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(54) **DEVICE FOR COOLING AN EXHAUST GAS STREAM EMERGING FROM A SOOT PARTICLE FILTER**

(76) Inventors: **Romain Brunet**, Mannheim (DE); **Scott D. Ochsner**, Cedar Falls, IA (US)

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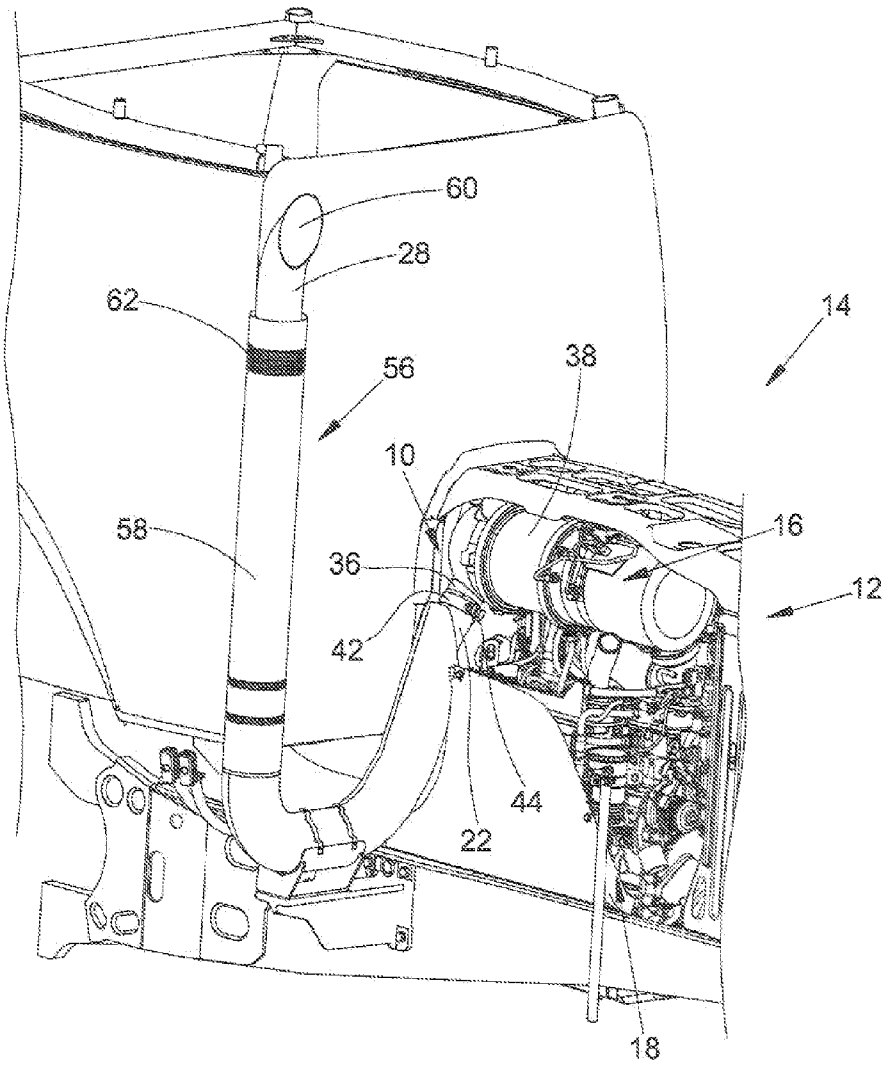
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(57) **ABSTRACT**

Device for cooling an exhaust gas stream emerging from a soot particle filter, having an outlet connector provided on the soot particle filter for conveying out the exhaust gas stream, the outlet connector comprising a mouth region tapering in the direction of the exhaust gas stream, which region projects into an open end of an adjacent exhaust gas pipe in such a way that a reduced pressure relative to the surrounding environment may be produced in a suction region between the outlet connector and the exhaust gas pipe on passage of the exhaust gas stream.



