

APPARATUS FOR REGULATING FLOW OF A MEDIUM IN A HEATING AND COOLING SYSTEM

The present invention relates to a device for the regulation of the amount of a flow,
5 having an adjustable Kvs-value, in a heating and cooling system according to the preamble of claim 1.

The object of a device according to the present invention is to keep the flow constant by combining a pressure difference valve with an integrated check device. The check
10 device can also be varied by choosing in a stepless manner a more or less open check device in order to in this way in the separate case let the desired flow reach a chosen pressure difference level.

The already known devices, designed to meet these objects, and in these cases
15 primarily pressure difference regulators or flow regulation valves, are impaired by various drawbacks.

A device, based on a pressure difference regulator, in principle can limit the flow to a level, which depends on the chosen pressure difference across the valve and the size
20 of the valve, i.e. the flow, which it is chosen to be able to limit the pressure for. The limitation is caused by the fact, that, when a smaller flow is needed, a flow, which is smaller than the predicted one, to the valve, which is related to a definite pressure difference, must be added a valve, which eliminates this too large flow. In this case this separate valve can be allowed to operate with a pressure level, which may cause
25 noise, since the chosen pressure difference valve cannot check this smaller flow and thus not limit the pressure for this smaller flow. Consequently, two different valves must be combined. One pressure difference valve and one flow regulating valve in order to obtain the desirable regulation functioning is of course an expensive solution.

A device, based on a flow regulation valve, can of course limit the flow, but such a system must include valves, which also limit the available pressure difference across the flow limitation valve. This means, that regardless of what system of the two mentioned above, which is chosen, the set-up must comprise at least two separate
5 units, one which limits the pressure difference level and one which regulates the flow.

In small set-ups, e.g. in small houses, the pressure levels are normally not so high, that the above-mentioned combination of difference- and flow limitation functions are required. In these set-ups radiator valves are used, which can be designed to allow
10 the opening between the cone and the seat of the valve to vary in various ways in order to be able to regulate the flow in a better way.

Examples of solutions for small set-ups are described in SE 8600679-8 and in DE 27
56 118.

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For large set-ups, i.e. often set-ups with high pressure differences, there are constructions, which are based on a limitation of the flow in steps, which arrangement is described in e.g. EP 0 591 873 A 1, and as an alternative a use of a pressure difference valve according to e.g. US patent no 6 196 259 B1.

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In all these existing solutions the total cost is high, in case a satisfactory functioning in a set-up is to be achieved, partly because several units are required and partly because the existing pressure difference valves often are complicated constructions. Since at least one pressure reducing function and one flow limiting function are
25 required, in most set-ups, the final cost for the client will be high. Two components must be installed and these require often some type of maintenance or control, which all in all means costs.

The object of the present invention is to counteract and as far as possible eliminate
30 the above-mentioned problem. Also, the invention is to develop the art in this field in

various respects. The object of the invention particularly is to develop a complete valve, which can be used during changing operation conditions.

These objects are achieved according to the present invention by means of a device of the type described in the introduction, which device is characterized by what is stated in the characterizing clause of claim 1.

Additional characterizing features and advantages of the invention are set forth in the following description, reference being made to the enclosed drawings, which show a preferred, but not limiting embodiment. The drawings show in detail in:

Fig. 1 a schematic picture of a device according to the present invention, being a part of a cooling or heating set-up or plant, the flow regulation valve according to the invention being integrated with an inlet or an outlet line;

Fig. 2 a complete valve 1 according to the invention;

Fig. 3 a pressure difference regulating part according to the invention:

- Fig. 3a showing a fully open position; and
- Fig. 3b showing a position, in which the passage is partially eliminated.

Fig. 4 the check valve part according to the invention:

- Fig. 4a showing the valve fully open; and
- Fig. 4b showing the valve with its cone partially closed, and in view from below, in

which the stop shoulder for the check device is shown.

