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(71) Applicant(s)
Mercedes-Benz AG

(Incorporated in the Federal Republic of Germany)

136 Mercedesstrasse, D70327 Stuttgart,
Federal Republic of Germany

(72) Inventor(s)
Roland Schreiber

(74) Agent and/or Address for Service
Jensen & Son
70 Paul Street, LONDON, EC2A 4NA, United Kingdom

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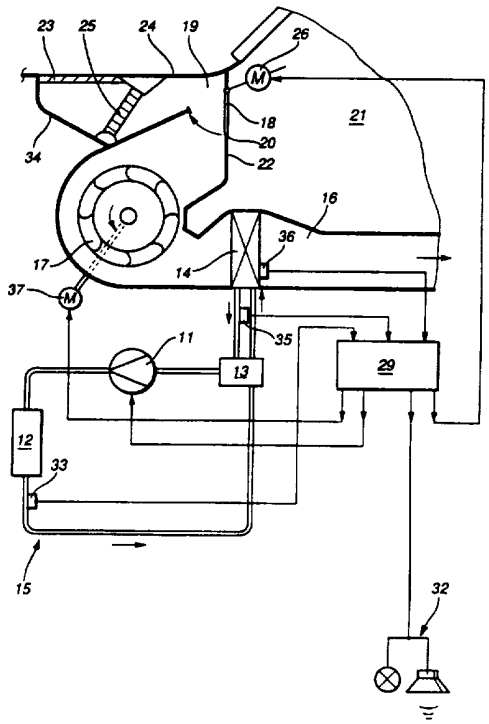
(54) Air-conditioning system for motor vehicles

(57) An air-conditioning system for motor vehicles has a compressor 11, a condenser 12, an expansion valve 13 and a vaporizer 14, through which a coolant flows in a coolant circuit 15 in the aforementioned sequence. An air distributor duct 16 which leads to the passenger compartment and in which the vaporizer 14 is arranged can be supplied with an airstream. The airstream can be set either to fresh-air supply or to air-circulation mode by actuation of a servo-controlled flap 18. Since a hydrocarbon which is environmentally acceptable but inflammable is to be used as coolant, for safety reasons a pressure sensor 35 for detecting the coolant pressure in the region of the vaporizer 14 is arranged between the vaporiser 14 and the expansion valve 13 of the coolant circuit. In the event of the coolant pressure dropping below a presettable, minimum acceptable limit value, the said pressure sensor 35 produces a pressure signal which, if appropriate, sets the flap control for the airstream to fresh-air supply and activates the corresponding blower 17 and an optical and/or audible warning device 32.