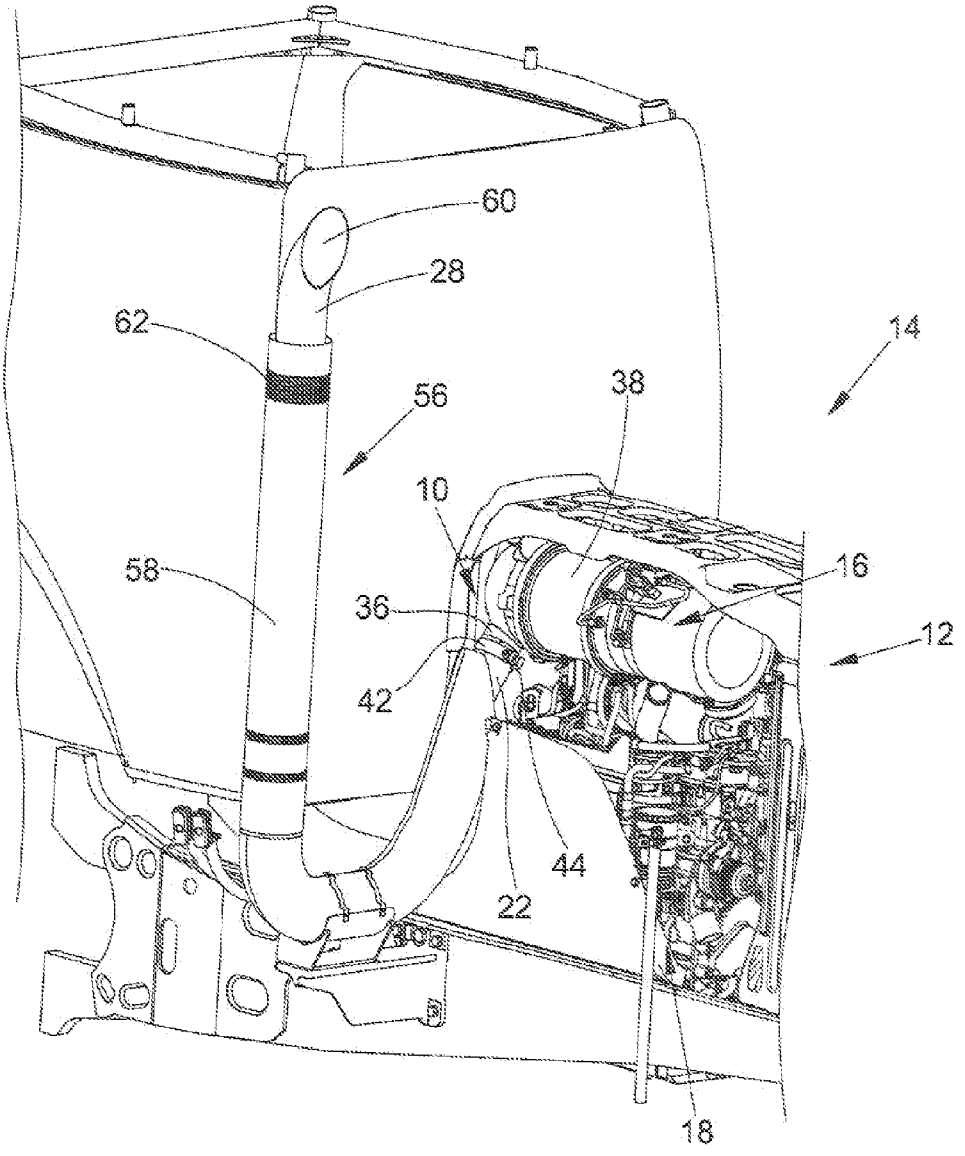


Fig. 1

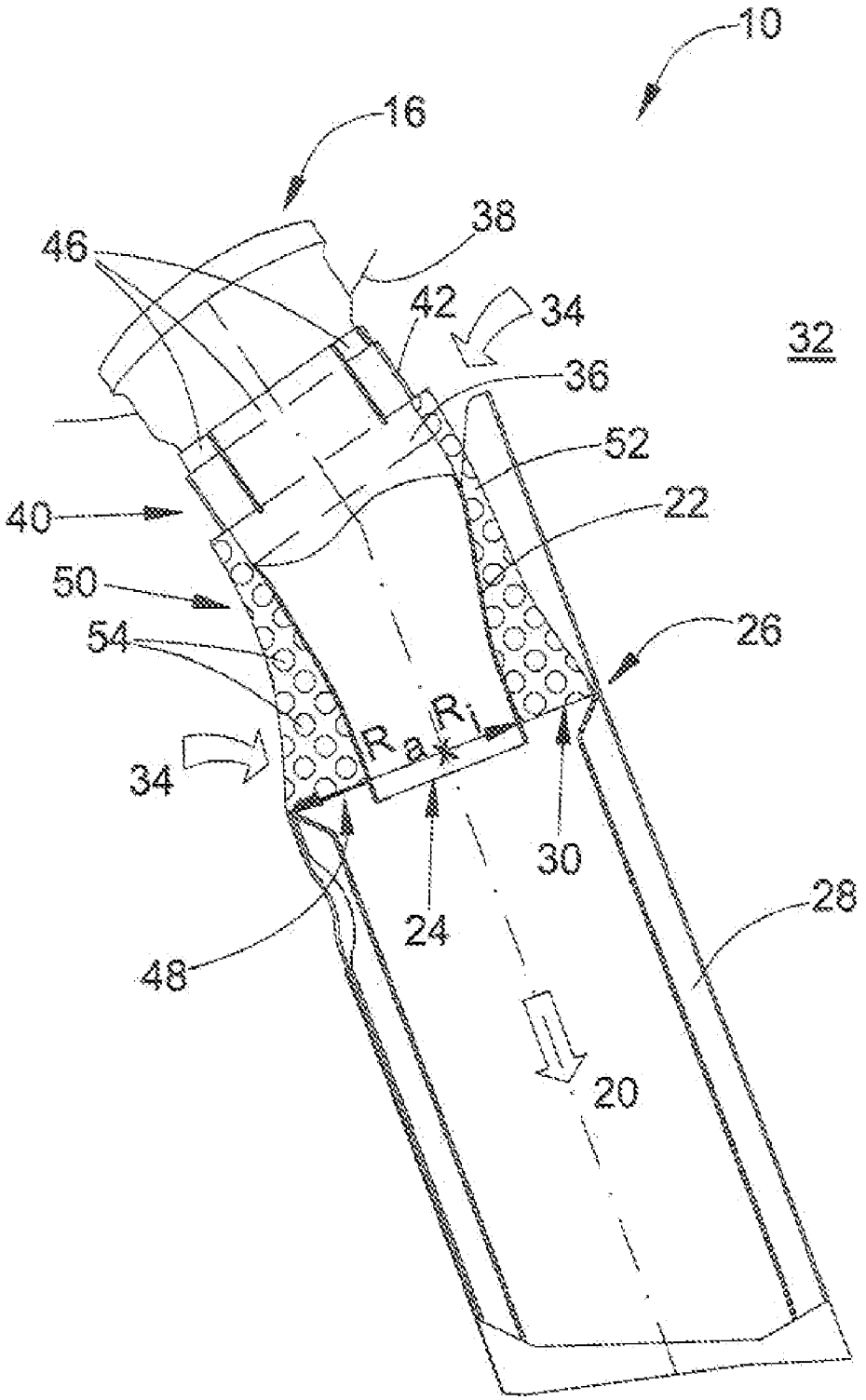


Fig. 2

DEVICE FOR COOLING AN EXHAUST GAS STREAM EMERGING FROM A SOOT PARTICLE FILTER

FIELD OF THE DISCLOSURE

[0001] The disclosure relates to a device for cooling an exhaust gas stream emerging from a soot particle filter.

