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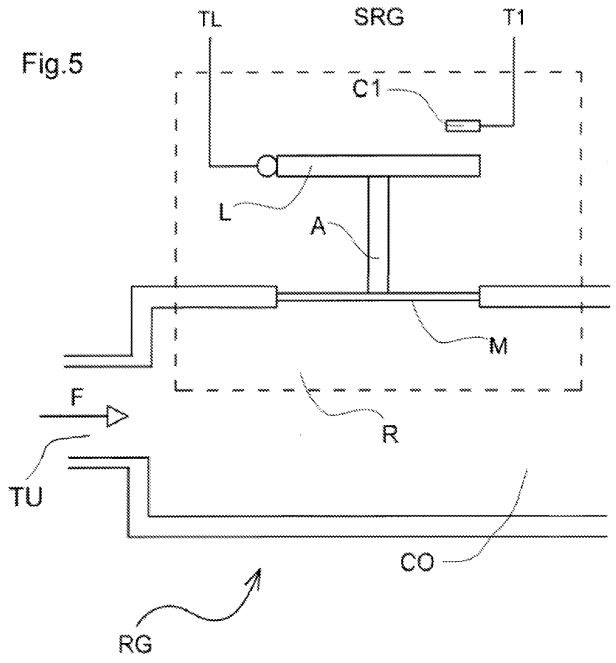
(54) Gas detector, gas distrubution assembly and cooking household appliance with gas detector

(57) The present invention relates to a gas detector generating an electric signal for only two or three gas pressure states. The gas detector may comprise a membrane (M), a rod (A), a lever (L), contacts (C1,C2) and electrical terminals (T1,T2,TL). The gas detector can be combined with a gas cooking household appliance. The invention relates further to a gas distribution assembly (AS) with such a gas detector.

Fig.5



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Description

[0001] The present invention relates to a gas cooking household appliance with automatic valves according to the preamble of claim 1.

[0002] Gas cooking appliances, in particular gas cooking tops, with automatic valves are not widespread on the market, although this typology of household appliances is accepted by the applicable Regulations, e.g. by the European safety Standard EN 30-1-4.

[0003] In these household appliances, the adjustment of the gas supplied to a burner is carried out by means of an automatic valve, i.e. a valve having an adjusting element not operated directly and manually by the user, but controlled through an automatic device (e.g. an electric one); such an automatic device may be actuated by a user's manual command (e.g. a knob, a slider, a push-button, a touch control device, etc.) and/or by an automatic command generated, for example, based on a detection carried out by a sensor.

[0004] For this type of household appliances, the above-mentioned Standard requires two valves installed in series along the gas line leading to a burner; in this way, should a valve fail or malfunction, the other valve should prevent any undesired gas leakage from the line. However, the Applicant has realized that, should a failure or malfunction of either valve be followed by a failure or malfunction of the other valve (which might occur even weeks or months or years later), there could be an undesired gas leakage from the line without the user noticing it.

[0005] Moreover, a cooking top is generally fitted with four or five burners. In such a case, when using known technologies the cooking top should therefore comprise eight or ten valves; this involves high direct and indirect costs and takes up space.

[0006] The general object of the present invention is to provide a gas cooking household appliance with automatic valves which complies with the above-mentioned safety standard while overcoming the drawbacks of the prior art.

[0007] A first particular object of the present invention is to provide a simple and reliable solution.

[0008] A second particular object of the present invention is to provide a solution which is well suited to automatic valves, in particular to piezoelectric automatic valves.

[0009] These and other objects are achieved by the household appliance having the features set out in the appended claims, which are intended as an integral part of the present description.

[0010] The present invention is based on the idea of providing the household appliance with only one individual automatic valve for each burner and one additional general automatic valve for the entire appliance, as well as with an electronic safety system adapted to detect any malfunction and/or failure which might cause undesired gas flow at least through the general valve, but preferably also through the individual valves.

[0011] In this manner, there will always be two automatic valves arranged in series along the gas line to each burner, and it will also be possible to check the proper operation of the valves and therefore of the household appliance in regard to the gas circuit.

[0012] According to a further aspect, the present invention also relates to a gas detector and a gas distribution assembly, both of which are particularly suitable for use in the cooking household appliance according to the present invention.

[0013] The present invention will become more apparent from the following description and from the annexed drawings, wherein:

Fig.1 shows a simplified block diagram of a first household appliance according to the present invention, which only includes those blocks which are relevant for the description of the invention,

Fig.2 shows a simplified block diagram of a second household appliance according to the present invention, which only includes those blocks which are relevant for the description of the invention,

Fig.3 shows a simplified block diagram of a third household appliance according to the present invention, which only includes those blocks which are relevant for the description of the invention,

Fig.4 shows a simplified block diagram of a fourth household appliance according to the present invention, which only includes those blocks which are relevant for the description of the invention,

Fig.5 shows a diagrammatic sectional view of a first gas detector according to the present invention,

Fig.6 shows a diagrammatic sectional view of a second gas detector according to the present invention, together with a portion of a gas distribution assembly.

[0014] Said description and said drawings are to be considered as non-limiting examples.

[0015] Though different, the examples of Fig.1, Fig.2, Fig.3 and Fig.4 are similar in terms of architecture and components; therefore, the same references will be used for designating corresponding items.

