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(54) EXHAUST GAS HEAT EXCHANGER, ESPECIALLY FOR MOTOR VEHICLES

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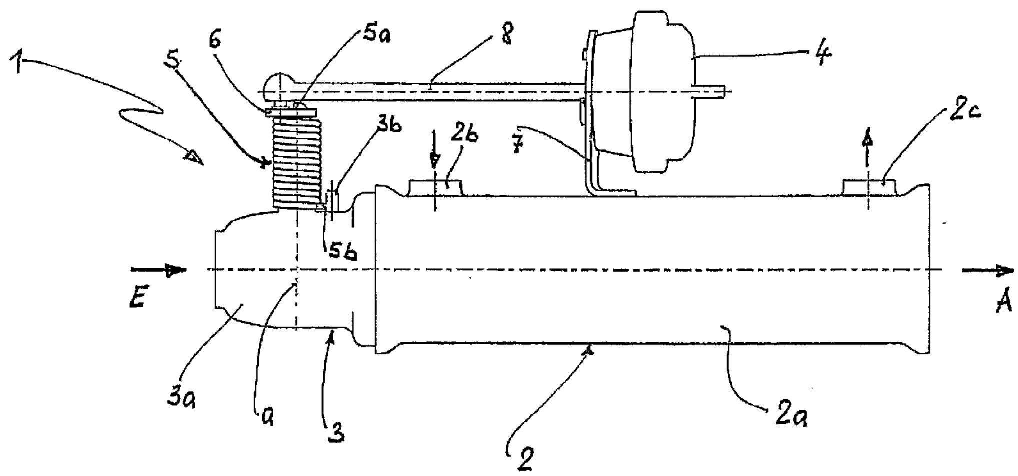
(57) **ABSTRACT**

The invention relates to an exhaust gas heat exchanger (**2**), especially for motor vehicles, comprising a main flow path and a secondary flow path (bypass) for the exhaust gas. Said heat exchanger comprises a valve device (**3**) which is used to control the exhaust gas flow and can be actuated by a servomotor (**4**) by means of a transmission device (**8**, **6**), the valve device (**3**) comprising a valve closing member fixed to a valve shaft (a). According to the invention, the valve shaft (a) can be loaded by a torsion spring (**5**) which can be supported on the valve shaft and on the valve device (**3**, **3***a*).



