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(54) COOLING SYSTEM

(75) Inventors: **Nicolai Tarasinski**, Frankenthal (DE); **Joachim Sobotzik**, Lambsheim (DE)

Correspondence Address:
Joel S. Carter
Patent Department
DEERE & COMPANY
One John Deere Place
Moline, IL 61265-8098 (US)

(73) Assignee: **Deere & Company, a Delaware corporation**

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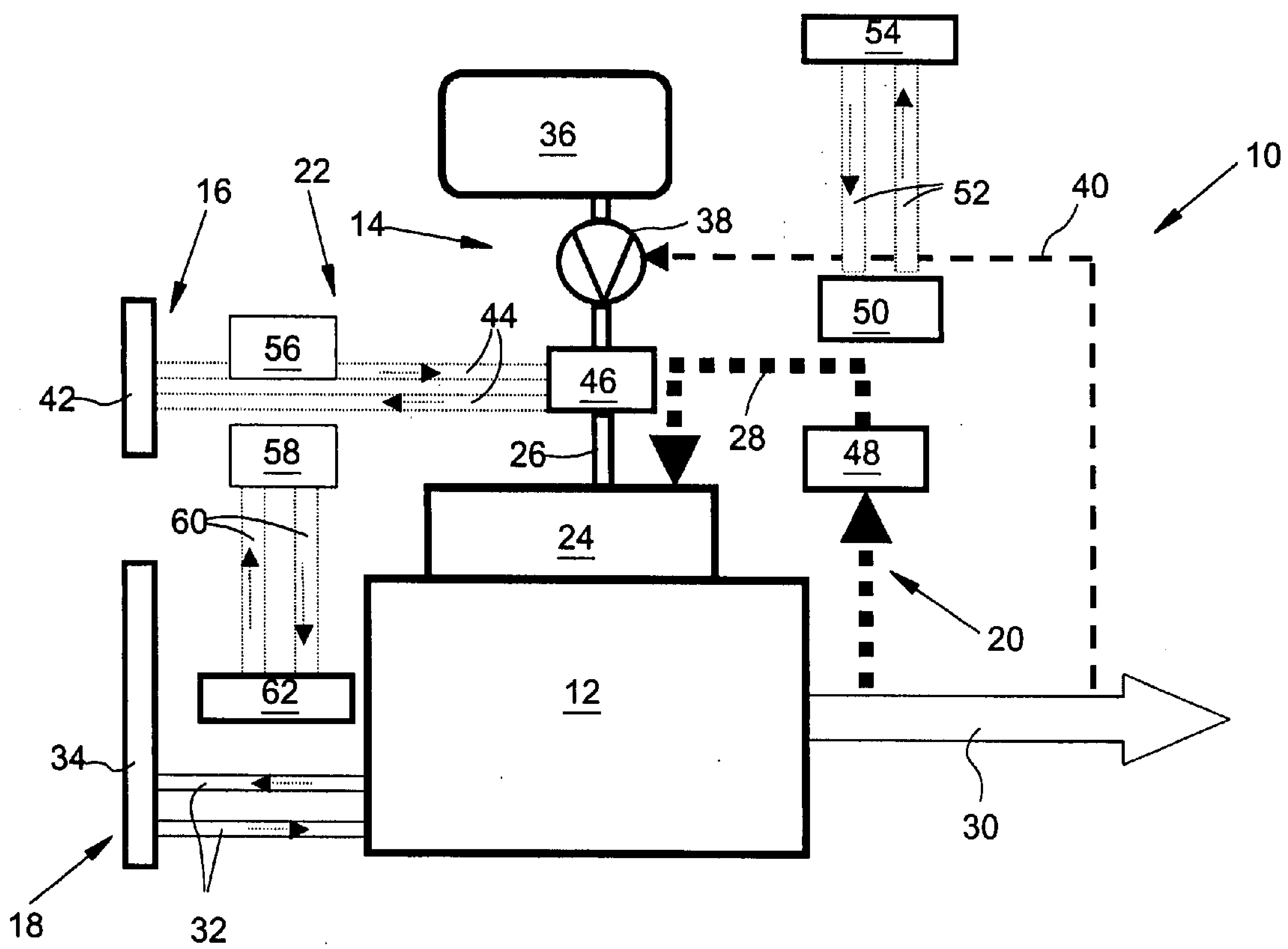
(57) **ABSTRACT**

A cooling system for an agricultural vehicle, such as a tractor driven by an internal combustion engine includes a main cooling system containing a coolant. The cooling system includes a sorption cooling system which includes an evaporator for evaporating a refrigerant, a sorption chamber for the sorption of the refrigerant vapor, a desorption chamber for the desorption of the refrigerant from the sorbent, and a condenser for condensing the refrigerant. An exhaust gas stream from the engine is conducted to the desorption chamber to provide the heat necessary for the desorption. The evaporator is used for additional cooling of the coolant of the main cooling system and/or for cooling a second exhaust gas stream from the engine.