BACKGROUND OF THE DISCLOSURE

[0002] The exhaust gas standards enacted by the European Union provide for a gradual reduction in the soot particles produced by diesel engines and discharged into the environment with the engine exhaust gas. Soot particle discharge is restricted by using soot particle filters, as a rule with "wall-flow filters," in which the engine exhaust gas passes through a porous filter wall of a ceramic or metallic material. In so doing, the soot particles contained in the engine exhaust gas become deposited both on the surface and also inside the filter wall, such that the exhaust gas back-pressure increases as the degree of clogging of the filter wall increases. To regenerate the soot particle filter, the deposited soot particles are therefore burned at regular intervals, for which purpose the temperature of the engine exhaust gas is increased from time to time to temperatures of over 500° C., for example using an oxidation catalytic converter connected upstream of the soot particle filter. During regeneration, correspondingly high exhaust gas temperatures may occur at the tail pipe of the exhaust gas system (exhaust), which may lead to the formation of undesirable nitrogen oxides. Against this background, DE 10 2008 051 958 A1 discloses a device for reducing the temperature of an exhaust gas stream emerging from a diesel particle filter, wherein cooler ambient air is admixed with the waste gas stream by means of an air pump during regeneration of the diesel particle filter. Because the air pump is electrically controlled, the known device is of comparatively complex construction.

[0003] It is therefore the object of the present disclosure to simplify a device of the above-mentioned type with regard to its structure.

[0004] This object is achieved by a device having the features of claim **1**.

SUMMARY OF THE DISCLOSURE

[0005] A device for cooling an exhaust gas stream emerging from a soot particle filter comprises an outlet connector provided on the soot particle filter for conveying out the exhaust gas stream, the outlet connector comprising a mouth region tapering in the direction of the exhaust gas stream, which region projects into an open end of an adjacent exhaust gas pipe in such a way that a reduced pressure relative to the surrounding environment may be produced in a suction region between the outlet connector and the exhaust gas pipe on passage of the exhaust gas stream. More precisely, the reduced pressure is produced according to the Venturi principle, wherein the mouth region of the outlet connector extends in the manner of a nozzle into the open end of the exhaust gas pipe. The ambient air drawn into the exhaust gas pipe due to the reduced pressure leads in the process, depending on the temperature thereof, to corresponding cooling of the exhaust gas stream.

[0006] Since the device is distinguished not only by a particularly simple, but simultaneously also by an extremely compact structure, it is possible to accommodate said device together with the soot particle filter inside an engine compartment of a motor vehicle operated by a diesel engine, in particular, of an agricultural utility vehicle.

[0007] Cooling of the diesel engine is conventionally achieved by a high temperature heat exchanger arranged in the engine compartment of the motor vehicle, which heat exchanger is a component of a liquid cooling circuit connected with the diesel engine, the high temperature heat exchanger being exposed to cooling air by means of a fan unit, which cooling air is drawn from the surrounding environment by way of a radiator grille and downstream filter inserts. Since the air conveyed in this way into the engine compartment is largely free of contaminants, undesired clogging of the suction region formed between the outlet connector and the exhaust gas pipe is largely avoided. In addition, the compression of the air located in the engine compartment, brought about on the part of the fan unit, leads to an increased volumetric flow rate in the suction region and thus to more efficient cooling of the exhaust gas stream.

[0008] Preferably, the outlet connector is connected detachably to a fastening flange of a filter housing surrounded by the soot particle filter. Accordingly, the fastening flange is a fixed component of the filter housing and, as such, is welded or otherwise firmly connected thereto. The outlet connector may comprise a fastening portion, which may be plugged onto the fastening flange and which may be brought into airtight engagement with the fastening flange.

[0009] The detachable connection between the outlet connector and the fastening flange of the filter housing may be produced in particular by means of a removable spring clip. The spring clip here consists of a stainless steel or otherwise appropriately surface-treated steel alloy. When fitted, the spring clip grips around the outlet connector in the region of the fastening portion in such a way that, by reducing the circumference of the spring clip by means of a clamping screw or the like, a clamp connection may be produced between the outlet connector and the fastening flange of the filter housing. To improve the clamping action, the outlet connector may comprise a plurality of fastening tabs extending transversely of the spring clip in the region of the fastening portion.

[0010] Alternatively, the outlet connector may also be a fixed component of the filter housing surrounded by the soot particle filter. The outlet connector is then welded or otherwise firmly connected to the filter housing.