[0016] The examples of Fig.1, Fig.2, Fig.3 and Fig.4 refer to a kitchen gas cooking top provided with one gas fitting AG and four gas burners B1, B2, B3 and B4. A gas cooking top is a household appliance well suited to the present invention; another very suitable household appliance is a gas oven or a gas cooker, the term "gas cooker" meaning any household appliance comprising at least a gas cooking top and a gas oven.

[0017] As known, gas must be supplied to the burners, and is therefore delivered from fitting AG to burners B through a series of pipes; four gas lines are thus provided, which supply gas from fitting AG to the four burners B1, B2, B3, B4; along these lines it is necessary to install valves for opening, closing and adjusting the gas supply to the burners.

[0018] The examples of Fig.1, Fig.2, Fig.3 and Fig.4 comprise one general valve VG and four individual valves V1, V2, V3, V4 for respective burners B1, B2, B3, B4. Said valves are automatic and, in particular, are of the piezoelectric type; piezoelectric automatic gas valves are currently available on the market, e.g. manufactured by FESTO, SERVOCELL and DIAMOND H. General valve VG is placed in the gas circuit in such a position that all gas flows passing through individual valves V1, V2, V3, V4 must first pass through general valve VG; thus, if general valve VG is closed, no gas can flow through any of individual valves V1, V2, V3, V4Valves V1, V2, V3, V4 are individually associated with burners B1, B2, B3, B4 and are used for opening, closing and adjusting the gas flow to said burners individually.

[0019] In Fig.1, Fig.2, Fig.3 and Fig.4, a gas pipe TU is pointed out and it which connects the outlet of valve VG to the inlets of all valves V1, V2, V3, V4. In the case of Fig.1 and Fig.3, it is a branched pipe; in the case of Fig.2 and Fig.4, it is a simple pipe coupled to a collector pipe CO.

[0020] The examples of Fig.1, Fig.2, Fig.3 and Fig.4 also comprise a general gas flow detector RG; general detector RG detects gas flow through general valve VG; moreover, general detector RG (due to the position thereof) can also detect gas flow through any of individual valves V1, V2, V3, V4, though not being able to determine which one.

[0021] The examples of Fig.3 and Fig.4 additionally comprise four individual gas flow detectors R1, R2, R3, R4; individual detector R1 detects gas flow through individual valve V1, and therefore substantially detects the gas flow reaching burner B1; individual detector R2 detects gas flow through individual valve V2, and therefore substantially detects the gas flow reaching burner B2; individual detector R3 detects gas flow through individual valve V3, and therefore substantially detects the gas flow reaching burner B3; individual detector R4 detects gas flow through individual valve V4, and therefore substantially detects the gas flow reaching burner B4.

[0022] All of valves VG, V1, V2, V3, V4 are controlled electrically; for this purpose, they are adapted to receive electric control signals SVG, SV1, SV2, SV3, SV4.

[0023] All of the gas flow detectors R1, R2, R3, R4, RG are adapted to generate electric detection signals SR1, SR2, SR3, SR4, SRG indicating the detected gas flow. These may be either active detectors, i.e. receiving an electric power supply and autonomously emitting an electric signal representative of the detected gas flow, or passive detectors, i.e. connected to an external electric or electronic circuit and producing in said circuit an electric signal being representative of the detected gas flow (the simplest example being a contact controlled by the gas flow). One or more of these gas flow detectors, in particular general detector RG, is adapted to generate a signal indicating the gas pressure within pipe TU (and thus, in the case of Fig.2 and Fig.4, within pipe CO); in such a situation, this signal will also indicate the gas flow within pipe TU (and within pipe CO, if present), if taken into consideration for a sufficiently long time interval, as better explained below.

[0024] The above-mentioned electric signals, whether for control or detection, may be either digital or analog depending on the type of valve and detector.

[0025] The examples of Fig.1, Fig.2, Fig.3 and Fig.4 comprise an electronic control system of the gas household appliance, schematized as a block EL adapted to control all functions of the household appliance.

[0026] An important function carried out by the system EL is the control of the gas flow to burners B1, B2, B3, B4; to this end, system EL is connected to valves VG, V1, V2, V3, V4 and may be connected to a control panel (not shown in the drawings) fitted, for example, with knobs and/or push-buttons and/or keys (e.g. touch control type) and one or more displays, so that it can receive flame level setting commands from the user, generate control signals SVG, SV1, SV2, SV3, SV4, and provide the user with information about the set flame level.

[0027] Importantly as well, system EL also acts as a safety system; to this end, system EL is connected to general detector RG (in all illustrated cases) and to individual detectors R1, R2, R3, R4 (only in the cases of Fig. 3 and Fig.4), so that it can receive detection signal SRG (in all illustrated cases) and detection signals SR1, SR2, SR3, SR4 (only in the cases of Fig.3 and Fig.4).

[0028] It should be made clear right away that the number of valves and the number of detectors depend on the embodiment of the present invention.

[0029] The embodiment examples of Fig.2 and Fig.4 differ from the embodiment examples of Fig.1 and Fig.3 in that some components are integrated into a gas distribution assembly AS having one gas inlet and four distinct gas outlets. In particular, assembly AS comprises a collector pipe CO housing valves V1, V2, V3, V4 and incorporates general detector RG; in addition, in the example of Fig.4, collector pipe CO also incorporates detectors R1, R2, R3, R4 respectively associated with the four gas outlets.

[0030] Fig.5 shows a diagrammatic view of a first gas detector R suitable for use in the household appliance according to the present invention. This detector may for example be associated with, in particular applied or mounted to, the inlet or the outlet or the inside of a gas valve.