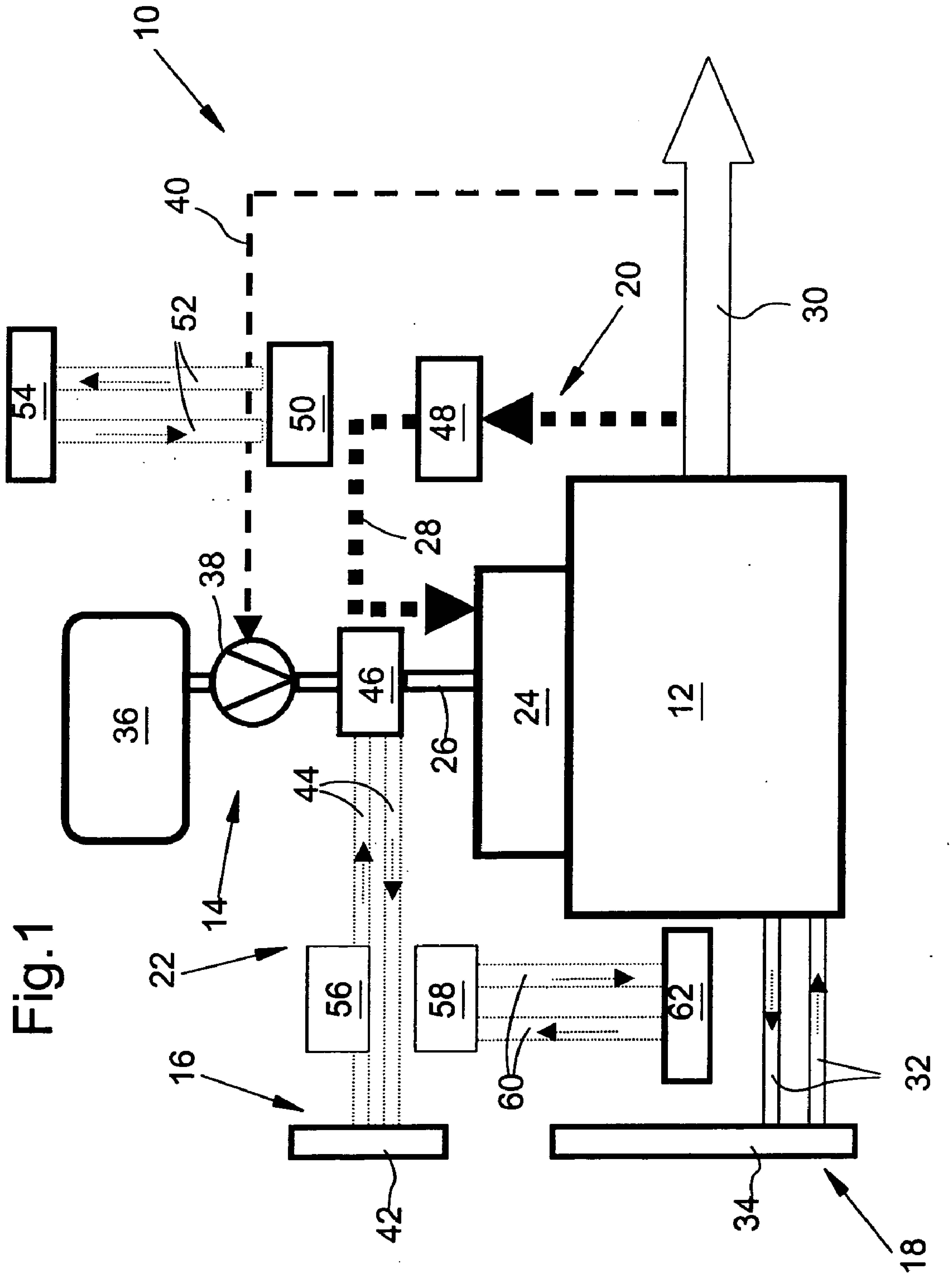

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Fig.1

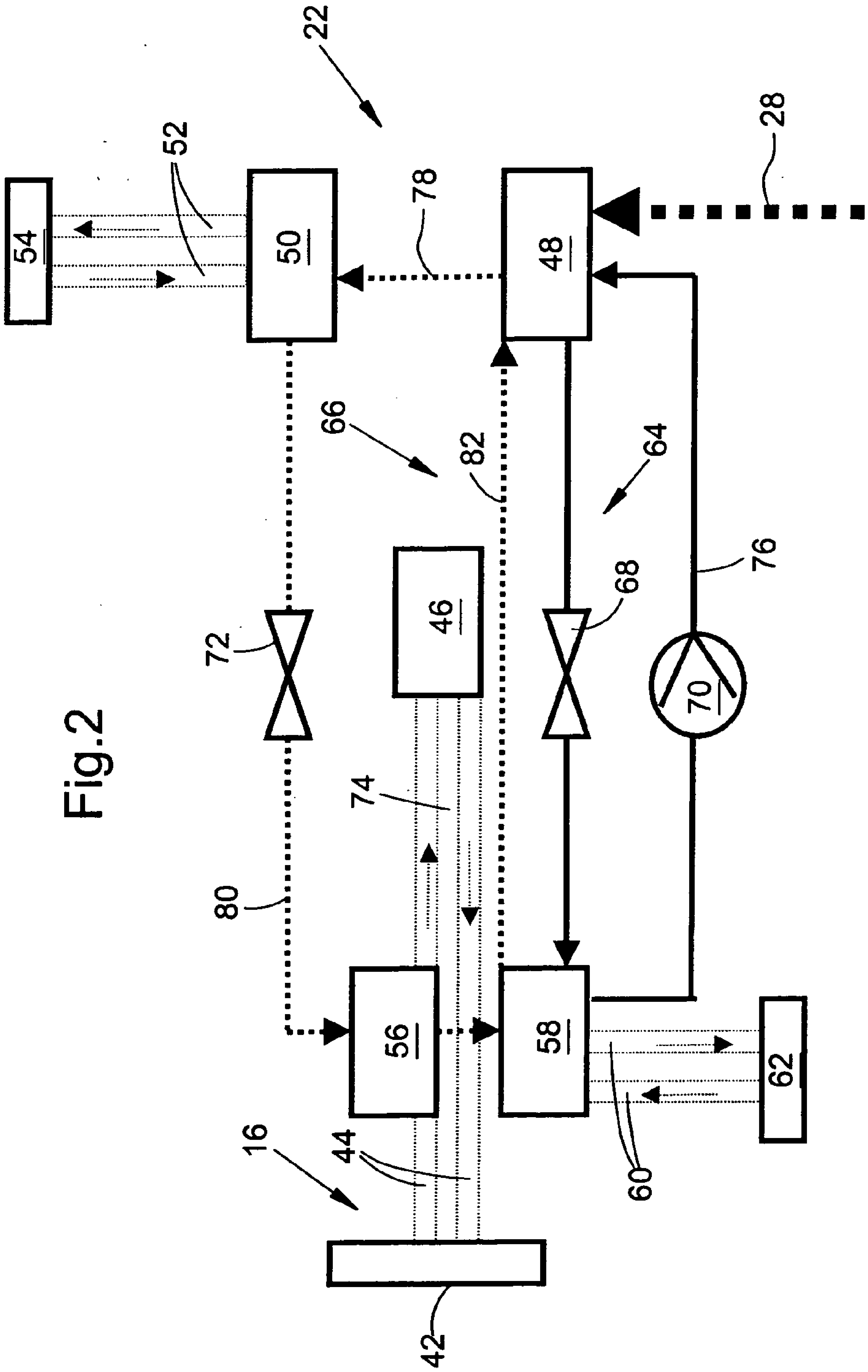

