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ABSTRACT

VACUUM PUMP WITH PRESSURE EQUALIZATION

Described herein is a vacuum pump (150), particularly for use in a motor vehicle (110), comprising an inlet side (230) for sucking in a fluid medium and an outlet side (240) for delivering the medium which is sucked into a surrounding area (280), where the outlet side (240) comprises an outlet non-return valve (260), which counteracts a return flow of the medium out of the surrounding area (280), where the outlet side (240) has a pressure equalization element (270) for equalizing a vacuum in the vacuum pump (150) with respect to the surrounding area (280), wherein the pressure equalization element (270) is set up for counteracting the entry of damaging substances out of the surrounding area (280) into the vacuum pump (150).

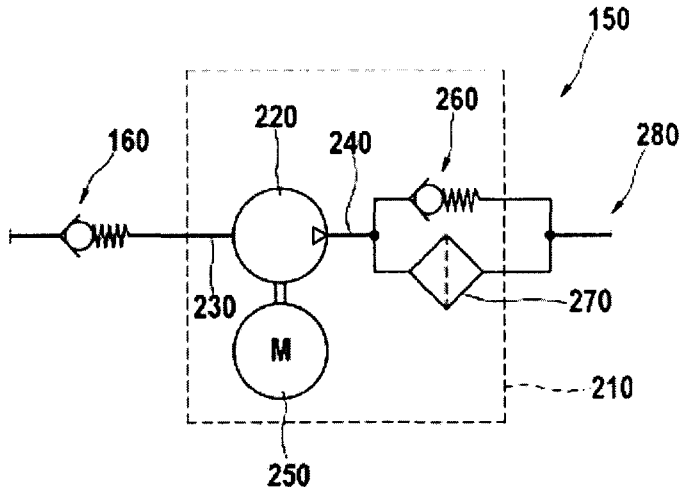

Fig. 2

I/We claim:

1. A vacuum pump (150), particularly for use in a motor vehicle (110), comprising an inlet side (230) for sucking in a fluid medium and an outlet side (240) for delivering the medium which is sucked into a surrounding area (280), where the outlet side (240) comprises an outlet non-return valve (260), which counteracts a return flow of the medium out of the surrounding area (280), where the outlet side (240) has a pressure equalization element (270) for equalizing a vacuum in the vacuum pump (150) with respect to the surrounding area (280), wherein the pressure equalization element (270) is set up for counteracting the entry of damaging substances out of the surrounding area (280) into the vacuum pump (150).

2. The vacuum pump (150) as claimed in claim 1, wherein the pressure equalization element (270) is formed as a particle filter (350, 400) for retaining particles of damaging substances.

3. The vacuum pump (150) as claimed in claim 2, wherein the particle filter is formed as a membrane (350), which is permeable for the medium.

4. The vacuum pump (150) as claimed in claim 3, wherein the membrane is one sided permeable for the medium.

5. The vacuum pump (150) as claimed in claim 4, wherein the membrane (350) is impermeable for liquid and solid substances.

6. The vacuum pump (150) as claimed in one of the preceding claims, wherein the outlet non-return valve (260) has a sealing surface (340), with which the pressure equalization element (270) is sealed in a blocking position and via which the pressure equalization element (270) is lifted in an open position.

7. The vacuum pump (150) as claimed in one of the preceding claims, wherein the inlet side (230) comprises a pump check valve (160) to allow a flow of the medium from the vacuum pump (150) to the inlet side (230).

8. The vacuum pump (150) as claimed in one of the preceding claims, wherein the vacuum pump (150) comprises a pump motor (250).

9. The vacuum pump (150) as claimed in one of the preceding claims, wherein the vacuum pump (150) comprises an evacuation pump for a pneumatic brake booster (120).

10. The vacuum pump (150) as claimed in one of the preceding claims, wherein it is adapted for an intermittent pump operation, so that during the pumping operation, the medium is discharged from the outlet into the surrounding area (280), and outside the pumping operation, a pressure gradient from the surrounding area (280) is reduced to the outlet.