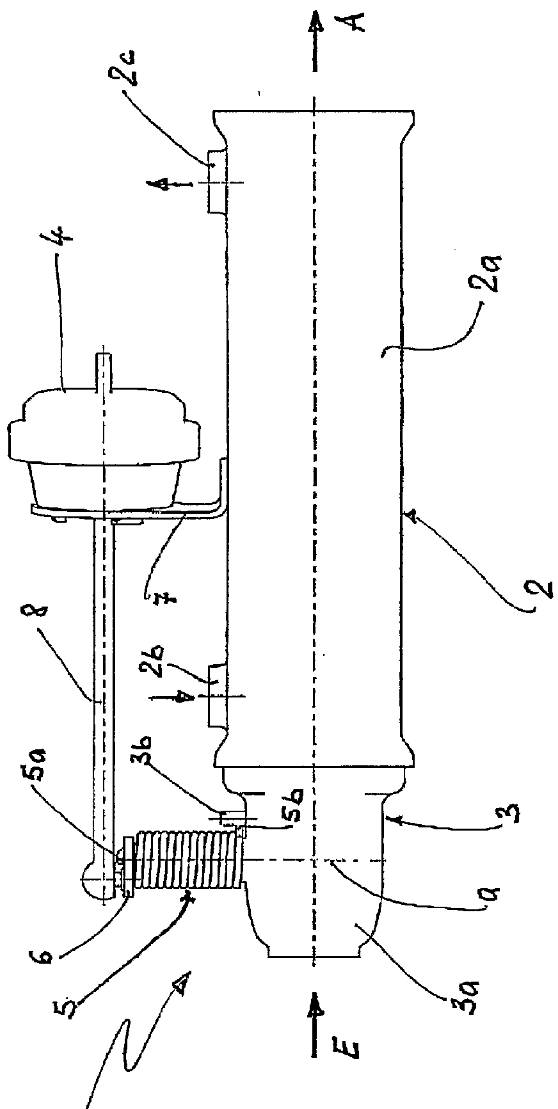


Fig.1

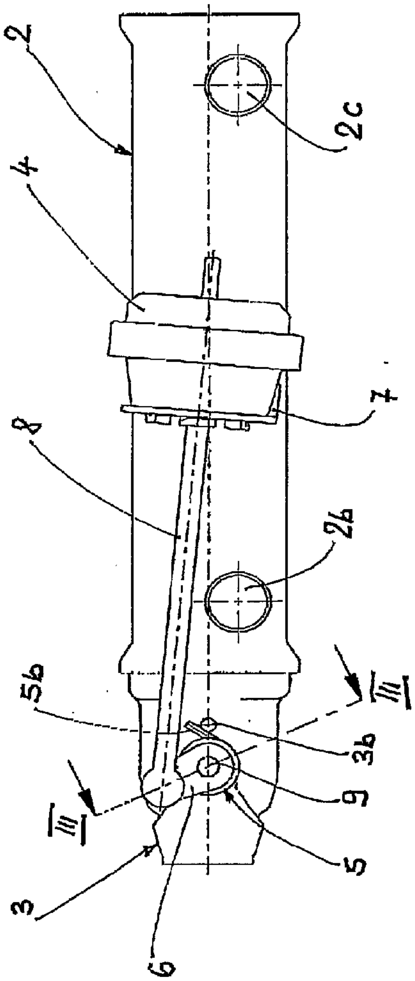


Fig.2

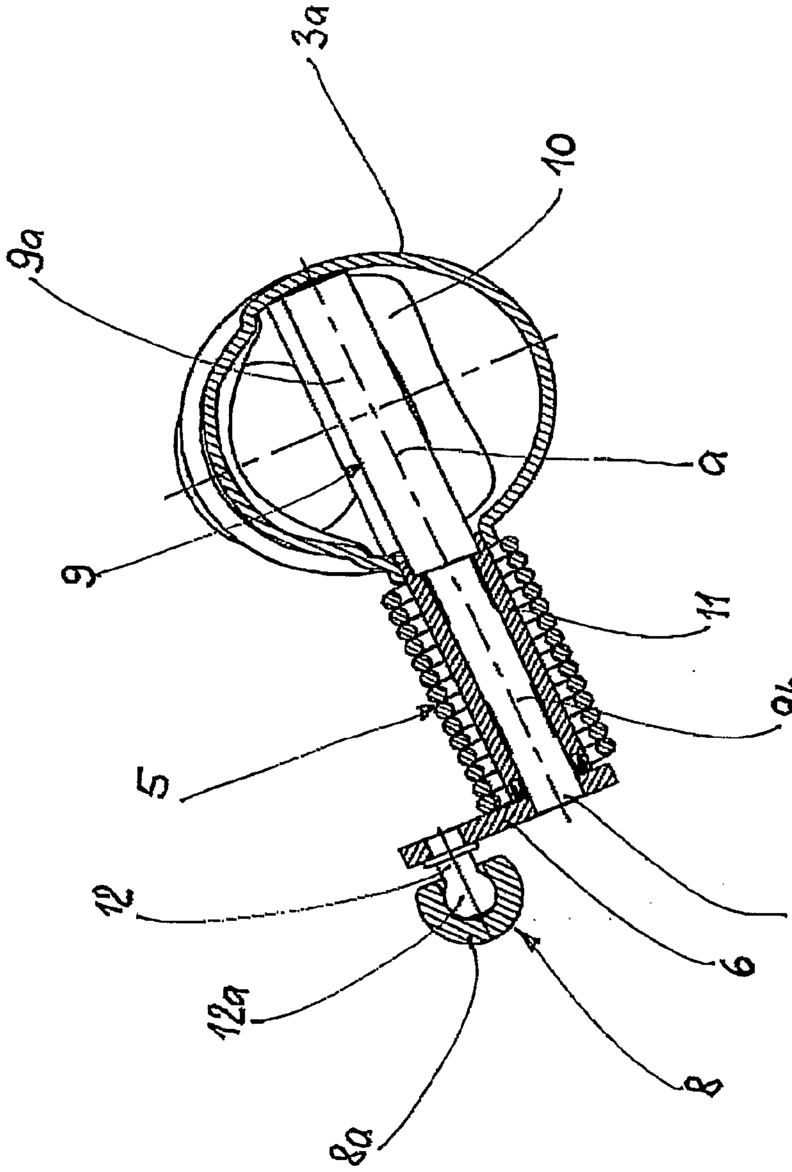


Fig.3

EXHAUST GAS HEAT EXCHANGER, ESPECIALLY FOR MOTOR VEHICLES

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application is a National Stage filing of International Application PCT/EP2006/000906, filed Feb. 2, 2006, claiming priority to German Application No. 10 2005 005 189.8, filed Feb. 3, 2005, entitled "EXHAUST GAS HEAT EXCHANGER, ESPECIALLY FOR MOTOR VEHICLES". The present application claims priority to PCT/EP2006/000906, and to German Application No. 10 2005 005 189.8, and both references are expressly incorporated by reference herein, in their entireties.

[0002] The invention concerns an exhaust gas heat, as disclosed in DE 102 03 003 A1, as well as an exhaust gas valve for exhaust gas heat exchangers.

[0003] Exhaust gas heat exchangers, in particular exhaust gas coolers as well as exhaust gas valves are well-known in exhaust gas recirculation systems, known as EGR systems, for motor vehicles. The recirculation of exhaust gases serves to reduce pollutants and fuel consumption in internal-combustion engines of motor vehicles. Exhaust gas heat exchangers can also be used for heating purposes, in particular with consumption-optimized engines, such as diesel engines—such a heat exchanger is described in DE 199 62 863 A1 of the applicant. The known exhaust gas heat exchanger comprises an integrated bypass, wherein the exhaust gas flow is directed by means of a control element through the heat exchanger part or through the bypass channel. Thus the amount of heat produced can be adapted to the need. The control element is operated by an actuator. An exhaust gas heat exchanger constructed as an exhaust gas cooler is known from DE 198 41 927 A1. A bundle of U-shaped bent exhaust pipes with a coolant flowing around them forms the exhaust gas heat exchanger, with which a valve mechanism is associated for controlling the exhaust gas flow. A pivoting flap located on a flap shaft controls the exhaust gas stream in such a way that there is either a flow through the exhaust gas heat exchanger or it is circumvented by means of a bypass channel. Thus the exhaust gas stream supplies its heat to the coolant only if necessary. Known pivotable exhaust gas flaps are preferably operated via an actuator arranged outside the valve mechanism, preferably a so-called vacuum control. Here the negative pressure derived from the suction tract of the internal-combustion engine acts against a diaphragm to which a control rod is fastened, and thus carries out an actuating motion, transmitted to the flap shaft, against the force of a reset spring.