[0011] Preferably, the suction region takes the form of an annular gap extending radially between the outlet connector and the exhaust gas pipe. In this case both the outlet connector and the exhaust gas pipe have a substantially circular cross section at least in the suction region.

[0012] It has become clear that exhaust gas stream cooling efficiency may be optimized if the ratio between an outer radius and an inner radius of the annular gap has a value in the range from 1.90 to 2.10. Thus, for example, with an outer radius of 60 millimetres and an inner radius of 29 millimetres, corresponding to a ratio of the two radii of approx 2.07, the exhaust gas stream temperature may be reduced by more than 200° C. It should be noted, however, that the above details are given merely by way of example and may differ to a greater or lesser degree as a function of the particular operating conditions.

[0013] The mouth region of the outlet connector preferably extends throughout over its entire circumference at a distance from the open end of the exhaust gas pipe. In other words, the

mouth region of the outlet connector is self-supporting relative to the open end of the exhaust gas pipe. The distance is selected such that, in the event of vibrations occurring between the outlet connector and the exhaust gas pipe as a result of operation, the mouth region of the outlet connector may move inside the open end of the exhaust gas pipe without touching it. This ensures extensive mechanical decoupling of the two components.

[0014] It is additionally possible for the filter element to taper in the direction of the outlet connector. The filter element tapers only insofar as to rule out mutual contact between the outlet connector and the exhaust gas pipe in the event of vibrations occurring between them as a result of operation.

[0015] Moreover, the suction region may be surrounded by a filter element, in particular by a perforated mesh. The openings in the perforated mesh are dimensioned such that above all relatively coarse contaminants, which would lead rapidly to clogging or blocking of the suction region, are reliably retained. To increase corrosion resistance the perforated mesh is made from an aluminium-coated steel alloy or the like.

[0016] The filter element may be arranged at the open end of the exhaust gas pipe and extend in the direction of the outlet connector. More precisely, the filter element forms an extension arranged on the exhaust gas pipe, which beyond the suction region surrounds the outlet connector over its entire circumference in the manner of a collar.

[0017] It is additionally possible for the filter element to taper in the direction of the outlet connector. The filter element here tapers only insofar as to rule out mutual contact between filter element and outlet connector in the event of vibrations occurring between the outlet connector and the exhaust gas pipe as a result of operation.

[0018] It is additionally feasible for the exhaust gas pipe to be surrounded by a touch guard. The touch guard takes the form in particular of a tubular cover, which is fitted along the outside of the exhaust gas pipe by means of a plurality of spacers. To prevent overheating of the exhaust gas pipe, the tubular cover may comprise a plurality of openings at least in the region of an exhaust, which allow circulation of the air present between the exhaust gas pipe and the tubular cover.

[0019] The device will be described in greater detail below with reference to the appended drawings, in which components of matching or comparable function are labelled with the same reference numerals. In the drawings:

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** is a perspective overall view of an exemplary embodiment of the device for cooling an exhaust gas stream emerging from a soot particle filter on an agricultural utility vehicle, and

[0021] FIG. **2** is a detail view of the exemplary embodiment shown in FIG. **1** of the device in longitudinal section.

DETAILED DESCRIPTIONS OF THE DRAWINGS

[0022] The soot particle filter **16** accommodated together with the device **10** in an engine compartment **12** of the agricultural utility vehicle **14**, in the present case, takes the form of a conventional wall-flow filter, the engine exhaust gas produced by a diesel engine **18** of the agricultural utility vehicle **14** passing through a porous filter wall of a ceramic or metallic material. In the process, the soot particles contained in the engine exhaust gas become deposited both on the surface and also inside the filter wall of the soot particle filter **16**. Since the exhaust gas back-pressure increases as the degree of clogging of the filter wall increases, the deposited soot particles are burned at regular intervals to regenerate the soot particle filter **16**, for which purpose the temperature of the engine exhaust gas is increased from time to time to temperatures of over 500° C. using an oxidation catalytic converter connected upstream of the soot particle filter **16**.