Dated this 17th day of February 2012

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To
The Controller of Patents
The Patent office at New Delhi

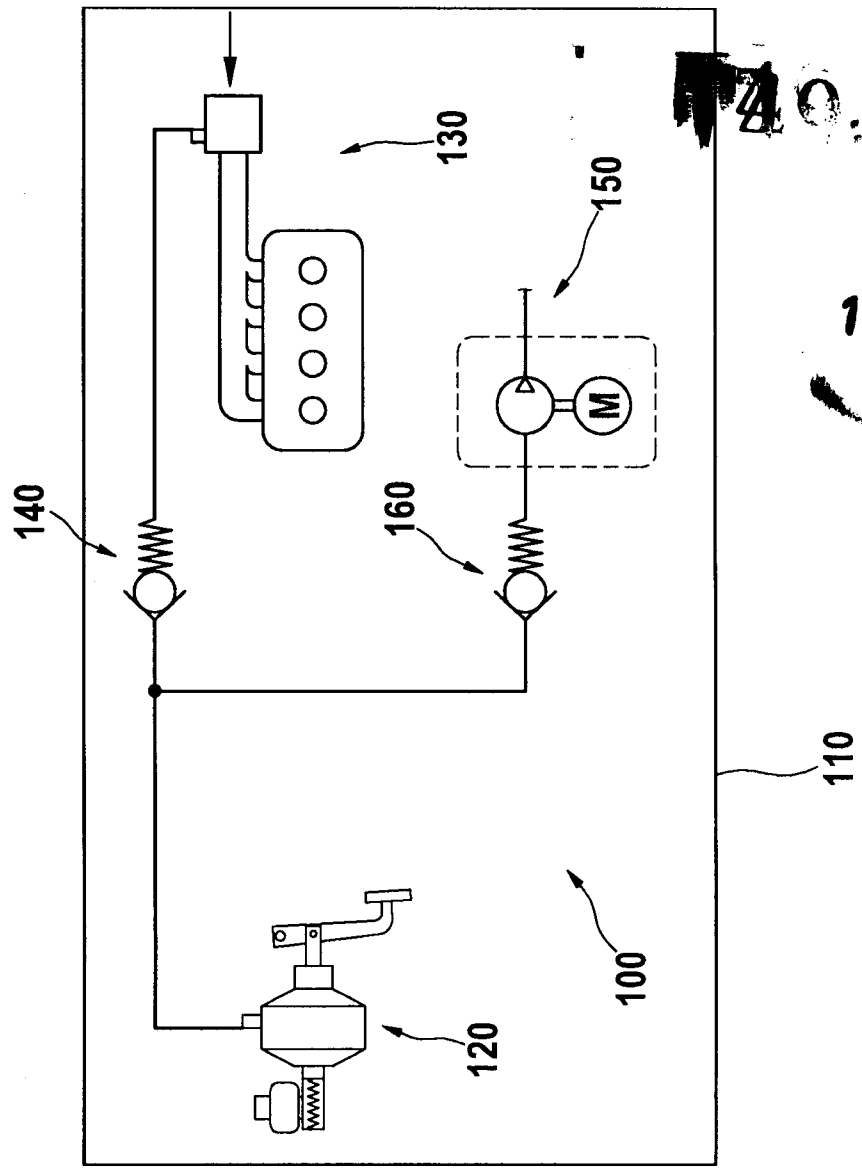

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Fig. 1

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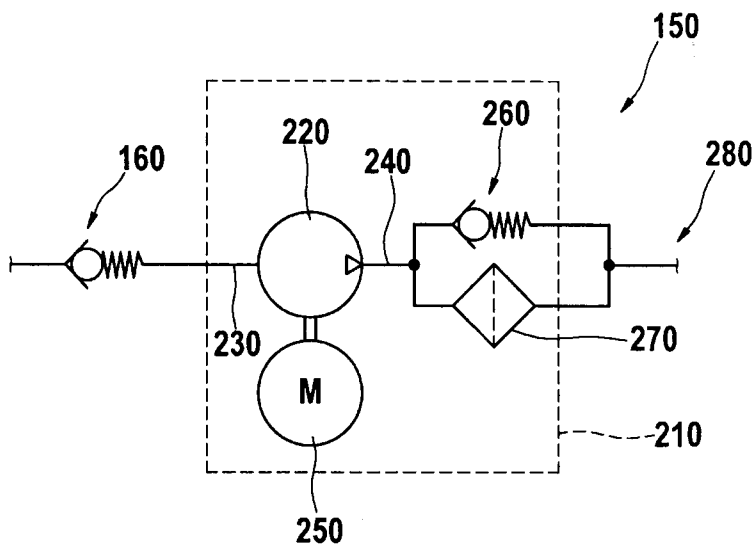

Fig. 2

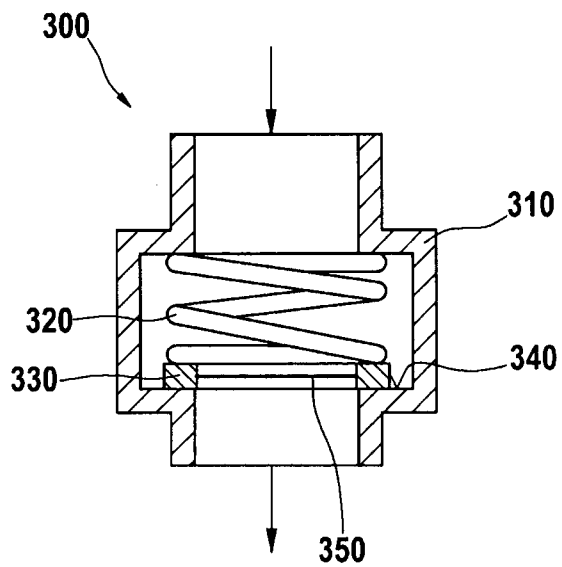

Fig. 3A