[0004] An exhaust recirculation system with an exhaust gas cooler cooled by a liquid coolant, with which a bypass line circumventing the exhaust gas cooler is associated, is known from EP 1 030,050 A1. Upstream of the exhaust gas cooler is arranged a valve mechanism, which operates as a switch for the exhaust gas stream and directs it either through the exhaust gas cooler or the bypass channel. The valve mechanism has a valve closing member, constructed either as a poppet valve or as a pivoting flap, wherein the valve closing member is driven in each case via a pneumatic control element, which comprises a reset spring in its remote cylinder. When the regulating unit is vented (removal of the negative pressure) the reset spring in the regulating unit causes a resetting of the valve and/or the flap into a preferred starting position.

[0005] An exhaust gas heat exchanger, in particular an exhaust gas cooler, in which—similarly to the above-mentioned patent DE 199 62 863 A1—a bypass channel is integrated into the housing of the exhaust gas cooler, is known from DE 102 03 003 AI, from which the invention proceeds. In the exhaust gas stream—upstream or downstream of the exhaust gas cooler—a valve mechanism is provided with a valve closing member, which operates as switch for the exhaust gas stream and is driven by an actuator arranged outside the housing, in particular a so-called vacuum control. The known valve mechanism is described in different versions: as a so-called half flap, in which the flap shaft is arranged eccentrically to the flap, or as a pivoting flap with a centric flap shaft arrangement. In addition, a so-called angle flap with a centrically arranged pivot axis and/or flap shaft is provided. The flap shaft is led out of the respective housing and connected via a suitable transmission mechanism to the vacuum control, wherein the translational movement of the vacuum control is converted into a rotational or pivoting motion of the flap shaft. The resetting of the exhaust gas valve is performed by the vacuum control, which in turn comprises a reset spring.