[0031] Detector R may for example be the core of general detector RG, which may be a separate device located anywhere in pipe TU, or be included in an assembly comprising general valve VG, or (as shown in Fig.5) be installed at the inlet of assembly AS of Fig.2 and Fig.4; it is for this reason that only collector pipe CO of assembly AS is visible in Fig.5.

[0032] Detector R cannot measure the (analog) value of the gas pressure within pipe CO (and therefore within pipe TU connected upstream of pipe CO), since it can only signal two gas pressure states. More precisely (as will become apparent later), detector R of Fig.5 can in-

dicate whether the gas pressure in collector pipe CO corresponds to pressure values substantially equal to the atmospheric pressure (i.e. within a certain range around the atmospheric pressure value) or the gas pressure in collector pipe CO corresponds to pressure values above the atmospheric pressure.

[0033] A gas flow enters pipe CO from pipe TU, typically in the direction of arrow F; detector R comprises a membrane M, the edges of which are secured to the edges of an aperture in pipe CO; detector R also comprises a rod A, a lever L (at least a portion of which is made from electrically conductive material), an electric contact C1 and two terminals T1 and TL, electrically connected to contact C1 and to lever L, respectively. The pressure outside pipe CO corresponds to the atmospheric pressure.

[0034] In the explanatory, non-limiting example of Fig. 5, rod A is constrained to membrane M, so that it can move substantially upwards or downwards as the central portion of membrane M moves upwards or downwards, respectively, through the effect of the pressure in pipe CO.

[0035] Lever L is constrained on one end thereof (the left end in Fig.5), so that it can rotate about said end, and to rod A, so that it can rotate upwards or downwards as rod A moves upwards or downwards, respectively. When lever L is totally rotated upwards, it touches contact C1, thus creating an electric path between terminal T1 and terminal TL (therefore producing a corresponding electric signal).

[0036] For clarity, membrane M, rod A and lever L are in a position (in particular an upper position) such that they touch contact C1 when the pressure in pipe CO exceeds the atmospheric pressure PA by at least a predetermined value P1, i.e. when the pressure in pipe CO becomes at least equal to PA+P1; with pressure values lower than PA+P1, lever L is in any of the various positions (in particular lower positions) wherein it cannot touch C1.

[0037] Detector R is therefore a very simple electromechanic device which allows to carry out effective gas pressure detections (typically in a gas cooking household appliance) as well as effective gas flow detections, as will be explained below.

[0038] Detector R is so designed that lever L touches contact C1 during the normal operation of the cooking household appliance (i.e. when there is gas flow in pipe CO in the direction of the arrow).

[0039] When the cooking household appliance is not being used (i.e. when valves VG, V1, V2, V3, V4 are all closed by the electronic safety system EL), any gas leakage through general valve VG will cause the pressure in pipes TU and CO to rise up to the threshold value PA+Pl, thus bringing about the closing of the electric contact between L and C1 and allowing the electronic safety system EL to detect said leakage.

[0040] It is apparent that said simple lever may be replaced with more complex linkages, and that membrane M may have any shape and be replaced with any other element which can be moved through the effect of gas pressure.

[0041] Fig.6 shows a diagrammatic view of a second gas detector R suitable for use in the household appliance according to the present invention. This detector may for example be associated with, in particular applied or mounted to, the inlet or the outlet or the inside of a gas valve.

[0042] In Fig.6, detector R may for example be the core of general detector RG located at the inlet of assembly AS of Fig.2 and Fig.4; it is for this reason that Fig.6 shows the collector pipe CO of the assembly AS as well as a first piezoelectric automatic valve V1 also associated with collector pipe CO, as detailed below. Adjacent to collector pipe CO, there is a chamber CP which houses the electronic components subject to tension of the gas distribution assembly AS. During the normal operation of the household appliance according to the present invention, chamber CP is under the atmospheric pressure PA, whereas in the event of an explosion inside chamber CP said pressure will rise up to a value by far exceeding the atmospheric pressure PA.

[0043] Detector R can simply signal three gas differential pressure states between chamber CP and collector pipe CO. More precisely (as will become apparent later), detector R of Fig.6 can indicate if the gas pressure PCO in pipe CO is higher than the gas pressure PCP in chamber CP by at least a predetermined value P1, if the gas pressure PCO in pipe CO is lower than the pressure PCP in chamber CP by at least a predetermined value P2, or if the pressures PCO and PCP are such that PCO<PCP+P1 and PCO>PCP-P2. A gas flow enters pipe CO from pipe TU, typically in the direction of arrow F; detector R comprises a membrane M, the edges of which are secured to the edges of an aperture in pipe CO; detector R also comprises a rod A, a lever L (at least a portion of which is made from electrically conductive material), a first electric contact C1, a second electric contact C2 and three terminals T1, T2 and TL, connected to contact C1, contact C2 and lever L, respectively. In the non-limiting example of Fig.6, rod A is constrained to membrane M in such a way that it can substantially move upwards or downwards as the central portion of membrane M moves upwards or downwards, respectively, through the effect of the pressure difference between pipe CO and chamber CP.

[0044] Lever L is constrained on one end thereof (the left end in Fig.6), so that it can rotate about said end, and to rod A, so that it can rotate upwards or downwards as rod A moves upwards or downwards, respectively. When lever L is totally rotated upwards, it touches contact C1, thus creating an electric path between terminal T1 and terminal TL (therefore producing a corresponding first electric signal); when lever L is totally rotated downwards, it touches contact C2, thus creating an electric path between terminal T2 and terminal TL (therefore producing a corresponding second electric signal).