Fig. 2 shows the complete flow regulating valve 1, which comprises a connection 7 for the flow pipe and a connection 8 for the return flow pipe. The valve is provided with measuring outlets to be able to control the actual total fall of pressure across pressure difference part 2 and check valve part 3. In connection 4 the pressure in the flow pipe can be measured / registered and in connection 5 the pressure in the return

flow pipe. The construction of the measuring nipples is known in the art. Examples regarding construction and operation are described in i.a. document SE 020 2851-2.

Also, the valve is provided with a stop valve 6, mounted in extended part 9 of return
5 connection 8 of the valve. This stop valve can with advantage be a ball valve, which is mounted with sealing elements 10 and a stop ball 11 and in which place these parts are fixed in an axial direction by means of a stop nut 12.

The regulating function of the complete valve consists of two interacting parts, which
10 are mounted in the common valve housing 1. The upper part, which contains check valve function 3, is mounted in the valve housing by fixing top piece 13 to housing 1 through locking nut 14, lower annular part 15 of the top piece being pressed against gasket 38, which is inserted into cylinder head 16 of the pressure difference part, which in its turn presses pressure difference part 2 downwards against control plane
15 18 of valve housing 1. On upper, outer thread 46 of top piece 13 suitably a protective cover 37 is mounted, which after its installation can be replaced by a suitable type of adjusting means – not shown in the figure.

A sealing in order to prevent outer leakage between the valve housing and the top
20 piece is done by means of O-ring 19. In a similar way an outer leakage via the inner components of check valve part 3 is prevented by the mounting of O-rings 20 and 21 respectively.

The construction of the pressure difference part is shown in Fig. 3, Fig. 3a showing
25 the pressure difference regulating part in its fully open position, i.e. when the spring force of spring 23 presses the cylindrical, basket-like part 24 with its upper sleeve-like part 25 upwards towards cylinder head 16 of the pressure difference part. In order to guarantee a small distance between sleeve-like part 25 and its upper side and the lower side of the cylinder head 16, the cylinder head is provided with a distance
30 shoulder 42. This will enable the pressure level, which exists inside components 24

and 24 – the pressure difference-part – having a pressure P_d – to act on a as large surface as possible. In this position, i.e. when the cylindrical basket-like part 24 is in its highest position, passage 26 is fully open.

5 In Fig. 3b an operation position is shown, in which spring unit 23 partially has been compressed, passage 26 having been reduced in this way. This operation position is obtained, when the pressure level of inlet side 7, called P_i , is higher than pressure level P_d , which is obtained after passage 26 in a downstream direction.

10 Thus, when inlet pressure P_i increases, basket-like part 24 will be pressed downwards and will consequently restrict / reduce passage 26 and the result of this will be a pressure loss of from level P_i to level P_d . The pressure difference between P_d and the pressure level of outlet side 8, called P_r , is chosen to let the P_d -force times the upper surface of sleeve-like part 25 compress spring 23 into a position, in which the spring
15 force jointly with the force, which pressure P_r times the surface, on which P_r acts in space 39 between basket-like part 24 and the inner diameter of the cylindrical casing, is balanced. Thus, the pressure difference between P_d and P_r is constant and not dependent on pressure level P_i of inlet side 7. This constant pressure difference is the basis of the operation of check valve 3.

20 Thus, in case P_i increases, from the position shown in Fig. 3b, spring unit 23 will be compressed additionally and this will in its turn result in a reduction of passage 26, since the pressure difference between P_d and P_r must be kept constant. Pressure P_r enters into space 39 via slots 29, which are present in lower cylindrical casing ring
25 41. In order to prevent, that the higher pressure P_i will enter into this space 39, an O-ring 22 is provided, which seals between valve housing 1 and lower cylindrical casing part 41, and sealing rings 30 respectively, which seals between this cylindric casing part 41 and the cylindrical basket-like part 24. Also between cylindrical casing 40 and sleeve-like part 25 in the upper end of the pressure difference part there are
30 sealing rings 30, designed to guarantee partly, that the higher pressure level P_i does

not leak into space 39 and partly that sealing rings 30 are provided, designed to provide a low friction between components 24 and 28 and between components 25 and 40 respectively. A low pressure is important in order to guarantee, that changes of the input static pressure quickly leads to a new operation position for the movable
5 (24) flow checking part of the pressure difference regulating part.