[0006] In the known flap drives it is disadvantageous that the actuator, the components of the transmission mechanism, e.g. the control rod, as well as the exhaust gas valve must be positioned exactly relative to one another, since otherwise no exact positioning for the flap results. This can result in unwanted clatter and premature wear. Beyond that, it is disadvantageous that the exhaust gas valve does not assume a defined position without an installed actuator, since it is not fixed due to the lack of a reset spring. This is a hindrance in shipping.

[0007] For an exhaust gas heat exchanger of the kind mentioned above and also for an exhaust gas valve, the problem of the present invention is to create an improved control drive, which leads to an increased fatigue strength for the valve closing member, in particular the flap, the flap shaft and the transmission mechanism.

[0008] This problem is solved first of all by the characteristics of the disclosed invention. It is provided according to the invention that the shaft of the valve closing member, in particular the flap shaft of the exhaust gas valve, is loaded by a torsion spring. The term torsion spring is to be understood as a spring element that is suitable for imparting a torque to the valve shaft or the flap shaft, so that the flap is moved into an end position and held there. Such a torsion spring element can thus have different constructional configurations, in particular, a helical torsion spring, for example. It is advantageous for the valve closing member or the exhaust gas valve to be brought into a defined preferred position, even if the actuator is not installed or fails in operation. In both cases, rattling or vibration and premature wear are thus avoided. According to the invention, the maximum possible retaining forces for the exhaust gas valve are achieved due to the torsion spring, which is particularly important due to the high frequency excitation of the flap by the pulsating exhaust gas stream. This stable fail-safe position achieves the advantage that the frictional wear on the flap shaft in the shaft guide that is due to vibration is substantially reduced. In the fail-safe position, it is additionally advantageous that the transmission mechanism between valve shaft and actuator or vacuum control is relieved, from which a reduction of material fatigue for these parts results. Finally it is of advantage that the reset spring in the actuator, particularly in a vacuum control, can be eliminated since the bias force on the flap is already applied by the torsion spring according to invention. Beyond that, the assembly tolerances thereby improve substantially. Although the torsion spring exerts primarily a torque on the valve shaft, i.e., a force in the circumferential direction, an axial force, i.e. one in the direction of the flap shaft, is also possible depending on the construction of the torsion spring. This yields the advantage that an unambiguous fixation of the shaft in the axial direction and a reduction of the axial tolerances are possible.

[0009] According to an advantageous configuration of the invention, the torsion spring is wound helically from a spring wire, i.e., formed as a so-called leg spring clip with two projecting spring legs. Such leg springs, which are guided on a mandrel, are well-known as a mechanical component. It is advantageous that a favorable spring rigidity results, in particular, a large spring travel, which can be influenced, by the number of the turns, among other things. Moreover the torsion spring can be arranged coaxially to the valve or flap shaft, a guide sleeve advantageously being arranged on the valve shaft. It is also advantageous with the leg spring that its legs can be supported in a relatively simple way on the housing, on the one hand, and on the valve shaft on the other. A pivoted lever, on which one leg of the leg spring acts and thus introduces the torque into the flap shaft, is advantageously mounted on the valve shaft for this purpose.

[0010] In a further advantageous configuration of the invention, the actuator is constructed as a pneumatically operated actuator, i.e. as a so-called vacuum control, which uses the negative pressure of the intake system of the internal-combustion engine as its operating medium. Due to the torsion spring according to invention and its arrangement on the valve shaft, the advantage results that the reset spring in the vacuum control can be omitted. The vacuum control thus acts against the force of the inventive torsion spring and adjusts the valve closing member or the flap into another end position. For fail-safe reasons, this will usually be the position in which the exhaust gas stream flows through the bypass channel, that is, during the warming-up phase of the engine. After reaching the end of the warming-up phase, the negative pressure supply is switched off, whereby the flap is transferred by torque of the torsion spring into its operating position, i.e., into the position in which the exhaust gas stream is steered trough the exhaust gas cooler and thus cooled by the coolant. The actuator in question, in particular a vacuum control, can thus be manufactured more simply and more economically.