[0045] It should be noted that, as an alternative, the electric detector may be adapted (by using a simple electric circuitry) to generate only one electric signal across two terminals; for example, a null voltage signal when lever L touches none of contacts C1 and C2, a positive voltage signal when lever L touches contact C1, and a negative voltage signal when lever L touches contact C2.

[0046] For clarity, membrane M, rod A and lever L are in the upper position (and touch contact C1) when the pressure PCO in pipe CO is higher than the pressure PCP in chamber CP by at least a predetermined value P1, i.e. PCP+P1, whereas they are in the lower position (and touch contact C2) when the pressure PCO in pipe CO is lower than the pressure PCP in chamber CP by at least a predetermined value P2, i.e. PCP-P2; with pressure values between PCP+P1 and PCP-P2, lever L is in any of the various intermediate positions and touches neither C 1 nor C2.

[0047] Detector R is therefore a very simple electromechanic device which allows to carry out effective gas pressure detections (typically in a gas cooking household appliance) as well as effective gas flow detections, as will be explained below.

[0048] It is apparent that said simple lever may be replaced with more complex linkages, and that membrane M may have any shape and be replaced with any other element which can be moved through the effect of gas pressure.

[0049] Detector R is so designed that lever L touches contact C1 during the normal operation of the gas household appliance (i.e. when there is gas flow in pipe CO in the direction of the arrow) and that lever L touches none of contacts C1 and C2 when the cooking top is not being used (i.e. no burner is lit).

[0050] For the purpose of pointing out some advantageous aspects of detector R of Fig.6, it is now proper to describe the automatic gas valve of Fig.6; it is worth reminding that both the detector and the valve shown very diagrammatically in Fig.6 are to be understood as non-limiting examples.

[0051] Fig.6 shows a piezoelectric automatic valve designated V1 as a whole because it could be, for example, valve V1 of the household appliance of Fig.2 or Fig.4.

[0052] Reference number 2 designates a piezoelectric element acting as an actuator of an adjusting device 3 of valve V1; 31 designates the shutter of valve V1, belonging to adjusting device 3; 32 designates an adjusting device stem, included in the adjusting device 3 of valve V1.

[0053] Shutter 31 and stem 32 are rigidly joined together, thus forming adjusting device 3, which is pushed by actuator 2.

[0054] Actuator 2 receives an electric signal S1 through two electric leads; actuator 2 is so conceived that, when a direct electric voltage is applied as a signal S1, it will bend downwards and adjusting device 3 will move downwards accordingly; the greater the amplitude of the voltage signal S1, the more actuator 2 will bend.

[0055] Valve V1 of Fig.6 comprises a hollow body 6 associated with collector pipe CO; pipe CO acts as a gas inlet duct of valve V1; there is also a gas outlet duct 8 which connects valve V1 to burner B1. The cavity of body 6 is delimited at the bottom by a rigid wall 4 corresponding to a wall of pipe CO; duct 8 starts in the cavity of body 6. Wall 4 has an aperture 40 (a flared hole) allowing the gas to flow from pipe CO to the cavity of body 6.

[0056] Shutter 31, for example having a conic shape, is adapted to shut aperture 40 of wall 4 by perfectly coupling thereto, thus ensuring tightness.

[0057] An elastic element, in particular a spring, may also be provided in order to obtain or facilitate the return of valve V1 to its idle or inoperative condition; in the case shown in the example of Fig.6, the downward motion of adjusting device 3 is obtained through actuator 2, whereas the upward motion of adjusting device 3 is obtained through the elastic element (not shown in the drawing).

[0058] In its upper portion, body 6 of valve V1 of Fig. 6 has a hole which allows stem 32 to slide while at the same time preventing any substantial gas leaks from the cavity of body 6. In particular, in valve V1 of Fig.6, the top wall of body 6 is not rigid; said wall consists of a diaphragm 9, e.g. a membrane made of an elastic material and circular or square in shape. In particular, said diaphragm 9 is so shaped that its area is enlarged; in fact, the drawing clearly shows the bends around stem 32.

[0059] Diaphragm 9 is secured in a substantially tight manner to the walls of body 6 and to stem 32; due to its elasticity, it allows stem 32 and thus the whole adjusting device 3 of valve V1 to move, in particular vertically, at the same time preventing any gas in the cavity of body 6 from flowing out, except through duct 8.

[0060] In order to understand the effect provided by diaphragm 9, it is necessary to observe valve V1 of Fig. 6 in operation.

[0061] When valve V1 is closed, the pressure in the cavity of body 6 corresponds to the pressure downstream of duct 8 (in substance, downstream of the burner, not shown), i.e. to the atmospheric pressure; the very same pressure is also found outside body 6; in this condition, the forces exerted by the pressure outside and inside the diaphragm are the same, so that the diaphragm does not transmit any force to stem 31 and thus to the whole device 3. When the valve begins to open, i.e. when device 3 begins to go down, the pressure in the cavity of body 6 rises a little, so that diaphragm 9 is subjected to a small upward force which is directly proportional to its area and to the difference between the pressure in the cavity of body 6 and the pressure PCP in chamber CP; said force is applied upwards to device 3, and therefore tends to counter the downward force exerted by element 2. When the valve is completely open, the pressure in the cavity of body 6 is highest and produces the greatest counteracting force tending to shut the valve again.