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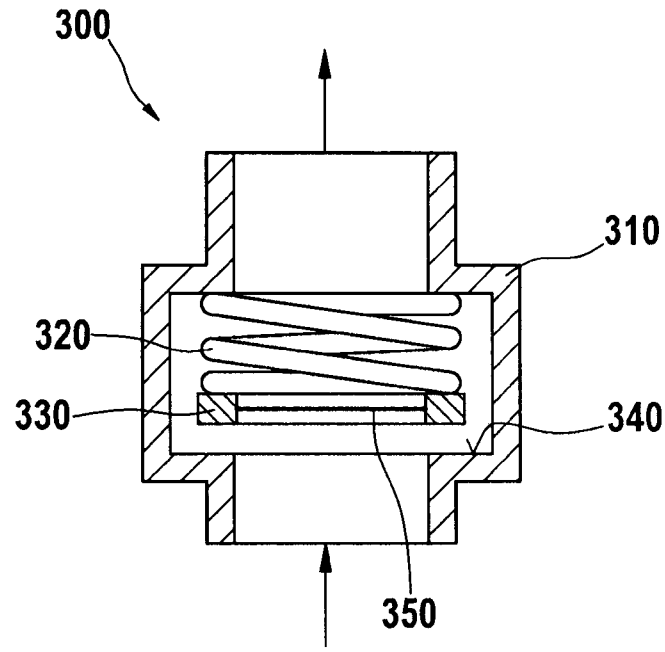

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Fig. 3B

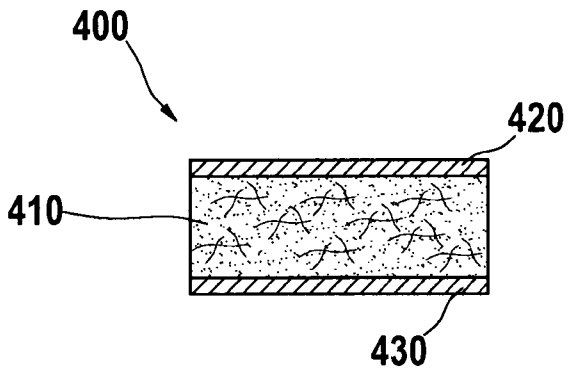

Fig. 4

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TECHNICAL FIELD

The present subject matter relates to a vacuum pump for use in a motor vehicle, and in particular relates to a vacuum pump with pressure equalization.