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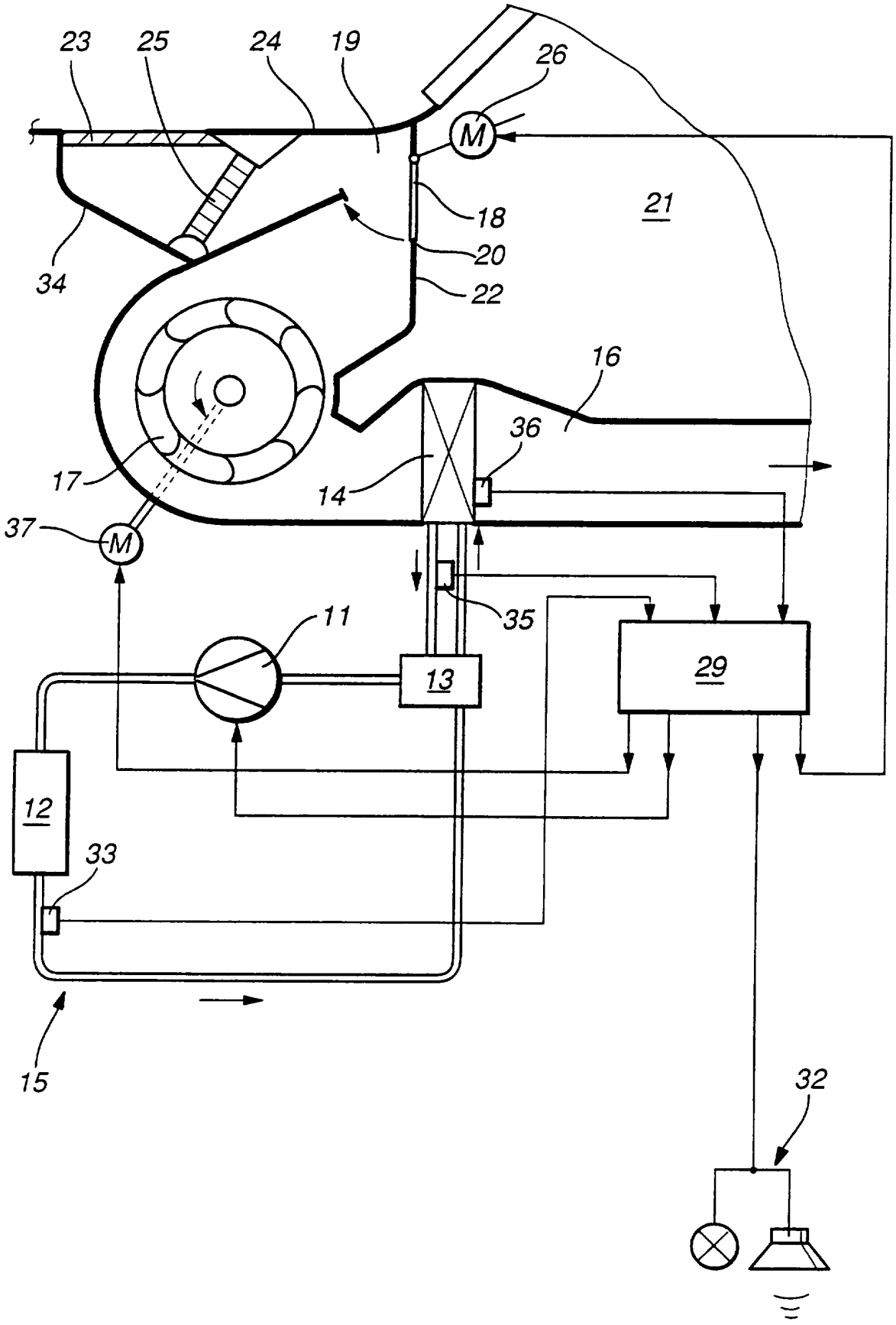
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Air-conditioning system for motor vehicles

The invention relates to an air-conditioning system for motor vehicles.

An older, non-prepublished patent application No. DE 44 26 339 A1 is concerned with a safety aspect in air-conditioning systems which are operated with a coolant, for example a hydrocarbon, which is environmentally acceptable but inflammable. In the event of a leak in the coolant circuit when such a coolant is used, the occupants of the vehicle may be put at risk by an inflammable mixture which consists of air and coolant and may be ignited by a spark, being capable of forming in the passenger compartment. In the older patent application, in order to eliminate this risk it is proposed continuously to detect by means of a suitable gas sensor any presence of a hydrocarbon in the air fed through the vaporizer and, if appropriate to shut off the circulation of coolant.

The present invention seeks to protect air-conditioning systems for motor vehicles, with the effect that in the case of a leak in the coolant circuit the occupants of the vehicle are not put at risk and are promptly warned, the intention being that the monitoring will be effective even if the air-conditioning system and/or an airstream directed into the passenger compartment is not switched on.

According to the present invention there is provided an air-conditioning system for motor vehicles having a compressor, a condenser, an expansion valve and a vaporizer through which a coolant flows in a coolant circuit in sequence, and having an air distributor duct which leads to the passenger compartment of the vehicle and can be supplied with an airstream and in which the vaporizer is arranged, it being possible to set the airstream either to fresh-air supply or to circulation-air mode by servo-controlled flap actuation, wherein a pressure sensor is arranged in the coolant circuit on a high-pressure side, and a further

pressure sensor is arranged in a low-pressure part, of the coolant circuit, which part conducts the coolant in vapour form, in order to detect the coolant pressure in the region of the vaporizer, which pressure sensors each produce a pressure signal in the event of the coolant pressure dropping below a minimum acceptable limit value which can be preset separately for each pressure sensor, which pressure signal sets the flap control for the airstream, if it is not in any case already set in this way, to fresh-air supply, the high-pressure-side pressure sensor being effective when the air-conditioning system is switched on and the low-pressure-side pressure sensor being effective when the air-conditioning system is not switched on.