Fig.2

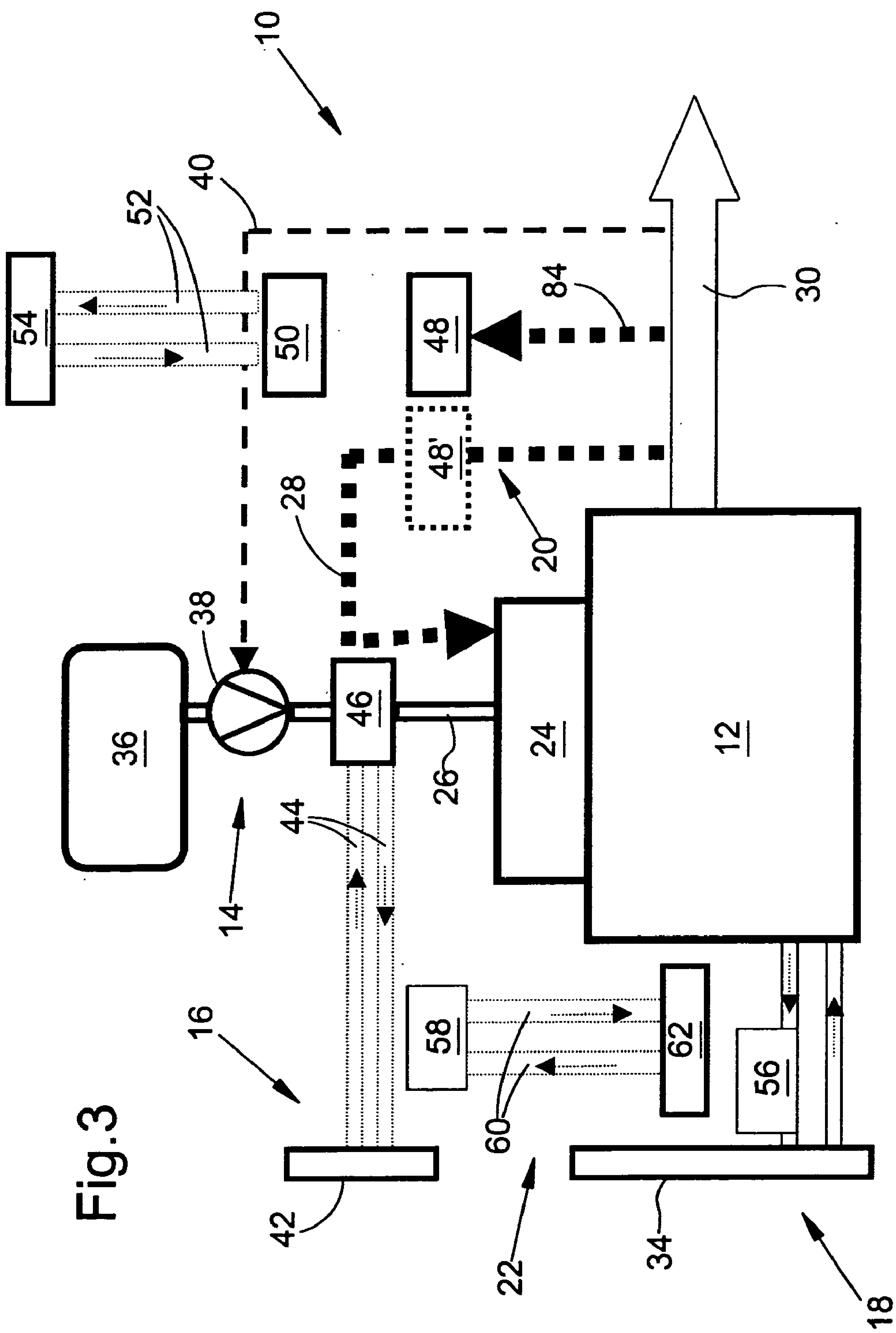
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Fig.3