BACKGROUND

Vacuum pumps are used, for example, in motor vehicles for different tasks. For example, a vacuum is provided in a pneumatic brake booster of a motor vehicle by a vacuum pump. For motor vehicles with gasoline engines, fuel mixture preparation takes place by means of a device with throttle valve, where a brake booster is usually evacuated over the fuel mixture preparation device. For gasoline engines, which enacts over a fuel injection system, and also in diesel engines, a throttle valve is sometimes not necessary, and the suction effect of the gasoline or diesel engine in the mixture preparation device is not enough to produce sufficient vacuum in the brake booster in all operating states.

Therefore an additional electrically-operated vacuum pump can be used in order to provide or support an evacuation of the brake booster. If no brake application takes place, a vacuum generated in the brake booster remains approximately constant. The brake booster is ventilated upon a brake actuation, and is again evacuated. The vacuum pump is therefore not operated during the entire operation duration of the motor vehicle, but can be switched on and off in dependence of the vacuum prevailing in the brake booster. In order to prevent flow of air through a switched-off vacuum pump in the brake booster, usually a non-return valve is provided between an inlet side of the vacuum pump and the brake booster.

Immediately after switching off of the vacuum pump, however, a certain volume under vacuum is still provided in the vacuum pump, so that air can be replenished from the surrounding in the pump stoppage, where air evacuated during the pumping operation is ejected.

The air entering into the vacuum pump may be contaminated with substances such as water, oil, dust, ice or salt spray, which can damage the vacuum pump during the long run. This is particularly observed when the vacuum pump is installed in the surrounding, such as in an engine compartment or at an underbody of the vehicle, polluted with such substances.

SUMMARY

This summary is provided to introduce concepts related to a vacuum pump with pressure equalization and the concepts are further described below in the detailed description. This summary is neither intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

In one embodiment, the subject matter describes a vacuum pump, particularly for use in a motor vehicle, comprising an inlet side for sucking in a fluid medium and an outlet side for delivering the medium which is sucked into a surrounding area, where the outlet side comprises an outlet non-return valve, which counteracts a return flow of the medium out of the surrounding area, where the outlet side has a pressure equalization element for equalizing a vacuum in the vacuum pump with respect to the surrounding area, wherein the pressure equalization element is set up for counteracting the entry of damaging substances out of the surrounding area into the vacuum pump.

BRIEF DESCRIPTION OF DRAWINGS

The present subject matter is further explained with reference to the accompanying figures. Further, identical or corresponding elements bear the same reference in all figures.

Fig. 1 shows a vacuum system in a motor vehicle, according to an embodiment of the present subject matter.

Fig. 2 shows a schematic representation of the structure of the vacuum pump of Fig. 1.

Figs. 3A and 3B shows an integrated pressure equalization element for use in the vacuum pump of Fig. 2 in two different positions.

Fig. 4 shows a filter element for use in the vacuum pump of Fig. 2.

DETAILED DESCRIPTION

An object of the present invention is to cure a vacuum pump against wear due to entrance of harmful substances.

The object is achieved by a vacuum pump with the features of claim 1. Claims indicate possible or advantageous embodiments.

A vacuum pump, particularly for use in a motor vehicle, having an inlet side for sucking in a fluid medium and an outlet for delivering the aspirated medium to the surrounding area, and has an outlet non-return valve at the outlet, which counteracts a reflux of the medium from the surrounding, where the outlet includes a pressure equalization element for compensating vacuum in the vacuum pump against the surrounding, the pressure equalization element is arranged to work against the entry of harmful substances from the surrounding area in the vacuum pump.