The construction of the check valve part is shown in Fig. 4, Fig. 4a showing the check valve fully open, i.e. revolving check device 34 has been rotated into a position, in which passage 43 outwards towards outlet side 8 of the valve is fully
10 open, and simultaneously cone 31 is positioned in its upper, open position.

The check valve will, due to its construction, always make it possible to choose an opening degree, which makes it possible to choose exactly the maximal flow, which is appropriate for the separate application case, and simultaneously it is possible to
15 restrict this flow by means of the axial movement of check device 34.

The desired maximal flow is guaranteed thanks to the fact, that the pressure difference part always provides a constant, maximal fall of pressure, which the check valve must manage. With this fall of pressure as a starting point it is then possible to
20 choose the flow, which the valve is to provide by rotating check device 34 in a stepless manner, the chosen opening degree corresponding to the desired flow. Check device 34 cooperates with fixed check veil 32, which is mounted into top piece 13. On top piece 13 it is advantageous to attach a graduated collar 17, according to Fig. 2, which interacts with pre-adjustment tool 36 – not shown in the drawings – which is
25 used, when a position for check device 34 is to be chosen in relation to check veil 32. Pre-adjustment tool 36 gears with holding case 45, which in its turn rotates check device 34.

Thus, through the described pre-adjustment it is possible to always dimension the
30 opening degree of the valve, the so called Kvs-value, depending on the present need,

and thus, it is not necessary to choose a valve having rigid steps between different openings degrees, different flows.

In addition to this function, the one with a stepplessly chosen KVS-value, it is also possible to restrict this flow by means of a cone 31, which can be displaced in an axial direction along spindle 33. The axial movement can always be utilized in its entire length, regardless of the opening degree, which has been chosen by means of check device 34. This means, that it is really possible to regulate the flow, regardless of whether the valve/cone it to restrict a small or a large flow.

When the cone reaches its lowest position, i.e. when the valve is to stop the flow entirely, this has been secured by letting the cone be lowered and sealed against rubber gasket 38, provided on top of cylinder head 16 of the pressure difference valve. In this position, when the cone seals, pressure level P_i , present in the system, would press the cone upwards. By introducing a small slot 44 between spindle 33 and cone 31 a small leakage flow up to the upper side of the cone is permitted and in this way a decompression of the cone is achieved and consequently the undesirable effect of a pressure/force increase on the cone is prevented and in this way the sealing functioning is secured. The decompression also implies, that the closing per se can be accomplished through minor forces, and it will be easy to operate the valve.

The check valve is provided with O-rings 20 and 21 in order to prevent an outer leakage via the inner parts in top piece 13 and also an O-ring 27 in order to limit an inner leakage. O-ring 19 will prevent an outer leakage between top piece 13 and valve housing 1.

In Fig. 4b and the view, which shows the check valve from below, the check valve is seen in a position, where the opening degree of the valve is limited to a certain extent. Check device 34 has in this situation been rotated, the opening in relation to check veil 32 having been reduced. Simultaneously this lateral view shows cone 31 in a

position, in which it has been removed downwards somewhat in relation to its upper position, its starting position. Check device 34 can in principle be rotated 180° and in its final position, when the opening between the check device and the fixed check veil is completely closed, the check device stops against an inner shoulder 47 on check
5 veil 32. Veil 32 has also an opening, a recess (180°), which means, that the opening – when the valve is fully open – is a 180° – segment, the height of which is “a” according to the figure.

Of course, the solution described above for a device, designed for a flow regulation,
10 can be modified to some extent within the scope of the inventive idea.