A leak in the coolant circuit can accordingly be determined independently of the switched-on state of the air-conditioning system by monitoring the pressure of the coolant circuit. When the pressure drops below a minimum level, the air-conditioning system is - if necessary - deactivated and/or the airstream is switched to fresh-air supply.

Apart from being applied alone, this safety device can of course also be used in combination with the gas sensor in accordance with the older patent application and the expedient refinements mentioned in that publication, which increases the redundancy and the safety.

In an expedient refinement of the present invention, the pressure sensor may be equipped with a measurement characteristic which acts in a chronologically differentiating fashion, such that it does not respond to slow pressure changes but rather only to pressure changes which are rapid, i.e. which change above a presettable chronological pressure gradient. As a result, slow pressure changes which are due to operational reasons are ignored, as are slow leaks which do not constitute a risk for the occupants of the vehicle. An unnecessary or avoidable response of the warning device can thus be avoided.

Furthermore, it may be expedient that, in the case

of the pressure sensor responding, the blower for feeding the fresh air is automatically adjustable to a maximum feeding level. As a result, a maximum thinning with air of the vapours which are formed or which emerge is brought about and the vapour/air mixture formed is forced below an ignitable concentration.

In a manner which is also advantageous, a control unit with vapour pressure curve, stored therein, of the coolant used is provided in the air-conditioning system, and the vaporizer is provided with a temperature sensor; in this way the presettable response threshold of the pressure sensor can be continuously adjusted automatically by the control unit as a function of the temperature of the vaporizer in such a way that the pressure value, corresponding to the response threshold, of the pressure sensor always lies below the respective working point of the vapour pressure curve of the air-conditioning system. As a result, a fault alarm owing to the coolant pressure dropping for operational reasons can be avoided; the coolant pressure normally drops at relatively low external temperatures.

The invention is explained below with reference to an exemplary embodiment illustrated in the drawing, in which the single figure shows a schematic view of an air-conditioning system for motor vehicles.

The air-conditioning system has, in the customary manner, a compressor 11, a condenser 12, an expansion valve 13 and a vaporizer 14 which are arranged in a coolant circuit 15 and through which a coolant flows in the aforementioned sequence. The coolant circuit 15 is produced by connection lines between the aforesaid constructional elements. The air-conditioning system also contains - as is customary - a temperature sensor 36 at the vaporizer and a pressure sensor 33 on the high-pressure side of the circuit. The vaporizer 14 is arranged in an air distributor duct 16 and covers its entire air-flow cross-section. The air distributor duct 16 is connected to the outlet of a blower 17 whose inlet can be alternately connected to a fresh air

orifice 19 or air-extractor orifice 20 of the passenger compartment 21 of the motor vehicle by means of an air circulation flap 18. The air-extractor orifice 20 is arranged in the end wall, indicated by 22, of the passenger compartment 21 while the fresh air orifice 19 is arranged in the wall of a cooling water reservoir 34 which is secured to the blower 17 and is connected to the ambient air via an air grille 23 in the engine bonnet 24. An air filter is designated by reference 25. The air circulation flap 18 is actuated by an electric servomotor 26 and alternately clears the fresh air orifice 19 for the blower-side sucking-in of fresh air from the outside or clears the air-extractor orifice 20 for the sucking-in of recirculation air from the passenger compartment 21.

The air-conditioning system contains a so-called air-conditioning control unit 29 which also comprises an electronic control system. The air-conditioning system cannot only be switched on and off manually with this control unit but also, owing to a certain "intelligence" of the control unit, it controls the air-conditioning system automatically as a function of the signals of installed sensors. When the air-conditioning system is switched on and off, the compressor 11 is started or deactivated. A hydrocarbon, which has good thermodynamic properties but can be combusted together with air is used as the coolant in the coolant circuit. For example, a mixture of propane and butane may be used. Certain precautions are taken both with respect to the coolant circuit and also to the air-conditioning control unit in order to prevent the combustibility of the coolant placing the occupants of the vehicle at risk. For example, the signals of the temperature sensor 36 and of the high-pressure-side pressure sensor 33 are switched to the input side of the air-conditioning control unit. In addition, for the purposes of the invention, a further pressure sensor 35 whose signal output is also switched to the air-conditioning control unit on the input side is arranged on the low-pressure side of the