The outlet non-return valve prevents an immediate subsequent flow of the medium, for example, air, into the vacuum pump, when this is turned off after operation. To prevent the internal elements of the vacuum pump, particularly seals, from increased wear by the vacuum remaining in the vacuum pump, the pressure compensating element allows a penetration of the medium from the surrounding area into the vacuum pump without leaving harmful substances to the vacuum pump. The vacuum pump is particularly suitable for use in a motor vehicle, where the vacuum pump harming substances such as water, dust or oil can be expected in the vicinity of the vacuum pump.

The pressure equalization element may be a particle filter, which retains particles of harmful substances, whose size exceeds, for example, a certain particle size. Solid and liquid droplets can be retained in the filter when air passes through the particle filter as a medium. The particle filter allows a more compact design than a compensating volume in the form of outlet pipe dimensioned in dependence of the volume to be permitted.

The particulate filter may be formed as a membrane which is permeable for the medium on one side. Thus a flow of medium is allowed through the pressure equalization element only in one direction, so that the deposited particles collect on only one side of the membrane, namely the side which communicates in contact with the surrounding. The permeability of the membrane is not at risk and the accumulation of the particles in the range of the vacuum pump is prevented.

The medium may be gaseous, and the membrane for liquid and solid substances may be impermeable. The medium may be, for example, air and the membrane is made of expanded polytetrafluoroethylene (ePTFE, known under the registered trademark "Gore-Tex"). Thus a proven and cost effective membrane with good long-term properties is available.

The outlet non-return valve may be designed integrally with the particle filter. Thus an integrated assembly is provided, with which an existing vacuum pump can be retrofitted, optionally in exchange for an existing pressure equalization element or a check valve.

The inlet side of the vacuum pump may include a pump check valve to counteract a flow of the medium from the vacuum pump to the inlet side. Thus the vacuum pump can be made in vacuum-free manner outside a pump operation, whereby seals of the vacuum pump are relieved, which leads to an increased operational safety.

The vacuum pump may be adapted for an intermittent pump operation, so that during the pumping operation, the medium is conveyed from the outlet to the surrounding area and a pressure gradient is degraded from the surrounding area to the outlet side outside the pumping operation. The control of the pumps can operate independent of the vacuum in a vessel to be evacuated. In one embodiment, a pump controller may be integrated with the vacuum pump. The pump controller can control the operation of the vacuum pump in response to the vacuum, which prevails at the inlet side of the vacuum pump or at the pump check valve, so that a fully integrated vacuum unit is provided.

Fig. 1 shows a vacuum system 100 on board of a motor vehicle 110. A pneumatic brake booster 120 is connected to a gasoline engine 130 by means of a motor-return valve 140 so that the gasoline engine 130 can evacuate air from the brake booster 120. The motor-check valve 140 prevents back flow of air from the gasoline engine 130 to the brake booster 120, for example, when the gasoline engine 130 is off and does not generate a vacuum. A vacuum pump 150 is connected to the brake booster 120 by means of a pump-reflux barrier 160, so that the vacuum pump 150 can evacuate air from the brake booster 120. Also, a back flow of the medium from the vacuum pump 150 to the brake booster 120 is prevented by the pump check valve 160.

The vacuum system 100 does not necessarily require the gasoline engine 130 and the motor-return valve 140, but can also be constructed by the brake booster 120 and the vacuum pump 150 with or without the pump check valve 160.

The vacuum pump 150 may be used in many different settings on the motor vehicle 110 or other technical units. Particularly the use of the vacuum pump 150 is not limited to evacuation of the brake booster 120, but may relate to the evacuation of any fluid medium in the surrounding.

Fig. 2 shows a schematic representation of the vacuum pump 150 with the pump check valve 160 of Fig. 1. The symbols as represented correspond to ISO symbols for hydraulic systems. The vacuum pump 150 includes an enclosure 210 in which a pumping device 220 with an inlet side 230 and an outlet 240, a pump motor 250, an outlet non-return valve 260, and a pressure equalization element 270. The pump check valve 160 is connected to the inlet side 230 of the pumping device 220. The outlet 240 of the pumping device 220 is connected in parallel with the outlet non-return valve 260 and the pressure equalization element 270, both of which are connected to the surrounding area 280.