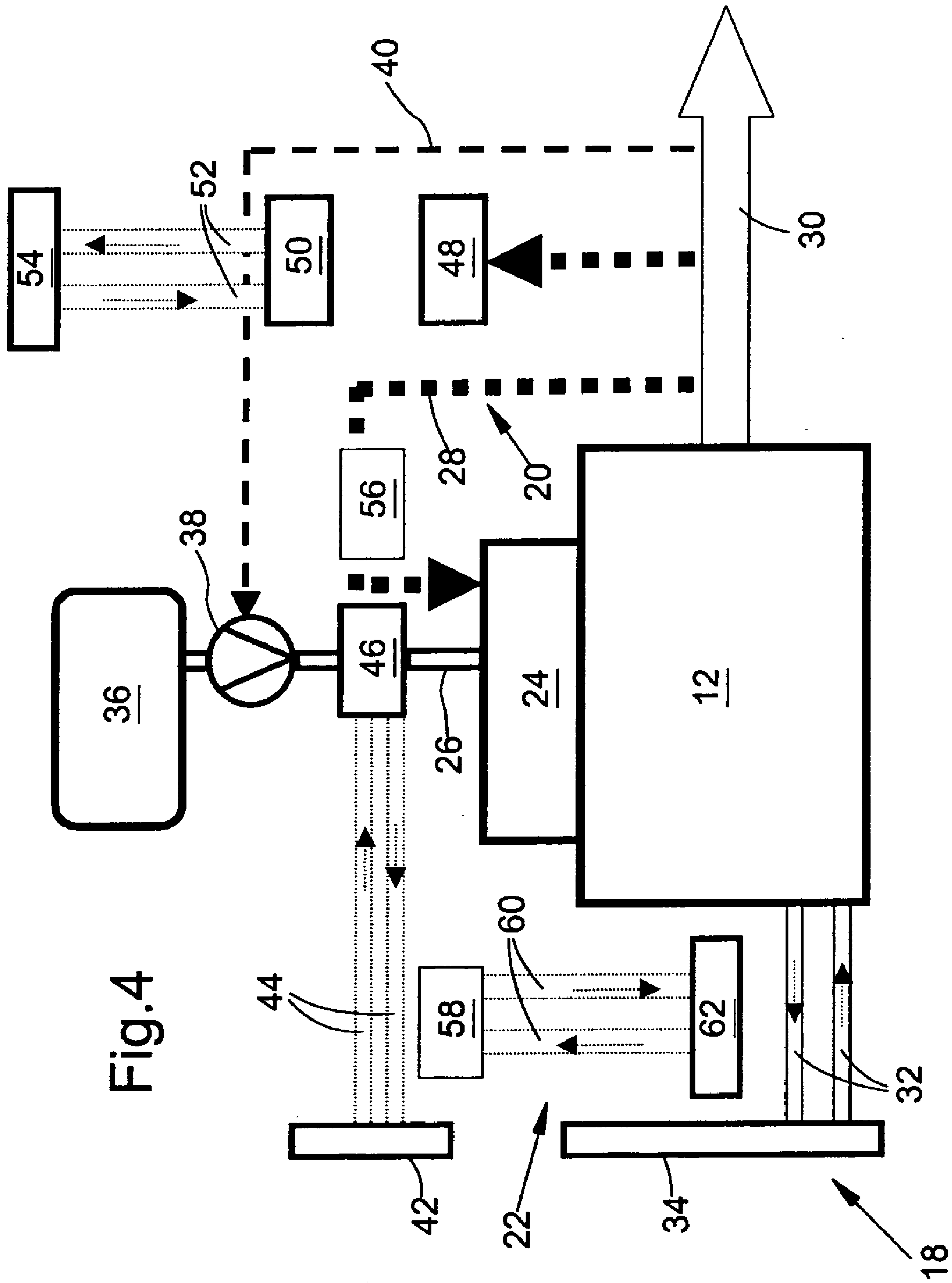

Fig.4

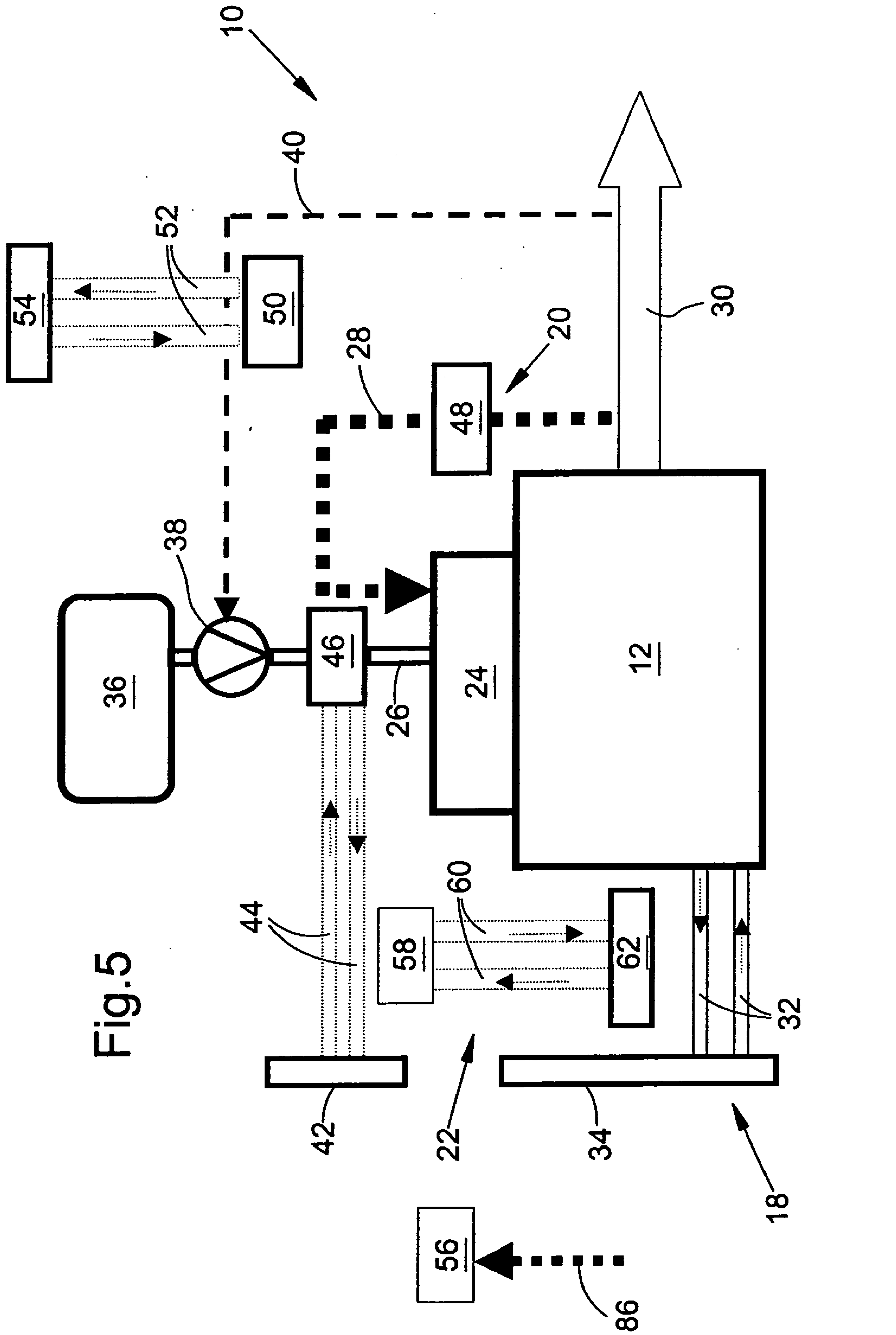
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Fig.5

COOLING SYSTEM

BACKGROUND

[0001] The present invention relates to an engine driven agricultural tractor cooling system with a main cooling system containing a coolant.

[0002] Increasing power output of engines and stricter emission control regulations increases the demands on a vehicle cooling system. The rate of thermal output that can be rejected by a conventional cooling system is essentially determined by parameters such as the size of the surface of a cooler, heat transmission coefficients, flow velocities of the coolant, and by temperature differences of the associated media (surroundings, coolant, etc.). In agricultural vehicles, particularly in tractors, the thermal output of conventional cooling systems is determined generally by the size of the available space of the configuration and the maximum allowable temperature difference. For a water-based cooling system, cooling this maximum temperature difference is a result of the maximum surrounding temperature and the highest allowable cooling water temperature.

[0003] Various cooling systems are known which achieve more efficient cooling with maximum prevailing temperature differences. For example, published German patent application DE 198 54 544 describes a cooling system for a supercharged engine with an improved cooling capacity. This cooling system includes a high temperature cooling circuit and a low temperature cooling circuit. The high temperature cooling circuit includes in a main branch, the engine, a high temperature re-cooler, and a branch circuit with a high temperature charge air cooler. The low temperature cooling circuit includes a low temperature re-cooler in series with a low temperature charge air cooler. Furthermore, this system also includes an engine oil/gearbox oil heat exchanger and a heat exchanger for cooling electronic components. Thus, the heat rejected in the engine oil/gearbox oil heat exchanger is rejected at a relatively high temperature level, while the electronic components and the charge air is cooled simultaneously at a lower temperature. However, this cooling system is costly, and the resulting temperature levels are not appropriate for the cooling of a supercharged engine of an agricultural tractor.