[0062] When designing diaphragm 9, it must be taken into account that the pressure in gas pipes typically ex-

ceeds the atmospheric pressure by just 20-30 mBar. It is for this reason that it is normally necessary to enlarge the area of diaphragm 9 in order to fully use its resistant effect; in general, and in particular for valves connecting to ¼in. GAS piping, the extension of diaphragm 9 has one characteristic dimension (diameter or side) comprised between 10mm and 30mm, preferably between 15mm and 20mm.

[0063] As shown in Fig.6, assembly AS has a pipe CO which is common to detector R and to all valves of the assembly (only valve V1 is shown), as well as a chamber CP adjacent to and hermetically separated from pipe CO. In Fig.6, said chamber houses both detector R and te valve V1, as well as the other individual valves, not shown.

[0064] Contact C2 is used for detecting a particular failure of the assembly AS. As a matter of fact, sometimes (very seldom, of course) explosions may occur within the above-mentioned chamber CP which might damage one or several valves included in assembly AS, e.g. valve V1; in such a case, the pressure in said chamber CP will exceed the pressure in pipe CO for a very short time; thanks to contact C2, this situation can be detected and the user can, for example, decide to close valve VG.

[0065] Said explosions may for example occur due to a damaged membrane M of detector R or to a damaged diaphragm of any of individual valves V1,V2,V3,V4 (e.g. diaphragm 9 of individual valve V1 shown in Fig.6), so that tightness is no longer ensured and gas can flow from he collector pipe CO to chamber CP, should one of the components subject to tension subsequently fail and generate a spark within chamber CP.

[0066] In order to prevent an explosion when membrane M or diaphragm 9 are damaged, the present invention allows to detect, during the normal operation of the gas appliance, any variation in the pressure PCP within chamber CP caused by such damage. In fact, detector R is so designed that lever L touches contact C1 during the normal operation of the gas appliance: any damage suffered by membrane M or diaphragm 9 will tend to reduce the pressure difference between PCO and PCP, so that lever L will move away from contact C1. If such a pressure difference reduction is not followed by a flame-off detection in any of the active gas burners B1, B2, B3, B4, electronic control system EL will deduce that either membrane M or diaphragm 9 has been damaged.

[0067] In one of the walls of chamber CP not adjoining pipe CO, a calibrated hole 89 is obtained where through a very limited, and therefore not dangerous, quantity of gas can flow.

[0068] As already mentioned, gas flow detectors of various types may be advantageously integrated into the automatic valves used in the household appliance according to the present invention; it is advantageous to use a gas flow detector adapted to generate an electric signal indicating only two gas flow states, in particular the substantial absence of gas flow and the substantial presence of gas flow.

[0069] A first possibility is integrating a flow detector of the type adapted to generate an electric signal related to pressure difference, in particular to the pressure detected in a first direction and the pressure detected in a second direction substantially perpendicular to said first direction.

[0070] A second possibility is integrating a flow detector of the type adapted to generate an electric signal related to the displacement or position of an adjusting device of at least one corresponding valve, thus indirectly detecting any gas flow through the valve. Said displacement or position may be detected through one or several simple electric contacts.

[0071] A third possibility is integrating a detector like those shown in Fig.5 or Fig.6.

[0072] In general, a gas cooking household appliance according to the present invention is provided with one gas fitting and one or more gas burners; it additionally comprises:

- one general automatic valve having an inlet associated with said fitting,
- one or more individual automatic valves having outlets respectively associated with said one or more burners, and
- one pipe connecting the outlet of the general valve to the inlets of said one or more individual valves;

furthermore, it also comprises an electronic safety system (advantageously integrated into the electronic control system of the appliance) adapted to detect any malfunctions and/or failures which might cause undesired gas flow at least through the general valve.

[0073] In this manner, there will always be two automatic valves arranged in series along the gas line to each burner, the number of valves will be reduced to a minimum, and it will also be possible to check the proper operation of the valves and therefore of the household appliance in regard to the gas circuit.

[0074] Typically, the household appliance according to the present invention will comprise more than one burner and, therefore, more than one individual valve; in the most typical applications, their number will be in the range from a minimum of two to a maximum of seven.

[0075] A gas flow detector may be advantageously so arranged as to detect gas flow through any one of the individual valves. As is apparent from the above-described examples, a single detector arranged, for example, along the pipe connecting the outlet of the general valve to the inlets of the individual valves allows to detect gas flow through both the general valve and any one of the individual valves.

[0076] It may also be advantageous to adapt the electronic safety system to detect any malfunctions and/or failures which might cause undesired gas flow through each individual valve. This can be obtained, for example, by installing a flow detector at the inlet, at the outlet or inside each individual valve.

[0077] Advantageously, the safety system is adapted to generate an alarm signal, in particular an acoustic signal and/or a visual signal in the event that any malfunction and/or failure is detected; thus the user can decide not to use the household appliance and to call for technical assistance.

[0078] Furthermore, if the household appliance, in particular the electronic control system thereof, is connected to a communication network, the safety system may be adapted to send information to a remote centre and to call for technical assistance automatically.

[0079] The safety system may also be so conceived as to prevent the household appliance from operating if any of said malfunctions and/or failures are detected; this will make the household appliance even safer. The operation of the appliance may for example be inhibited only in the event of very serious malfunctions and/or failures.

[0080] The general automatic valve of the household appliance according to the present invention may act as a safety valve, being preferably of the electromagnetic type and installed upstream of the individual automatic valves; typically said valve is of the type adapted to provide only two operating conditions: completely open valve and fully closed valve. In such a case, the safety system may be adapted to close said safety valve should any of said malfunctions and/or failures occur.