COMPONENT LIST

- 1 = valve housing
- 2 = pressure difference regulation part
- 5 3 = check valve part
- 4 = measuring nipple – Pi level
- 5 = measuring nipple – Pr level
- 6 = stop valve
- 7 = flow pipe connection
- 10 8 = flow pipe return connection
- 9 = extended part of the valve housing
- 10 = sealing element
- 11 = stop ball
- 12 = stop nut
- 15 13 = top piece
- 14 = locking nut
- 15 = lower annular portion of the top piece
- 16 = cylinder head of the pressure difference part
- 17 = graduated collar
- 20 18 = control plane of the valve housing
- 19, 20, 21, 22 = O-rings
- 23 = spring
- 24 = cylindric basket-like part
- 25 = sleeve-like part
- 25 26 = passage
- 27 = O-ring
- 28 = lower, not movable check portion
- 29 = slot
- 30 = sealing ring
- 30 31 = cone

- 32 = check veil
- 33 = spindle
- 34 = check device
- 35 = spring
- 5 36 = adjusting tool
- 37 = protective cover
- 38 = gasket
- 39 = space
- 40 = cylindrical casing
- 10 41 = lower casing ring
- 42 = distance shoulder
- 43 = passage
- 44 = slot for leakage flow
- 45 = holding case
- 15 46 = outer thread
- 47 = shoulder
- 48 = adjusting device

CLAIMS

1. A device for a flow regulation of a medium in a heating or cooling system, comprising a combined valve, which in one and the same valve housing (1) includes
5 one part for pressure difference regulation (2) and one part for flow limitation (3), the complete valve also including measuring nipples (4,5) for measuring pressure levels as well as a stop valve function (6), **characterized in that** the flow amount is regulated by a check valve part (3), which eliminates the flow amount in a steppless manner by a check device (34), **a n d i n t h a t** the flow is limited by a
10 cone (31), which in all chosen adjustments of the check device (34) operates with its complete stroke length.

2. A device according to claim 1, **characterized in that** the flow limitation is done by a check value part (3), which interacts with the pressure
15 difference regulation part (2), the check valve part (3) always operating with the total chosen differential pressure Pd-Pr.

3. A device according to claim 1, **characterized in that** the pressure difference part (2) and the check valve part (3) are mounted in the same valve
20 housing (1) and are fixed in the valve housing (1) by the top piece (13) via the locking nut (14).

4. A device according to claim 3, **characterized in that** a sealing between the pressure difference regulation part (2) and the check valve part (3) is
25 done by pressing the lower annular part (15) of the top piece against the gasket (38) in connection with the mounting of the locking nut (14).

5. A device according to claims 1 and 2, **characterized in that** the check valve part (3), by rotating the check device (34), obtains a steplessly adjustable
30 passage (43).

6. A device according to claim 5, **characterized in that** the check device (34) interacts with the check veil (32).

5 7. A device according to claim 1 or 2, **characterized in that** the cone (31) of the check valve part (3) always operates with all its stroke length, regardless of what the opening degree of the check device (34) might be.

8. A device according to claims 1 and 2, **characterized in that** the cone
10 (31) of the check valve part in its closed position, when it seals against the gasket (38), is completely decompressed thanks to a leakage flow up to the top side of the cone via a slot (44) between the spindle (33) and the cone (31).

9. A device according to claim 1, **characterized in that** the pressure
15 difference part (2) operates with a low friction thanks to the design of the sealing rings (30), which results in, that the chosen pressure difference = $P_d - P_r$ is kept almost constant irrespective of the changes of the present static pressure-level = P_i .

10. A device according to claim 1, **characterized in that** the static
20 pressure-level = P_r , from the outlet side (8) of the check valve directly, without signal circuits, can be registered / measured via the measuring nipple (5) and also directly actuates the pressure difference unit via the slots (29).

11. A device according to claim 1, **characterized in that** the static
25 pressure-level on the inlet side (7) = P_i of the pressure difference regulation part (2) is to be registered / measured via the measuring nipple (4).