[0004] Other cooling systems are known that are based on the principle of the sorption cooling, in which cold is primarily generated from heat. Such systems are gaining importance, particularly in connection with air conditioned vehicles. Adsorption and absorption refrigeration machines are described in various publications, for example, Andreas Gassel, "Die Adsorptionskaeltemaschine-Betriebserfahrungen und thermodynamische Berechnung"-"The adsorption refrigeration machine—Operating experience and thermodynamic calculations"; Article draft for Ki air and refrigeration technology or York International "Prinzip Absorptionskaltemaschine"-"Principles of absorption refrigeration machine", prospectus KK14300). DE 199 27 879 A1 describes a vehicle air conditioning system with an adsorption refrigeration arrangement. The system includes an adsorption refrigeration arrangement in which liquid refrigerant is evaporated, in order to extract the heat required for it from a liquid or gaseous medium for the generation of low temperatures. The evaporated refrigerant is conducted to a sorbent to be adsorbed. The sorbent loaded with refrigerant is heated in order to desorb the refrigerant again, and the refrigerant is subsequently liquified in order to make it available for renewed evaporation. Thus, the heat rejected by the engine is used to heat the sorbent. The system includes methanol as refrigerant and activated charcoal as sorbent. However, this absorption refrigeration system is configured for the air conditioning of a vehicle, and appears to be inappropriate for the cooling of individual components of a supercharged engine, particularly that of an agricultural tractor. Furthermore, other potential sources of heat, such as the engine exhaust, cannot be utilized for the high temperatures required for the desorption in the adsorption refrigeration machine disclosed by published German patent application DE 199 27 879 A1 because extensive design-engineering changes would be required.

SUMMARY

[0005] Accordingly, an object of this invention is to provide a cooling system which reduces the thermal load on a conventional main cooling system.

[0006] A further object of the invention is to provide such a cooling system for an engine block or a charge air cooling system.

[0007] These and other objects are achieved by the present invention, wherein a cooling system includes a known sorption cooling system. The sorption cooling system includes an evaporator for evaporating a refrigerant, a sorption chamber containing an absorbent which absorbs the evaporated refrigerant, a desorption chamber for desorption of the refrigerant from the absorbent and a condenser for condensing the refrigerant. To supply the heat required for the desorption, a first exhaust gas stream of the engine is communicated to the desorption chamber. The evaporator provides additional cooling of the coolant of the main cooling system, and/or cools a second exhaust gas stream from the engine. Combining a conventional main cooling system with a sorption cooling system decreases the load on the main cooling system and the evaporator reduces heat rejection. The evaporator is positioned at the cylinder head and directly cools the cylinder head, so that the heat rejected there does not fully load the main cooling system.

[0008] The heat removed by the sorption cooling system or the heat removed by the evaporator can be delivered to the surroundings at a considerably higher temperature level by the condensation of the refrigerant. Thus, higher temperature differences to the surroundings can be realized and hence a more compact configuration of coolers is possible.

[0009] The evaporator can be positioned to extract heat from other components, such as, for example, the engine itself, parts of the mechanical power transmission, components of the power electronic system, electrical machines, the vehicle cab, the charge air, a recirculated exhaust gas stream or any other components that can be cooled contained in or on the vehicle. Moreover, this cooling system can be used to cool fluids such as engine oil or gearbox oil.

[0010] The sorption cooling system extracts heat from the conventional main cooling system, at a cost in thermal output. Preferably, thermal output supplies the power for the sorption cooling system. Thereby in a sorption cooling system a "thermal compressor" is realized in contrast to the mechanically driven compressors which are widely used in refrigeration machines and in air conditioners.

[0011] The thermal output required to drive the sorption cooling system is extracted from the vehicle, preferably from the exhaust gas of the engine. But, other sources of thermal energy are also conceivable. For example, the rejected heat of the engine or the engine cooling water or any other available source of heat in the vehicle could be used.

[0012] The process where a material is taken up selectively by another material is known as absorption or adsorption. When the particular process is unknown, the process is known as sorption. The sorbing material is referred to as a sorbent. The material that is sorbed is the sorbate. "Desorption" is the regeneration or the separation of the material that was sorbed.

[0013] Absorption is the process in which gases are taken up by fluids or solids, wherein the dissolved gas component is the absorbent and the fluid (solvent) is the absorbate. Desorption is the reverse of the absorption, wherein gas is driven off at increased temperature and/or reduced pressure and the solvent is regenerated.

[0014] Adsorption is the deposition of gases and dissolved materials (adsorbate) on the surface of solids (adsorbent), for example, the binding of steam as adsorbate to an activated charcoal adsorbent. Adsorption takes place not only on the outer surface of the absorbent, but also in its pores, as long as these are accessible to the absorbate. During the adsorption process, the heat of adsorption is liberated. The heat of adsorption is approximately of the magnitude of the heat of condensation. Important adsorbents are activated charcoal, silica jell, aluminum oxide or even fullers earth.

[0015] In general, desorption is the reverse of the absorption or adsorption process at higher temperatures or lower pressures where absorbed or the adsorbed material is regenerated.

[0016] An absorption cooling system operates with a liquid solvent as sorbent or absorbent, and an adsorption cooling system operates with a solid sorbent. An absorption cooling system will include an absorbent and an absorbate, such as, for example, a solvent and a refrigerant, where the refrigerant is absorbed by the solvent and is again separated from it in the desorption process. For example, lithium bromide absorbs water, and water absorbs ammonia. The material absorbed functions as a refrigerant (absorbate), while the other material functions as a solvent (absorbent). The refrigerant and the solvent are together characterized as an operating pair. The solution of the materials is heated in order to separated them from each other again in the desorption chamber (boiler or separator). The refrigerant evaporates first because of its lower evaporation temperature. The evaporated refrigerant is freed from the rest of the solvent with which it had been evaporated by means of a liquid separator. Then, the refrigerant is cooled in the condenser (liquefier) and thereby liquified. The pressure of the refrigerant is reduced to an evaporation pressure corresponding to a predetermined temperature by a control valve. In the evaporator the refrigerant is evaporated by absorbing heat, and the heat absorbed provides the cooling effect. Next, the refrigerant vapor is conducted into the sorption chamber. After the separation from the refrigerant (absorbent) or after the desorption, the pressure of the solvent (absorbate) is reduced by a valve to the sorption chamber pressure, cooled and conducted to the sorption chamber. Thereby, the solvent takes up the refrigerant vapor in the sorption chamber. A solvent pump conducts the enriched solution back to the ejector, the circulation is thereby closed. The entire solvent circulation operates as a "thermal compressor", and functions as a compressor of a compression refrigeration machine. As noted initially, the amount of heat required for the evaporation QO and the amount of heat required for the desorption QH can be derived from differing vehicle components, so that the amount of heat that is to be rejected by the main cooling system is reduced, and that the amount of heat required for the evaporation QO is derived from the main cooling system. ***The system operates more effectively with higher temperature of the cooling water of the main cooling system. The tendency to raise the pressure level in the main cooling circuit in order to attain correspondingly higher allowable temperatures therefore promotes the possibilities of the absorption cooling systems. The driving temperatures for the ejection lie between 90° C. and 140° C., where the medium or the components to be cooled can assume similar temperatures as with the cooling with an adsorption cooling system.