[0023] To cool the exhaust gas stream **20** emerging from the soot particle filter **16**, the device **10** comprises an outlet connector **22** provided on the soot particle filter **16** for conveying out the filtered exhaust gas stream **20**, the outlet connector **22** comprising a mouth region **24** tapering in the direction of the exhaust gas stream **20**, which region projects into an open end **26** of an adjacent exhaust gas pipe **28** in such a way that a reduced pressure relative to the surrounding environment **32** may be produced in a suction region **30** between the outlet connection **22** and the exhaust gas pipe **28** on passage of the exhaust gas stream **20**.

[0024] More precisely, the reduced pressure is produced according to the Venturi principle, wherein the mouth region **24** of the outlet connector **22** extends in the manner of a nozzle into the open end **26** of the exhaust gas pipe **28**. The ambient air **34** drawn into the exhaust gas pipe **28** due to the reduced pressure leads in the process, depending on the temperature thereof, to corresponding cooling of the exhaust gas stream **20**.

[0025] The outlet connector **22** is connected detachably to a fastening flange **36** of a filter housing **38** surrounded by the soot particle filter **16**. The fastening flange **36** is a fixed component of the filter housing **38** and as such is welded or otherwise firmly connected thereto. The outlet connector **22** comprises a fastening portion **40**, which may be plugged onto the fastening flange **36** and which may be brought into airtight engagement with the fastening flange **36**.

[0026] The detachable connection between the outlet connector **22** and the fastening flange **36** of the filter housing **38** is produced by means of a removable spring clip **42**. The spring clip **42** here consists of a stainless steel or appropriately surface-treated steel alloy. When fitted, the spring clip **42** grips around the outlet connector **22** in the region of the fastening portion **40** in such a way that, by reducing the circumference of the spring clip **42** by means of a clamping screw **44** or the like, a clamp connection may be produced between the outlet connector **22** and the fastening flange **36** of the filter housing **38**. To improve the clamping action, the outlet connector **22** comprises a plurality of fastening tabs **46** extending transversely of the spring clip **42** in the region of the fastening portion **40**.

[0027] According to an alternative configuration of the device according to the device **10**, the outlet connector **22** is a fixed component of the filter housing **38** surrounded by the soot particle filter **16**.

[0028] The suction region **30** takes the form of an annular gap **48** extending radially between the outlet connector **22** and the exhaust gas pipe **28**, such that both the outlet connector **22** and the exhaust gas pipe **28** have a substantially circular cross section at least in the suction region **30**.

[0029] The ratio between an outer radius R_a and an inner radius R_i of the annular gap **48** has a value in the range from 1.90 to 2.10. Preferably, the outer radius R_a and the inner radius R_i amount, in each case taking account of tolerances

conventional in manufacturing, to 60 millimetres and 29 millimetres respectively, corresponding to a ratio R_a/R_i of the two radii of approx 2.07.

[0030] The mouth region **24** of the outlet connector **22** preferably extends throughout over its entire circumference at a distance from the open end **26** of the exhaust gas pipe **28**. The distance is selected such that, in the event of vibrations occurring between the outlet connector **22** and the exhaust gas pipe **28** as a result of operation, the mouth region **24** of the outlet connector **22** may move inside the open end **26** of the exhaust gas pipe **28** without touching it. In this way, extensive mechanical decoupling of the two components **22**, **28** is achieved.

[0031] Furthermore, the suction region **30** is surrounded by an optional filter element **50** in the form of a perforated mesh **52**. The openings **54** in the perforated mesh **52** are dimensioned such that above all relatively coarse contaminants, which would lead rapidly to clogging or blocking of the suction region **30**, are reliably retained. To this end the diameter of the openings **54** is selected to be smaller than the gap size R_a-R_i of the suction region **30**. To increase corrosion resistance the perforated mesh **52** is made from an aluminium-coated steel alloy or the like.

