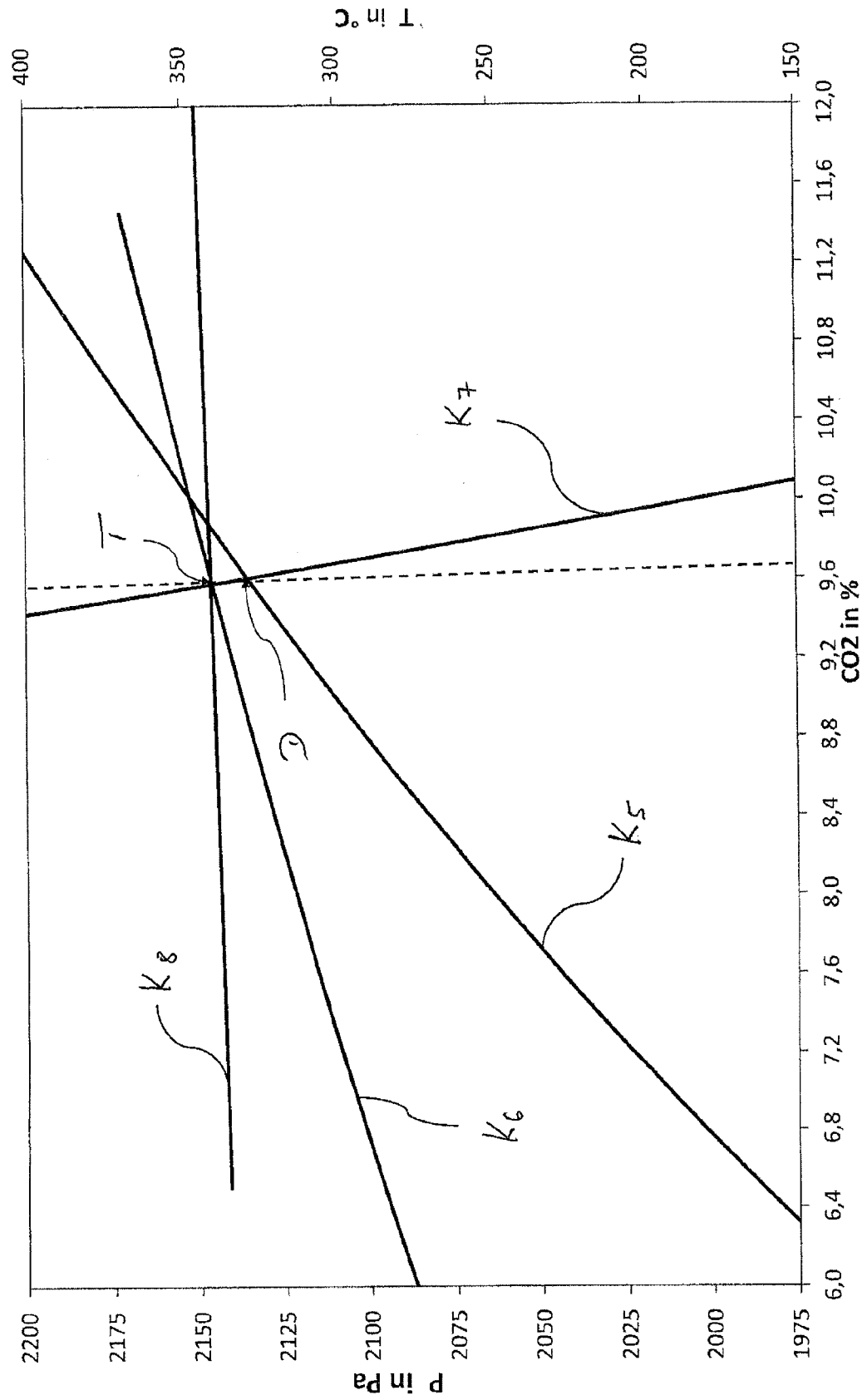


Fig. 3