[0017] An adsorption cooling system includes an adsorption chamber filled with a sorbent or an adsorbent, and a desorption chamber filled with an adsorbent, a condenser and an evaporator. As in the case of an absorption cooling system, in an adsorption cooling system various pairs of materials are possible. The adsorbent may be for example, silica gel, and the refrigerant may be adsorbate water. It is also known to use activated charcoal as adsorbent and methanol as adsorbate. The process is discontinuous and closed. During a cycle the following processes occur: The water (adsorbate) adhering to the silica gel (adsorbent) is driven out in the desorption chamber with the supply of an amount of heat QH by a heated water circulation associated with the desorption chamber. The water is liquified in the condenser and heat is carried away by the cooling water circuit associated with the condenser. The condensate is sprayed into the condenser and evaporated under strong negative pressure. An amount of heat QO is extracted from the surroundings or from a component that is to be cooled. The water vapor is adsorbed in the adsorption chamber and the resulting heat of adsorption is conducted to a cooling water circuit associated with the adsorption chamber. By simply reversing the heating and cooling water circuits of the desorption or the adsorption chamber between the two chambers the functions of desorption and adsorption are interchanged at the end of a cycle and the process is started anew.

[0018] The desorption of the adhering water and the generation of pressure for the condensation occurs at low temperatures of 60° C.-70° C., so that this technology can be applied at lower temperatures than with an absorption cooling system.

[0019] Such a sorption cooling system can be driven "at no cost" by heat sources available on the vehicle, for example, the exhaust gas, instead of mechanical power required by compressors. Furthermore, the cooling capacities of a conventional cooling system can be reduced, and the amount of heat that must be removed in a water-to-air heat exchanger from the engine is reduced, thereby reducing the load on the main cooling system, and it is possible to remove heat at a higher temperature than in a conventional cooling system. Moreover, the energy required for cooling of further components can be minimized and fuel consumption can be reduced. In addition, it is possible to use environmentally benign refrigerants. Furthermore, if an air conditioning installation exists, mechanical or electrical compressor drive units can be omitted or their size reduced. Furthermore, various fluids and tractor components can be cooled to temperatures below the temperature of the surroundings. In contrast to a cooling system with a compressor, fewer moving parts are required, and hence fewer components are subject to wear. Beyond that, the exhaust back pressure is not increased with the heat exchanger outside at the exhaust pipe of the vehicle.

[0020] In a preferred embodiment of the invention, a first exhaust gas stream of the engine is an exhaust gas stream of an exhaust gas recirculation system, so that the heat required for desorption is extracted from the vehicle exhaust gas recirculation system. This advantageously cools the recirculated exhaust gas, and when the recirculated exhaust gas reaches the engine combustion chamber it results in a reduced heating of the charged air and thereby an improved charging or improved emission values can be obtained during the combustion.

[0021] In another embodiment, the first exhaust gas stream is branched off from the main exhaust gas stream delivered to the environment. Thus, the heat of an exhaust gas stream can be used to drive the desorption chamber, thereby improving the total energy balance of the vehicle.

[0022] In a further embodiment, the main cooling system is a charge air cooling system and that the evaporator of the sorption cooling system is used for additional cooling of the charge air cooling system. Thus, the charge air cooling system can be configured more efficiently, or the cooling performance for the charge air can be improved so that an increased amount of charge air reaches the engine combustion chamber. This improves emission values.

[0023] In a further embodiment, the main cooling system is an engine block cooling system and that the evaporator of the sorption cooling system is used for additional cooling of the engine block cooling system. This reduces the load on the main engine cooling system. This can be utilized either to reduce the required cooler volume or, if necessary, to increase the entire cooling capacity.

[0024] In a further embodiment, the main cooling system is an air conditioner cooling system and that the evaporator of the sorption cooling system is used for additional cooling of the cab air flow. This permits a reduced size of the air conditioner compressor, and less mechanical energy needs to be drained away from the vehicle. This, in turn, leads to an improved total energy balance of the vehicle and hence a lower fuel consumption.

[0025] In a further embodiment, the second exhaust gas stream is an exhaust gas stream of an exhaust gas recirculation system, where the evaporator of the sorption cooling system cools the exhaust gas in the exhaust gas recirculation system. Thus, the heat of the exhaust gas is used to drive the desorption chamber, thus improving the total energy balance of the vehicle. Another advantage is that the recirculated exhaust gas is cooled, and upon the recirculation of the exhaust gas into the engine combustion chamber, heating of the charge air is reduced, thereby improving air charge or emissions during the combustion.

[0026] Preferably, the condenser is connected with a cooler, which carries away the heat liberated in the condenser. The amount of heat generated by condensing the refrigerant (sorbent) can thereby be efficiently delivered to the surroundings, and heat is transferred at a higher temperature.

[0027] In another embodiment of the invention, the sorption chamber is connected with a cooler which carries away the heat liberated in the sorption chamber. Thereby the amount of heat generated by the sorption of the refrigerant (sorbent) can be efficiently delivered to the surroundings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] **FIG. 1** is a schematic block diagram of a cooling system according to the invention with a sorption cooling system to reduce the load on a charge air cooling circuit;

[0029] **FIG. 2** is a schematic block diagram of a sorption cooling system which reduces the load on the charge air cooling system;

[0030] **FIG. 3** is a schematic block diagram of a cooling system according to the invention with a sorption cooling system which reduces the load on the cooling circuit for an internal combustion engine;

[0031] **FIG. 4** is a schematic block diagram of a cooling system according to the invention with a sorption cooling system which cools an exhaust gas recirculation system; and

[0032] **FIG. 5** is a schematic block diagram of a cooling system according to the invention with a sorption cooling system which reduces the load on a cab air cooling system.