coolant circuit, specifically in close proximity to the vaporizer 14, downstream between the said vaporizer 14 and the expansion valve 13. This pressure sensor is switched in such a way that it is only active when the vehicle is being used but the air-conditioning system is not in operation. Then, the pressure sensor 35 reacts to any pressure drop in the coolant circuit 15 which is due to leakage, and when there is an unacceptably large or sudden pressure drop it sends an electrical detection signal to the air-conditioning control unit 29.

On the basis of the detection signals for sensors and as a function of them, the air-conditioning control unit 29 generates certain activation signals which, if appropriate, are present at different outputs. These outputs are connected to an electrical and audible warning device 32, the blower motor 37 and the servo motor 26 for the air circulation flap 18. The interventions of the air-conditioning control unit at various points of the air-conditioning system are intended to prevent coolant which emerges from the coolant circuit 15 and can get into the passenger compartment 21 with the air stream via the air distributor duct 16 from being able to become enriched in the said passenger compartment 21 and can form, together with the air there, a combustible mixture which could place the occupants of the vehicle at considerable risk.

In this context, the air-conditioning control unit 29 initially generates an activation signal for the optical and audible warning device 32 on the basis of the detection signal, which warning device 32 is thus switched on and alerts the driver to the defect in the air-conditioning system. In addition, the air-conditioning control unit 29 produces an actuation signal for the air circulation flap 18 which is transmitted to its servo motor 26 and switches it on until the air circulation flap 18 assumes its position illustrated in the drawing, in which position the air-extractor orifice 20 of the passenger compartment 21 is completely closed off and the inlet of the blower 17 is

connected to the fresh-air orifice 19. In the case of a leakage, the system therefore switches over automatically to fresh-air mode. Moreover, in the event of the low-pressure-side pressure sensor 35 responding as a result of the air-conditioning unit 29, the blower 17 is automatically set to a maximum feeding level by means of the blower motor 37 which is actuated by it, as a result of which the emerging vapours are thinned with air to the maximum possible extent so that the resulting mixture is no longer ignitable.

The pressure sensor 35 is expediently equipped with a measurement characteristic which acts in a chronologically differentiating fashion, as a result of which it does not react to slow pressure changes. Instead, it only reacts to pressure changes which occur relatively rapidly and which occur above a presettable chronological pressure gradient. As a result, slow pressure changes for operational reasons are ignored, as are slow leaks which do not constitute any risk to the occupants of the vehicle. An unnecessary or avoidable response of the warning device can thus be avoided.

The vapour pressure curve of the coolant used is stored in the air-conditioning control unit 29. In addition, the vaporizer 14 is provided with the temperature sensor 36 which has already been mentioned. Furthermore, the pressure sensor 35 is constructed in such a way that its response threshold is remote-actuated by the air-conditioning control unit 29 and can be preset in an automated fashion and also modified at any time. As a result, the response threshold of the pressure sensor 35 is continuously set automatically as a function of the temperature of the vaporizer in such a way that the response pressure value of the pressure sensor always lies below the respective working point of the vapour pressure curve of the air-conditioning system. As a result, a false alarm owing to the coolant pressure dropping for operational reasons can be avoided; the coolant pressure normally drops at relatively low external temperatures.

If, in contrast, the air-conditioning system is in operation, the pressure sensor 35 on the vaporizer is not active. If a leak occurs in the state in which the air-conditioning system is ready for operation, and if a pressure drop occurs as a result of this, the air-conditioning system is switched off by the signal of the high-pressure-side pressure sensor 33 which is customarily present. The control signals, generated by the air-conditioning control unit 29, for the blower 17, the air circulation flap 18 and the warning device 32 are the same as in the previously described case of the switched-off air-conditioning system.