The pumping device 220 may be a vane pump, piston pump, diaphragm pump or other pump for the medium to be evacuated. The pump motor 250 may be located inside or outside the enclosure 210. The outlet non-return valve 260 and the pressure equalization element 270 are connected by means of suitable connections, such as hoses or pipes. The enclosure 210 can be sealed relative to the medium to be supplied, and dedicated connections between the outlet 240 of the pumping device 220 and the outlet non-return valve 260 as well as the pressure equalization element 270 are omitted. The outlet non-return valve 260 and the pressure equalization element 270 may be disposed in corresponding recesses of a wall of the enclosure 210 so that each element is connected directly with the surrounding area 280.

The connection of the outlet non-return valve 260 and/or the pressure equalization element 270 with the surrounding area 280 may also include a connecting element such as a hose or a tube in order to relocate a transition point to the surrounding area 280, for example, with respect to pollution advantageous place, such as within an engine compartment of the motor vehicle 110 from Fig. 1. The connection of sides of the outlet non-return valve 260 facing the surrounding area 280 and the pressure equalization element 270 within or outside the enclosure 210 may be connected to one another.

Figs. 3A and 3B show an integrated valve 300 for use in the vacuum pump 150 of Fig. 2, which interconnects the functions of the outlet non-return valve 260 and the pressure equalization element 270. The valve 300 includes a housing 310, a resilient element 320 (shown here as a spiral spring), a border 330, a sealing surface 340 formed on the housing 310, and a membrane 350. The membrane 350 is exemplary shown for a pressure equalization element 270. A filter element 400 can also be used in its place (Fig. 4). The

housing 310 can be inserted into a corresponding recess in the enclosure 210 of Fig. 2, or integrally guided with the enclosure 210.

The housing 310 is connected with its above represented side with the surrounding area 280 of Fig. 2 and is connected with its bottom side with the outlet 240 of the pumping device 220. The membrane 350 is supported by the border 330, which is driven by the spring 320 within the housing 310 against the sealing surface 340.

Fig. 3A shows the integrated valve 300 outside the pumping operation of the vacuum pump 150. The spring 320 pushes the border 330 against the sealing surface 340, so that air, as indicated by the arrows at the top side and the bottom side of the integrated valve 300, may flow through only in a relatively low volume flow through the membrane 350, so that the pressure gradient exists from the upper to the lower side for a long time. The membrane 350 consists of expanded polytetrafluoroethylene and passes only gases but that retain liquid and solid substances. In one implementation, the membrane may pass air from top to bottom and retain all other flows. The membrane 350 may have a diameter of about 20mm.

Fig. 3B shows the integrated valve 300 during a pumping operation of the vacuum pump 150 of Fig. 2. There exists a pressure gradient from the bottom of the housing 310 to the top, so that the membrane 350 with the border 330 is lifted from the sealing surface 340 against the force of the spring 320. Optionally, a part of the medium passes through the membrane 350, and another part of the medium flows around the sides of the border 330, so that a relatively large volume flow is possible regardless of the size and permeability of the membrane 350.

Fig. 4 shows a filter element 400 for use as a pressure equalization element 270 in the vacuum pump 150 of Fig. 2. Particularly, the filter element 400 may replace the membrane 350 within the integrated valve 300 in Figs. 3A and 3B. A filter medium 410 includes a fleece, a bed, porous solids, tissues and/or paper. The filter media 410 is bounded above by an upper support element 420 and downwardly by a lower support element 430. The support elements 420 and 430 hold the filter medium 410 such that it is not deformed by the flow of the medium. In addition, the supporting elements 420 and 430 are used for supporting the filter element 400 in the housing or some other surrounding area structure, for example, at the border 330 in Fig. 3, and is formed in such a manner that no medium flows past to the side of the filter medium 410.