[0081] Anyway, it is conceivable to provide the adjustment of the gas flow through the individual valves only; in such a case, the general valve may be of the type adapted to provide only two operating conditions (completely open valve and fully closed valve), being in particular of the electromagnetic type.

[0082] The above safety measures may also be combined together.

[0083] At least one individual gas flow detector may be installed either downstream or upstream of at least one valve, so that any gas flow is detected through said valve; in particular, as shown in the illustrated examples, there may be one detector for the general valve and possibly also one detector for each individual valve. In such a case, it may be advantageous that the detector is associated with, in particular applied to or built in, the inlet or the outlet of said individual valve. The gas flow detector may also be integrated into the individual valves.

[0084] For the purpose of detecting any failures or malfunctions, it is most useful to be able to check if an automatic valve is open in spite of a closing control signal; in fact, in such a case there will be a risk of unburnt gas (i.e. without flame) coming out of the burner.

[0085] In general, it is useful to detect such a condition as soon as it arises, and preferably to warn the user before it can cause irreparable personal injury and/or material damage.

[0086] If it is deemed to be useful that the household appliance can perform an accurate self-diagnosis for finding any failures and/or malfunctions, it will also be important to know exactly which valve is faulty or defective; this will imply that, according to the present invention, a larger number of gas flow detectors will be required.

[0087] The type of automatic valve which is most suitable for the present invention is the piezoelectric one; this applies not only to the general valve, but mostly to the individual valves; as for the safety valve, if present (which may be the general valve itself), it will be appropriate to use an electromechanical valve, e.g. an electromagnetic one.

[0088] For the purposes of the present invention, in order to find which valve has suffered a gas leak, it is sufficient that the gas flow detectors are suitable for generating an electric signal indicating two gas flow states, in particular the substantial absence of gas flow and the substantial presence of gas flow; this allows their structure to be made simpler, leading to smaller dimensions and lower costs. In fact, the two main verifications to be carried out are the following:

A) when the valve receives a closing control signal, there must be no gas flow,
B) when the valve receives an opening control signal, there must be gas flow.

[0089] An effective system for detecting gas flow provides for generating an electric signal related to pressure difference, in particular to the difference between the pressure detected in a first direction and the pressure detected in a second direction substantially perpendicular to said first direction; as known, this is the basic principle of a Pitot tube, which is a device used in aeronautics for measuring air velocity.

[0090] Another effective system for detecting gas flow, which is particularly suited for integration into an automatic valve, provides for generating an electric signal related to the displacement or position of the valve shutter. This is an indirect flow measurement which is nonetheless more than sufficient for the purposes of the present invention: if the shutter is in the closed position, there will be no flow; if the shutter is not in the closed position, there will be flow (small or large).

[0091] As already mentioned, the household appliance according to the present invention may comprise an electronic safety system advantageously integrated into the electronic control system of the appliance; such an integration will be easier if the electronic control system is based on a microprocessor or a microcontroller and uses control programs controlling the operation of the system and thus, through actuators and sensors, the operation of the appliance.

[0092] Such a safety system may be designed either for signaling malfunctions and/or failures only or for providing a complete and accurate self-diagnosis being user-oriented and/or service-oriented (e.g. for the service technician); in this frame, it may also be useful to conceive some kind of remote signaling and/or technical assistance, since malfunctions and/or failures of gas cook-

ing household appliances can have very serious consequences for the users, e.g. explosions.

[0093] The electronic safety system may be adapted to carry out repeatedly and/or cyclically at least one procedure for verifying the proper operation of the general valve and/or one or more individual valves, typically of all valves.

[0094] Several verification procedures are possible depending on the number and type of detectors used in the household appliance. For example, one may use gas flow detectors and/or gas flow variation detectors and/or gas pressure detectors and/or gas pressure variation detectors. Said detectors may be installed near valves or along pipes, in particular along a pipe connecting the general valve to the individual valves.

[0095] A verification procedure may be carried out each time any one of the individual valves is closed. In fact, if an individual valve is operating correctly, there should be no gas flow through it after it has been closed.

[0096] In order to carry out such a verification through a gas flow detector associated with each individual valve, one may leave the general valve open and check that actually there is no gas flow through an individual valve after it has been closed; this verification can take place in a very short time (e.g. ten milliseconds).

[0097] A verification procedure may be carried out each time the general valve is closed; said closing can occur, for example, when the user decides to turn off all burners. In fact, if the general valve is operating correctly, there should be no gas flow through it after is has been closed.

[0098] In order to carry out such a verification through a gas flow detector associated with said general valve, one may leave at least one individual valve open and check that there is actually no gas flow through the general valve after it has been closed; this verification can take place in a very short time (e.g. ten milliseconds).

[0099] In order to verify that one or more individual valves (or a gas distribution assembly) are perfectly tight through a pressure detector associated with a pipe connecting the general valve to the individual valves, one may first close all the individual valves, then close the general valve, and afterwards check that the pressure in the pipe remains constant, without decreasing due to leaks caused by imperfect tightness of one or more individual valves (or, for example, of a gas distribution assembly); such a verification requires some time (e.g. a few seconds).

[0100] In order to verify that the general valve is perfectly tight through a pressure detector associated with a pipe connecting the general valve to the individual valves, one may first close the general valve, then close all the individual valves (thus draining the pipe), and afterwards check that the pressure in the pipe remains constant, without increasing due to leaks caused by imperfect tightness of the general valve; such a verification takes some time (e.g. a few seconds).