DETAILED DESCRIPTION

[0033] **FIG. 1** shows a cooling system **10** for an internal combustion engine **12** with a charge air system **14**, a charge air cooling system **16**, an engine cooling system **18**, an exhaust gas recirculation system **20**, and a sorption cooling system **22**. The sorption cooling system **22** is applied in order to reduce the load on the charge air cooling system **16**.

[0034] The engine **12** includes an intake system **24** which is supplied with super charged and cooled air **26** and recirculated exhaust gas **28**. The recirculated exhaust gas **28** is withdrawn from the exhaust gas stream **30** flowing out of the engine **12** and conducted to the intake system **24** of the engine **12**. By means of the exhaust gas recirculation system **20**, the amount of the exhaust gas delivered to the surroundings can be reduced and the emissions reduced.

[0035] In order to cool the engine **12**, the engine cooling system **18** is connected to the engine **12** over coolant lines **32**. The coolant lines **32** are connected with an engine cooler **34**, so that a coolant (not shown) in the coolant lines **32** circulates between the engine cooler **34** and the engine **12** and carries away heat generated in the engine **12** to the engine cooler **34**.

[0036] The charge air system **14** is used, among other uses, to compress the intake air taken in from the surroundings so that an increased amount of air flows into the intake system **24** of the engine **12**, resulting in improved combustion of the fuel and thereby reducing emissions in the exhaust gas. The charge air system **14** includes an air filter **36** that filters intake air taken in from the surroundings and from which the filtered intake air is conducted into a turbo-supercharger **38**. The turbo-supercharger **38** includes a drive side (not shown) and a compressor side (not shown). The drive side of the turbo-supercharger **38** is driven by a drive exhaust gas stream **40**, where the drive exhaust gas stream **40** is also branched off from the exhaust gas stream **30**. The intake air from the air filter **36** is compressed in the compressor side of the turbo-supercharger **38**. This compression increases the density of the intake air and increases the heat of the intake air. This heat, in turn, has a negative effect on the combustion of the fuel, for which reason the charge air system **14** as a rule is also connected to a charge air cooling system **16**. The charge air cooling system **16** includes a charge air cooler **42** which is connected over charge air coolant lines **44** with a heat exchanger **46**. The heat exchanger **46** is positioned between the turbo-supercharger **38** and the intake system **24** so that a coolant (not shown) in the charge air coolant lines **44** circulates between the heat exchanger **46** and the charge air cooler **42** and cools a flow of heat coming from the compressed charge air on the charge air cooler **42**.

[**0037**] According to **FIG. 1**, the sorption cooling system **22** includes a desorption chamber **48** arranged in the recirculated exhaust gas stream **28**, a condenser **50** associated with the desorption chamber **48**, a condenser cooler **54** connected by condenser coolant lines **52** for removing the heat liberated in the condenser, an evaporator **56** arranged at the charge air coolant lines **44**, and a sorption chamber **58** with a sorption chamber cooler **62** connected by sorption chamber coolant lines **60** for removing the heat liberated in the sorption chamber **58**.

[**0038**] At least some components similar to those shown in **FIG. 1** and with the same reference numbers are also included in **FIGS. 2-5**.

[**0039**] **FIG. 2** illustrates the principle of operation of a cooling system wherein the sorption cooling system **22** reduces the load on the charge air cooling system **16**. Several components shown in **FIGS. 1 and 3-5** are omitted from **FIG. 2** to better illustrate the operation of the cooling system **10**.

[**0040**] The sorption cooling system **22** of **FIG. 2** includes a solvent circulation circuit **64** and a refrigerant circuit **66**. The solvent circuit **64** includes the desorption chamber **48** driven by the recirculated exhaust gas stream **28**, a first control valve **68**, the sorption chamber **58** and a solvent pump **70**. The refrigerant circuit **66** includes the desorption chamber **48** driven by the recirculated exhaust gas stream **28**, the condenser **50**, a second control valve **72**, the evaporator **56** and the sorption chamber **58**. Furthermore, the condenser **50** and the sorption chamber **48** are each connected with a cooler **54**, **62** which delivers the thermal output to be carried away from the condenser **50** or the sorption chamber **58** to the surroundings. To reduce the load on the charge air cooling system **16**, the evaporator **56** of the sorption cooling system **22** is integrated into the charge air cooling circuit **74** of the charge air cooling system **16**.

[**0041**] The cooling system **10** includes a two-material mixture (not shown) in the solvent circuit **64**, which is located in the supply line **76** directed at the desorption chamber **48**. The two-part mixture in the supply line **76** consists of a solvent (not shown) which is mixed with a refrigerant (not shown) for cooling and circulating in the refrigerant circuit **66** or which has sorbed this in the sorption chamber **58**. The two-part mixture is conveyed by the solvent pump **70** into the desorption chamber **48**. In the desorption chamber **48** the two-part mixture is heated by the heat from the recirculated exhaust gas stream **28**. The refrigerant taken up by the solvent has a lower evaporation temperature than the solvent, so that the refrigerant evaporates before the solvent evaporates. This causes the desorption of the refrigerant out of the solvent. The refrigerant vapor desorbed in the desorption chamber **48** or driven out, flows through a first connecting line **78** into the condenser **50**. The refrigerant vapor is liquified in the condenser **50** where the thermal flow is carried away at a higher temperature level compared to a conventional cooling system and with a higher temperature difference between the condenser cooler **54** and condenser **50**. The condensed or cooled refrigerant flows into the evaporator **56** over a supply line **80** controlled by the second control valve **72**. The refrigerant is evaporated in the evaporator while taking up heat from the charge air cooling system **16**. Heat is thereby effectively withdrawn from the charge air cooling system **16** by the evaporator **56** or by the heat taken up by the refrigerant. Thus the cooling system **10** reduces the load on the charge air cooling system **16**, thereby either improves the cooling capacity of the charge air cooling system **16** or reduces the dimensions of the charge air cooling system **16**.