[0011] The problem of the invention is also solved for an exhaust gas valve. The invention is thus not limited to exhaust gas heat exchangers with a bypass channel, whether integrated or formed as a separate bypass channel, but also extends generally to exhaust gas channels controlled by exhaust gas valves. The same advantages mentioned above apply to this configuration, in particular a secure fail-safe position of the exhaust gas valve and the omission of a reset spring for the actuator.

[0012] Advantageous arrangements of the exhaust gas valve according to the invention result from the additional subordinate claims.

[0013] In another advantageous configuration of the invention, the exhaust gas valve comprises at least one torsion spring, which winds up when actuated.

[0014] In another advantageous configuration of the invention, the exhaust gas valve comprises at least one torsion spring, which unwinds when actuated.

[0015] An embodiment of the invention is represented in the drawings and described in detail below.

BRIEF SUMMARY

[0016] An exhaust gas heat exchanger (**2**), especially for motor vehicles, comprising a main flow path and a secondary flow path (bypass) for the exhaust gas. The heat exchanger comprises a valve device (**3**) which is used to control the exhaust gas flow and can be actuated by a servomotor (**4**) by means of a transmission device (**8**, **6**), the valve device (**3**) comprising a valve closing member fixed to a valve shaft (a). The valve shaft (a) can be loaded by a torsion spring (**5**) which can be supported on the valve shaft and on the valve device (**3**, **3***a*).

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0017] FIG. **1** shows an exhaust gas cooler with flap control drive according to the invention as a front view.

[0018] FIG. **2** shows the exhaust gas cooler in accordance with FIG. **1** as a plan view.

[0019] FIG. **3** shows a section along the line III-III in FIG. **2**.

DETAILED DESCRIPTION

[0020] For the purposes of promoting an understanding of the disclosure, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the disclosure is thereby intended, such alterations and further modifications in the illustrated device and its use, and such further applications of the principles of the disclosure as illustrated therein being contemplated as would normally occur to one skilled in the art to which the disclosure relates.

[0021] FIG. **1** shows an exhaust cooling device **1**, which can be used in an exhaust recirculation system, not shown, of a motor vehicle. Exhaust cooling device **1** comprises an exhaust gas cooler **2** and a valve mechanism **3**, which can be driven by an actuator constructed as a vacuum control **4**. Exhaust gas cooler **2***c* comprises a housing **2***a* with a coolant inlet connector **2***b* and a coolant inlet connector **2***c*, by which exhaust gas cooler **2** is connected to a coolant circulation, not shown, of an internal-combustion engine of the motor vehicle. Within housing **2***a*, a bundle of exhaust tubes, not represented, is arranged, through which an exhaust gas flows and around which coolant flows. Coolant inlet **2***b* and coolant outlet **2***c* can be exchanged, i.e., the coolant circulation can be performed in the reverse direction if required, i.e., in co-current or counter-current flow relative to the exhaust gas. Exhaust gas cooler **2** includes, in addition to the bundle of exhaust tubes, not shown, an integrated bypass channel, likewise not shown, according to the above-mentioned DE 102 03 003 A1, whose contents are hereby incorporated in full by reference into the disclosure of the present application. The exhaust gas, which is fed through an EGR line, not shown, enters according to arrow E into an opening of valve mechanism **3** and exits from the exhaust gas cooler **2** according to arrow A. The valve mechanism **3** has a housing **3***a* that is connected, preferably welded, to housing **2***a* of exhaust gas cooler **2**, and accommodates inside itself an exhaust gas valve, not shown, for controlling the exhaust gas flow. The exhaust or valve flap has a pivot axis a, which is represented as a broken line and at the same time constitutes the shaft of a helically wound torsion spring **5**, which is arranged outside valve housing **3***a*. Torsion spring **5**, also known as a leg spring, has two spring legs **5***a*, **5***b*, which are braced on the one hand against a pivoted lever **6** rotatable about axis a, and against a pin **3***b* of housing **3***a* on the other. A vacuum control **4** is mounted by means of a holder **7** on housing **2***a*, and is connected via a control rod **8** to pivoted lever **6**.