[0101] The two above-mentioned verification procedures may be carried out in succession in order to perform a verification cycle to be preferably repeated at each operation cycle of the gas appliance: for example, the general valve verification procedure may be carried out at the beginning of an operation cycle and the individual valve verification procedure may be carried out at the end of every operation cycle (or vice versa); alternatively, both verifications may be carried out either at the beginning or at the end of every operation cycle.

[0102] A verification procedure can be carried out every time the general valve is opened; this opening may take place, for instance, when the burners are all off, after the user has decided to turn on one of the burners; once the verification is completed, it will be possible to open one of the individual valves in order to use the corresponding burner.

[0103] Of course, many other verification procedures are also possible.

[0104] A complete verification procedure may be carried out cyclically (e.g. once every hour or once every day) during the idle periods of all the burners of the household appliance, i.e. after the user has sent commands for turning off all burners to the electronic control system of the appliance; in a household kitchen, these periods of time represent most of the life of the appliance and can be used to advantage in order to keep the appliance under control and to ensure the utmost safety.

[0105] During these idle periods of all burners of the household appliance, all automatic valves are preferably kept closed (e.g. by turning off the power supply thereof) by the safety system, which is often built in the control system.

[0106] The complete verification procedure may consist of one or more of the following steps:

- verification of the general valve,
- verification of a generic individual valve or a gas distribution assembly comprising several individual valves,
- verification of each specific individual valve.

[0107] As previously mentioned, a specific aspect the present invention relates to a gas detector.

[0108] In general, the gas detector according to the present invention may, according to a first embodiment, be adapted to generate at least one electric signal indicating only two pressure states within a pipe or a chamber containing gas; in particular, a first one of said pressure states corresponds to pressure values within said pipe or chamber which are substantially equal to the outside pressure, and a second one of said pressure states corresponds to pressure values within said pipe or chamber which are higher than the outside pressure.

[0109] The gas detector according to the present invention may, according to a second embodiment, be adapted to generate at least one electric signal indicating only three pressure states within a pipe or a chamber containing gas; in particular, a first one of said pressure

states corresponds to pressure values within said pipe or chamber which are substantially equal to the outside pressure, a second one of said pressure states corresponds to pressure values within said pipe or chamber which are higher than the outside pressure, and a third one of said gas pressure states corresponds to pressure values within said pipe or chamber which are lower than the outside pressure.

[0110] Such a detector may comprise a typically electromechanic device adapted to generate at least one electric signal indicating only two or three gas pressure states and comprising an element adapted to move through the effect of gas pressure and adapted to be in only two or three operating conditions.

[0111] One or two of the operating conditions of the movable element may correspond to one or two predetermined positions; in the example of Fig.5 there is only one predetermined position, while in the example of Fig. 6 there are two predetermined positions.

[0112] As shown in the examples of Fig.5 and Fig.6, one operating condition may correspond to a set of contiguous positions.

[0113] Such a gas detector may be advantageously used in a household appliance according to the present invention and, in particular, in a gas distribution assembly of the household appliance.

[0114] Said gas distribution assembly is provided with a gas inlet and a plurality of gas outlets; in addition, a plurality of automatic valves are respectively associated with said plurality of gas outlets; finally, a gas detector is mounted to or built in the assembly, in particular associated with a collector pipe of the assembly.

[0115] The most effective type of automatic valve for the purposes of the present invention is the piezoelectric one, i.e. comprising at least one shutter associated with one valve outlet and at least one piezoelectric element controlled electrically for moving the shutter.

[0116] A plurality of gas flow detectors may also be associated with said plurality of gas outlets.

[0117] This component, i.e. the gas distribution assembly, is very compact and is fully capable of performing a self-diagnosis, even automatically.

[0118] It is worth making clear that a household appliance according to the present invention may be provided with more than one gas distribution assembly as previously described; for example, two gas distribution assemblies may be connected together in series and be used for the cooking top and for the oven, respectively. In this case, either gas distribution assembly according to the present invention may additionally be fitted with at least one available gas outlet not associated with any automatic valve.

[0119] The present invention has been described with reference to particular embodiment examples, but it is clear that many changes may be made thereto by those skilled in the art, and that all such changes will still fall within the scope defined by the appended claims.

Claims

1. Gas detector (R) **characterized by** being adapted to generate at least one electric signal indicating only two or three gas pressure states.

2. Gas detector (R) according to claim 2, **characterized in that** a first one of said gas pressure states corresponds to pressure values which are substantially equal to the atmospheric pressure, a second one of said gas pressure states corresponds to pressure values which are higher than the atmospheric pressure, and a third one of said gas pressure states corresponds to pressure values which are lower than the atmospheric pressure.

3. Gas detector (R) according to claim 1 or 2, **characterized by** comprising a device adapted to generate at least one electric signal indicating only two or three gas pressure states, said device comprising an element adapted to move through the effect of gas pressure and adapted to be in only two or three operating conditions.

4. Gas detector (R) according to claim 3, **characterized in that** one or two of said operating conditions of said movable element correspond to one or two predetermined positions.

5. Gas detector (R) according to claim 3 or 4, **characterized in that** one of said operating conditions corresponds to a set of contiguous positions.