[0032] The filter element **50** is arranged at the open end **26** of the exhaust gas pipe **28** and extends in the direction of the outlet connector **22**. More precisely, the filter element **50** forms an extension arranged on the exhaust gas pipe **28**, which beyond the suction region **30** surrounds the outlet connector **22** over its entire circumference in the manner of a collar.

[0033] In addition, the filter element **50** is tapered in the direction of the outlet connector **22**. The filter element **50** tapers only insofar as to rule out mutual contact between the filter element **50** and the outlet connector **22** in the event of vibrations occurring between the outlet connector **22** and the exhaust gas pipe **28** as a result of operation.

[0034] According to FIG. **1**, the exhaust gas pipe **28** is surrounded at least in places by a touch guard **56**. The touch guard **56** takes the form of a tubular cover **58**, which is fitted along the outside of the exhaust gas pipe **28** by means of a plurality of spacers. To prevent overheating of the exhaust gas pipe **28**, the tubular cover **58** comprises a plurality of openings **62** at least in the region of an exhaust **60**, which allow circulation of the air present between the exhaust gas pipe **28** and the tubular cover **58**.

[0035] Although the agricultural utility vehicle **14** shown in FIG. **1** is, by way of example, a tractor, it is likewise feasible for the device **10** to be used with any other desired diesel-engined motor vehicles. In addition, it may also be used in stationary applications, such as for example a diesel-engined power generator or the like.

[0036] While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such illustration and description is to be considered as exemplary and not restrictive in character, it being understood that illustrative embodiments have been shown and described and that all changes and modifications that come within the spirit of the disclosure are desired to be protected. It will be noted that alternative embodiments of the present disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations that incorporate one or more of the features of the present disclosure and fall within the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A device for cooling an exhaust gas stream emerging from a soot particle filter, wherein an outlet connector is provided on the soot particle filter for conveying out the exhaust gas stream, the outlet connector comprising a mouth region tapering in the direction of the exhaust gas stream, the region projects into an open end of an adjacent exhaust gas pipe in such a way that a reduced pressure relative to the surrounding environment may be produced in a suction region between the outlet connector and the exhaust gas pipe on passage of the exhaust gas stream.

2. The device according to claim **1**, wherein the outlet connector is connected detachably with a fastening flange of a filter housing surrounded by the soot particle filter.

3. The device according to claim **1**, wherein the detachable connection between the outlet connector and the fastening flange of the filter housing may be produced by means of a removable spring clip.

4. The device according claim **1**, wherein the outlet connector is a fixed component of the filter housing surrounded by the soot particle filter.

5. The device according to claim **1**, wherein the suction region takes the form of an annular gap extending radially between the outlet connector and the exhaust gas pipe.

6. The device according to claim **5**, wherein the ratio between an outer radius and an inner radius of the annular gap has a value in the range from 1.90 to 2.10.

7. The device according to claim **1**, wherein the mouth region of the outlet connector extends throughout over its entire circumference at a distance from the open end of the exhaust gas pipe.

8. The device according to claim **1**, wherein the suction region is surrounded by a filter element, in particular by a perforated mesh.

9. The device according to claim **8**, wherein the filter element is arranged at the open end of the exhaust gas pipe and extends in the direction of the outlet connector.

10. The device according to claim **8**, wherein the filter element is tapered in the direction of the outlet connector.

11. The device according to claim **8**, wherein the filter element tapers in the direction of the outlet connector.

12. The device according to claim **1**, wherein the exhaust gas pipe is surrounded at least in places by a touch guard.

13. A motor vehicle having a device for cooling an exhaust gas stream emerging from a soot particle filter, wherein an outlet connector is provided on the soot particle filter for conveying out the exhaust gas stream, the outlet connector comprising a mouth region tapering in the direction of the exhaust gas stream, the region projects into an open end of an adjacent exhaust gas pipe in such a way that a reduced pressure relative to the surrounding environment may be produced in a suction region between the outlet connector and the exhaust gas pipe on passage of the exhaust gas stream.

14. The motor vehicle of claim **13**, wherein the device is positioned in an engine compartment.

15. The motor vehicle of claim **13**, wherein the motor vehicle is an agricultural utility vehicle.

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