Claims

1. An air-conditioning system for motor vehicles having a compressor, a condenser, an expansion valve and a vaporizer through which a coolant flows in a coolant circuit in sequence, and having an air distributor duct which leads to the passenger compartment of the vehicle and can be supplied with an airstream and in which the vaporizer is arranged, it being possible to set the airstream either to fresh-air supply or to circulation-air mode by servo-controlled flap actuation, wherein a pressure sensor is arranged in the coolant circuit on a high-pressure side, and a further pressure sensor is arranged in a low-pressure part, of the coolant circuit, which part conducts the coolant in vapour form, in order to detect the coolant pressure in the region of the vaporizer, which pressure sensors each produce a pressure signal in the event of the coolant pressure dropping below a minimum acceptable limit value which can be preset separately for each pressure sensor, which pressure signal sets the flap control for the airstream, if it is not in any case already set in this way, to fresh-air supply, the high-pressure-side pressure sensor being effective when the air-conditioning system is switched on and the low-pressure-side pressure sensor being effective when the air-conditioning system is not switched on.

2. An air-conditioning system according to Claim 1, wherein at least the low-pressure-side pressure sensor has a measurement characteristic which acts in a chronologically differentiating fashion, such that it does not respond to slow pressure changes but rather only to pressure changes which occur above a presettable chronological pressure gradient.

3. An air-conditioning system according to Claim 1, wherein, in the event of the pressure sensors responding, the blower for feeding fresh air is automatically set to a

maximum possible feeding level.

4. An air-conditioning system according to Claim 1, wherein an air-conditioning control unit with vapour pressure curve, stored therein, of the coolant used is provided and the vaporizer is provided with a temperature sensor, and the presettable response threshold of the further pressure sensor can be continuously set automatically by the air-conditioning control unit as a function of the vaporizer temperature, in such a way that the pressure value, corresponding to the response threshold, of the further pressure sensor always lies below the respective working point of the vapour pressure curve of the air-conditioning system.

5. An air-conditioning system for motor vehicles substantially as described herein with reference to, and as illustrated in, the accompanying drawing.

Amendments to the claims have been filed as follows

1. An air-conditioning system for motor vehicles having a compressor, a condenser, an expansion valve and a vaporizer through which a coolant flows in a coolant circuit in sequence, and having an air distributor duct which leads to the passenger compartment of the vehicle and can be supplied with an airstream and in which the vaporizer is arranged, it being possible to set the airstream either to fresh-air supply or to circulation-air mode by servo-controlled flap actuation, wherein a pressure sensor is arranged in the coolant circuit on a high-pressure side, and a further pressure sensor is arranged in a low-pressure part, of the coolant circuit, which part conducts the coolant in vapour form, in order to detect the coolant pressure in the region of the vaporizer, which pressure sensors each produce a pressure signal in the event of the coolant pressure dropping below a predetermined minimum acceptable limit value which can be preset separately as the response threshold for each pressure sensor, which pressure signal sets the flap control for the airstream, if it is not in any case already set in this way, to fresh-air supply, the high-pressure-side pressure sensor being effective when the air-conditioning system is switched on and the low-pressure-side pressure sensor being effective when the air-conditioning system is not switched on.

2. An air-conditioning system according to Claim 1, wherein at least the low-pressure-side pressure sensor has a measurement characteristic which acts in a chronologically differentiating fashion, such that it does not respond to slow pressure changes but rather only to pressure changes which occur above a presettable chronological pressure gradient.

3. An air-conditioning system according to Claim 1, wherein, in the event of the pressure sensors responding, the blower for feeding fresh air is automatically set to a

maximum possible feeding level.

4. An air-conditioning system according to Claim 1, wherein an air-conditioning control unit with vapour pressure curve, stored therein, of the coolant used is provided and the vaporizer is provided with a temperature sensor, and the presettable response threshold of the further pressure sensor can be continuously set automatically by the air-conditioning control unit as a function of the vaporizer temperature, in such a way that the pressure value, corresponding to the response threshold, of the further pressure sensor always lies below the respective working point of the vapour pressure curve of the air-conditioning system.

5. An air-conditioning system for motor vehicles substantially as described herein with reference to, and as illustrated in, the accompanying drawing.

The Patent Office

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Claims searched:	1 to 5	**Date of search:**	9 October 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F4V (VCM, VCG) ; F4H (HGXK, HGXG) ; F4U (U22)

Int Cl (Ed.6): B60H 1/32 ; F25B 49/02

Other: Online : WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 4677830 (SUMIKAWA)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.