[**0042**] The refrigerant vapor flowing out of the evaporator **56** flows into the sorption chamber **58**. The solvent circulating in the solvent circuit flows over the first control valve **68** into the sorption chamber **58** and is available to take up the refrigerant vapor or for the sorption of the refrigerant vapor. In the sorption chamber the refrigerant vapor is taken up by the solvent or it is sorbed, thereby generating heat of solution that is carried away over the sorption cooler **62**. The refrigerant flowing out of the evaporator that has not been evaporated or is still liquid is conducted over a further supply line **82** over the desorption chamber **48** and driven into the condenser **50**. Thereby, both circuits are closed, that is, the refrigerant circuit **66** and the solvent circuit **64** are closed. The improved cooling performance relative to the charge air on the basis of lower combustion temperatures in the intake system **24** of the engine **12** improves emissions.

[**0043**] The cooling system **10** and the sorption cooling system **22** of **FIG. 2** can also reduce the load on other main cooling systems or even for the cooling of the recirculated exhaust gas **48**. This is shown in **FIGS. 3-5**.

[**0044**] In a second embodiment shown in **FIG. 3**, the evaporator **56** is integrated into the engine cooling system **18**. In this embodiment the heat removal of the engine cooling system **18** or the reduction of the load on the engine cooling system **18** is performed in the same way by the evaporator **56**, as is the case with the reduction of the load on the charge air cooling system **16** of **FIG. 1** or **2**. In the **FIG. 3** embodiment a separate exhaust gas stream **84** is branched off from the main exhaust gas stream **30** in order to drive the desorption chamber. The embodiment shown in **FIGS. 1 and 2** is also conceivable, in which the desorption chamber **48** is driven by the recirculated exhaust gas stream **28** as is shown in **FIG. 3** with a desorption chamber **48'** driven by a recirculated exhaust gas stream. Furthermore, an embodiment is conceivable even without the charge air cooling system **16** and without the exhaust gas recirculation system **20**. Similar to the charge air cooling system **16** of **FIGS. 1 and 2**, the **FIG. 3** embodiment reduces the load on the engine cooling system **18**, either by increasing the cooling capacity of the engine cooling system **18** or by reducing the size of the engine cooling system **18**.

[**0045**] In the further embodiment of **FIG. 4**, the sorption cooling system **10** can be used to cool the recirculated exhaust gas stream **28**, to improve combustion performance of the engine **12** and thereby reduce the load on the engine cooling system **18** and the charge air cooling system **16**, or improve the entire energy balance of the engine **12**. If the recirculated exhaust gas stream **28** is conducted without any cooling into the intake system **24** of the engine **12**, the charge air that was previously cooled by the charge air cooling system **16** is heated. This worsens emission performance of the engine **12**. The evaporator **56** of **FIG. 4** is integrated into the exhaust gas recirculation system **20** and heat is withdrawn from the recirculated exhaust gas stream **28** during the evaporation of the refrigerant in the evaporator **56**. According to **FIG. 4**, as is also shown in **FIG. 3**, the separated exhaust gas stream **84** is also used to drive the desorption chamber **48**.

[**0046**] In a further embodiment shown in **FIG. 5**, the evaporator **56** is integrated into an air conditioning cooling system (not shown). In this way a cab air stream **86** pre-cooled by a conventional, mechanically driven compressor (not shown), can be post-cooled or, in a reverse arrangement, also pre-cooled by the evaporator **56** and post-cooled by the compressor. The other components of the cooling system of **FIG. 5** can be arranged similarly to the embodiments of **FIGS. 1-4**. The reduced load on the air conditioning system by the desorption cooling system leads to smaller mechanically driven compressor and thereby reduces energy requirements for the air conditioning system.

[**0047**] The sorption cooling systems of **FIGS. 1-5** can also be combined with each other. For example, several evaporators can be arranged in a parallel or a series circuit and used to cool the charge air, the recirculated exhaust gas, **58**, the engine cooling water and/or the cab air stream **86**.

[**0048**] While the present invention has been described in conjunction with a specific embodiment, it is understood that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, this invention is intended to embrace all such alternatives, modifications and variations which fall within the spirit and scope of the appended claims.

We claim:

1. A cooling system for an engine driven agricultural vehicle having a main cooling arrangement with a main cooling medium, the cooling system comprising:

a sorption cooling system including an evaporator for evaporating a refrigerant, a sorption chamber containing an absorber for absorbing refrigerant vapor, a desorption chamber for desorption of the refrigerant from the absorber, and a condenser for condensing the refrigerant, the evaporator cooling the main cooling medium; and

an exhaust gas conduit communicating a first engine exhaust gas stream to the desorption chamber to provide heat required by the desorption chamber.

2. The cooling system of claim 1, wherein:

the main cooling system comprises a charge air cooling system and the evaporator cools the charge air cooling system.

3. The cooling system of claim 1, further comprising:

a second engine exhaust gas stream branched off from an exhaust gas stream which is communicated to the environment.

4. The cooling system of claim 1, wherein:

the main cooling system comprises an engine cooling system, and the evaporator cools the engine cooling system.

5. The cooling system of claim 1, wherein:

the main cooling system comprises an air conditioner cooling system which conditions a cab air stream, and the evaporator cooling the cab air stream.

6. The cooling system of claim 3, wherein:

the evaporator cools the first engine exhaust gas stream.

7. The cooling system of claim 1, wherein:

a cooler is connected to the condenser, the cooler removing heat from the condenser.

8. The cooling system of the preceding claims, wherein:

a cooler is connected with the sorption chamber, the cooler removing heat from the sorption chamber.

9. A cooling system for an engine driven agricultural vehicle having a main cooling arrangement with a main cooling medium, the cooling system comprising:

a sorption cooling system including an evaporator for evaporating a refrigerant, a sorption chamber containing an absorber for absorbing refrigerant vapor, a desorption chamber for desorption of the refrigerant from the absorber, and a condenser for condensing the refrigerant;

a first exhaust gas conduit communicating a first engine exhaust gas stream to the desorption chamber to provide heat required by the desorption chamber; and

a second exhaust gas conduit communicating a second engine exhaust gas stream from the engine, the evaporator cooling both the main cooling medium and the second exhaust gas stream.

10. A cooling system for an engine driven agricultural vehicle having a main cooling arrangement with a main cooling medium, the cooling system comprising:

a sorption cooling system including an evaporator for evaporating a refrigerant, a sorption chamber containing an absorber for absorbing refrigerant vapor, a desorption chamber for desorption of the refrigerant from the absorber, and a condenser for condensing the refrigerant;

a first exhaust gas conduit communicating a first engine exhaust gas stream to the desorption chamber to provide heat required by the desorption chamber; and

a second exhaust gas conduit communicating a second engine exhaust gas stream from the engine, the evaporator cooling the second exhaust gas stream.

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