[**0022**] FIG. **2** shows exhaust cooling device **1** according to FIG. **1** in a view from above, wherein identical reference numbers are used for identical parts. Pivotable lever **6** pivotable about an axis is fixedly connected to a flap shaft **9** led out of valve housing **3***a*. Thus a translational movement of control rod **8** of vacuum control **4** is converted into a rotational or pivoting movement of flap shaft **9**. One also sees clearly in this plan view how lower spring leg **5***b* of leg spring **5** is braced against pin **3***b* of housing **3***a*. The other spring leg **5***a*, not visible in the plan view, acts with a lever arm in reference to pivot axis a at pivoted lever **6** and acts against the actuating movement of control rod **8**.

[**0023**] FIG. **3** shows a section in the plane III-III, as drawn in FIG. **2**. Flap shaft **9** has one shaft section **9***a* arranged substantially inside valve housing **3***a* and one shaft section **9***b* arranged outside valve housing **3***a*, to whose end **9***c* pivoted lever **6** is fastened without rotational play, preferably by welding. An exhaust gas valve **10** (shown in abbreviated form) is arranged co-rotating on internal shaft section **9***a*. Exhaust gas valve **10** operates as a switch and directs the exhaust gas stream entering housing **3***a* either through the bundle of tubes of the exhaust gas cooler or through the bypass, which are not visible in this representation, but correspond in construction to the publication mentioned above and incorporated into the present disclosure. As previously mentioned, torsion spring **5** is constructed as a spiral spring wound from a spring wire, which—not visible here—is braced against pivoted lever **6** and housing **3***a*. Thus a torque is exerted on flap shaft **9** by the pre-stressed torsion spring **5** and exhaust gas valve **10** is pressed into an end position, which preferably corresponds to a closed bypass channel. A bushing **11** is arranged on section **9***b* of flap shaft **9**, which causes a guidance of torsion spring **5**. A pivot pin **12** with a ball head **12***a* that is enclosed by ball cap **8***a* of control rod **8** is fastened to pivoted lever **6** at a distance from pivot axis a. Articulated pin **12** and control rod **8** thus form a ball joint via ball **12***a* and ball cap **8***a*.

[**0024**] The mode of operation of the flap drive is the following: If the negative pressure control drive **4** (vacuum control) is deactivated, i.e., no negative pressure is present, torsion spring **5** actuates flap shaft **9** due to its bias force, and thus moves exhaust flap **10** into a base or fail-safe position. This preferably corresponds to a position in which the bypass channel is closed off, i.e., the exhaust gas stream flows through the exhaust gas cooler and is thus cooled. The flap **10** can be constructed in accordance with the designs of the state of the art as mentioned above. If vacuum control **4** is activated, i.e., subjected to negative pressure, then control rod **8** is moved contrary to the direction of action of torsion spring **5**, so that a rotation movement is imparted to flap shaft **9** and exhaust gas valve **10** is actuated into a position that corresponds to an opening of the bypass channel. This happens, for example, during the warming-up phase of the engine when cooling of the exhaust gases is not necessary. Torsion spring **5** is designed in such a manner with regard to its spring travel and spring force that a firm contact of exhaust gas valve **10** against the housing **3***a* results in case of a deactivated control drive **4**, i.e., fluttering of the flap due to the pulsating exhaust gas flow is avoided. A reset spring normally used in actuating drives of the state of the art, in particular, vacuum controls can be omitted for vacuum control **4**.

[**0025**] The torsion spring according to the invention for biasing the flap shaft of an exhaust gas valve is not limited to use in an exhaust gas heat exchanger with a bypass channel, whether integrated or constructed as a separate channel. On the contrary the invention can also advantageously be applied to exhaust gas valves arranged in an exhaust channel and driven by a flap shaft and an actuator. For example this could be the case in a valve mechanism according to the state of the art mentioned above according to DE 198 41 927 A1.

[**0026**] While the preferred embodiment of the invention has been illustrated and described in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that all changes and modifications that come within the spirit of the invention are desired to be protected.

1-**17**. (canceled)

18. An exhaust gas heat exchanger (**2**), in particular for motor vehicles, with a main flow path and an alternate flow path (bypass) for the exhaust gas, with a valve mechanism (**3**) controlling an exhaust gas flow, operable by an actuator (**4**) via a transmission mechanism (**8**, **6**), wherein valve mechanism (**3**) comprises a valve closing member (**10**) mounted on a valve shaft (**9**), characterized in that valve shaft (**9**) can be loaded by a torsion spring (**5**), which is braced on the one hand against valve mechanism (**3**, **3***a*) and against valve shaft (**9**) on the other.

19. The exhaust gas heat exchanger according to claim 18, characterized in that the torsion spring is constructed as a helically wound spiral spring (leg spring **5**) with two spring legs (**5***a*, **5***b*) or as a spiral spring.

20. The exhaust gas heat exchanger according to claim 19, characterized in that valve shaft (**9**) has a shaft section (**9***b*) led out of valve mechanism (**3**, **3***a*), and that torsion spring (**5**) is arranged coaxially on shaft section (**9***b*).

21. The exhaust gas heat exchanger according to claim 20, characterized in that a bushing (**11**) is arranged inside torsion spring (**5**) on shaft section (**9***b*).

22. The exhaust gas heat exchanger according to claim 21, characterized in that a pivoted lever (**6**) that is articulated to a control rod (**8**) is fastened to an end (**9***c*) of shaft section (**9***b*).

23. The exhaust gas heat exchanger according to claim 22, characterized in that the actuator is constructed as a negative pressure actuator (**4**).

24. The exhaust gas heat exchanger according to claim 23, characterized in that torsion spring (**5**) is constructed as a reset spring for the negative pressure actuator (**4**).

25. The exhaust gas heat exchanger according to claim 24, characterized in that actuator (**4**) is fastened to a housing (**2***a*) of exhaust gas heat exchanger (**2**).

26. The exhaust gas heat exchanger according to claim 25, characterized in that the valve closing member is constructed as a flap (**10**) and the valve shaft is constructed as a flap shaft (**9**).

27. The exhaust gas heat exchanger according to claim 26, characterized in that flap shaft (**9**) is arranged centrically or off center with respect to flap (**10**).

28. The exhaust gas valve according to claim 18, characterized in that valve shaft (**9**) has a shaft section (**9***b*) led out of valve mechanism (**3**, **3***a*), and that torsion spring (**5**) is arranged coaxially on shaft section (**9***b*).

29. The exhaust gas valve according to claim 18, characterized in that the actuator is constructed as a negative pressure actuator (**4**).

30. The exhaust gas valve according to claim 18, characterized in that torsion spring (**5**) is constructed as a reset spring for a negative pressure actuator (**4**).

31. The exhaust gas valve according to claim 18, characterized in that the valve closing member is constructed as a flap (**10**) and the valve shaft is constructed as a flap shaft (**9**).

32. An exhaust gas valve for an exhaust gas heat exchanger, in particular for motor vehicles, wherein exhaust gas valve (**10**) is pivotably seated on a flap shaft (**9**) that is in a housing (**3***a*) and that is led out of housing (**3***a*) and is operable by an actuator (**4**), characterized in that a torsion spring (**5**) biases flap shaft (**9**) in the pivoting direction and is arranged coaxially to flap shaft (**9**).

33. The exhaust gas valve according to claim 32, characterized in that torsion spring (**5**) is arranged outside housing (**3***a*) on flap shaft (**9**).

34. The exhaust gas valve according to claim 33, characterized in that the torsion spring is constructed as a leg spring (**5**) with two spring legs (**5***a*, **5***b*), which act in the circumferential direction on flap shaft (**9**) and are braced on housing (**3***a*).

35. The exhaust gas valve according to claim 34, characterized in that torsion spring (**5**) is constructed and arranged to be used as a reset spring for the actuator, said actuator being a pneumatic actuator (**4**).

36. The exhaust gas valve according to claim 35, characterized in that at least one torsion spring (**5**) winds up when actuated.

37. The exhaust gas valve according to claim 35, characterized in that at least one torsion spring (**5**) unwinds when actuated.

38. The heat exchanger with a flap according to claim 32.

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