6. Gas detector (R) according to one or more of the preceding claims, **characterized in that** it comprises a membrane (M), a rod (A), a lever (L) at least a portion of which is made from electrically conductive material, a first electric contact (C1) and at least a first and a second terminal (T1, TL), electrically connected to said first contact (C1) and to said lever (L), respectively, and in which said rod (A) is constrained to said membrane (M), so that it can move through the effect of pressure acting on said membrane (M), said lever (L) being constrained on one end thereof, so that it can rotate about said end, and to said rod (A), so that it can rotate as rod (A) moves, in order to touch said first contact (C1), for creating an electric path between said first and second terminals (T1, TL).

7. Gas detector (R) according to claim 6, **characterized in that** it comprises a second electric contact (C2) connected to a third terminal (T2), said third terminal (T2) being displaced on the opposite side of said first terminal (T1) with respect to said lever (L) so that when said lever (L) is rotated in one direction it touches said first contact (C1), thus creating an electric path between said first terminal (T1) and

said second terminal (TL) and when lever (L) is rotated in an opposite direction, it touches said second contact (C2), thus creating an electric path between said third terminal (T2) and said second terminal (TL).

8. Gas detector (R) according to claim 6 or 7, **characterized in that** said lever (L) and said first contact (C1) are displaced on the same side of said membrane (M), said first contact (C1) and said second contact (C2) being preferably displaced on the same side of said membrane (M).

9. Combination of a gas detector (R) according to any of claims 6 to 8 and a gas cooking household appliance provided with at least a gas pipe (CO), **characterized in that** said membrane (M) comprises edges which are secured to edges of an aperture in said gas pipe (CO).

10. Gas distribution assembly (AS) for gas cooking household appliance, **characterized in that** it comprises a gas detector (R) according to any of claims 6 to 8, at least a gas pipe (CO) and a chamber (CP), said chamber (CP) being adjacent to and hermetically separated from said gas pipe (CO) at least by said membrane (M).

11. Gas distribution assembly (AS) according to claim 10, **characterized in that** said lever (L) and said first contact (C1) are housed in said chamber (CP), said second contact (C2) being preferably housed in said chamber (CP).

12. Gas distribution assembly (AS) according to claim 11, **characterized in that** on a wall of said chamber (CP) not adjoining said pipe (CO), a calibrated hole (89) is obtained.

13. Gas distribution assembly (AS) according to claim 11 or 12, **characterized in that** it comprises at least a piezoelectric automatic gas valve (V1), housed in said chamber (CP), and said gas valve (V1) comprising at least a piezoelectric element (2) acting as an actuator of an adjusting device (3) provided with at least a shutter (31) and an adjusting device stem (32) rigidly joined together, said adjusting device (3) being pushed by an actuator (2), said valve (V1) further comprising a gas inlet duct comprising an hollow body (6) associated with said collector pipe (CO), and a gas outlet duct (8) connected to a burner (B1), said hollow body (6) being provided with a hole which allows said stem (32) to slide preventing any gas leaks from said body (6), said body (6) having a top wall comprising a diaphragm (9), secured in a substantially tight manner to the walls of said body (6) and to said stem (32).

14. Gas cooking household appliance comprising a gas distribution assembly (AS) according to any of claims 10 to 13, said gas distribution assembly (AS) being interposed between a gas fitting (AG) and one or more gas burners (B1,B2,B3,B4).

15. Gas cooking household appliance according to claim 14, comprising an electronic safety system (EL) adapted to detect any malfunctions and/or failures which may cause undesired gas flow.

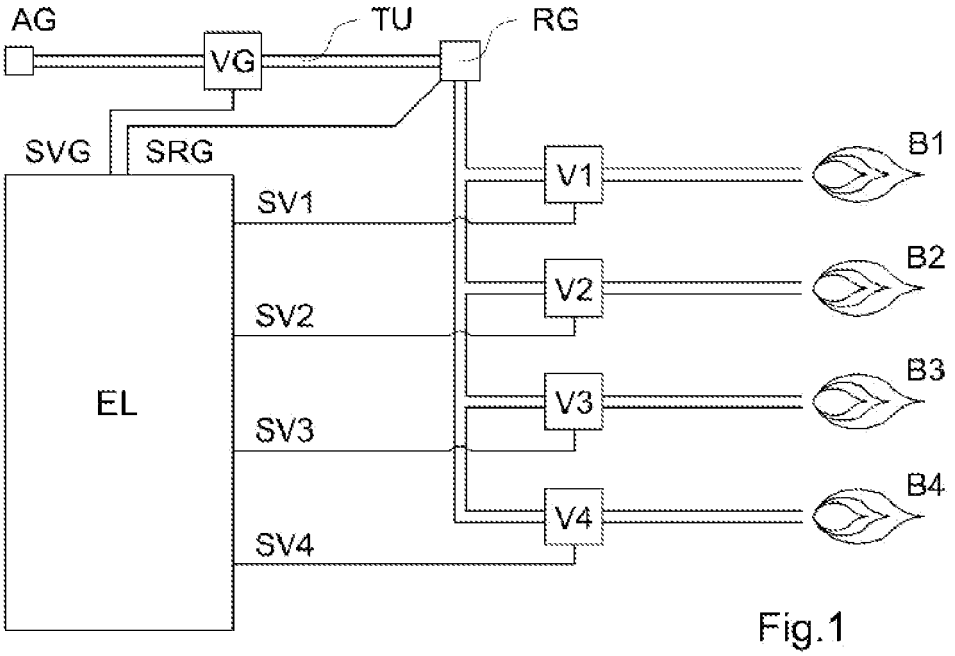
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Fig.1

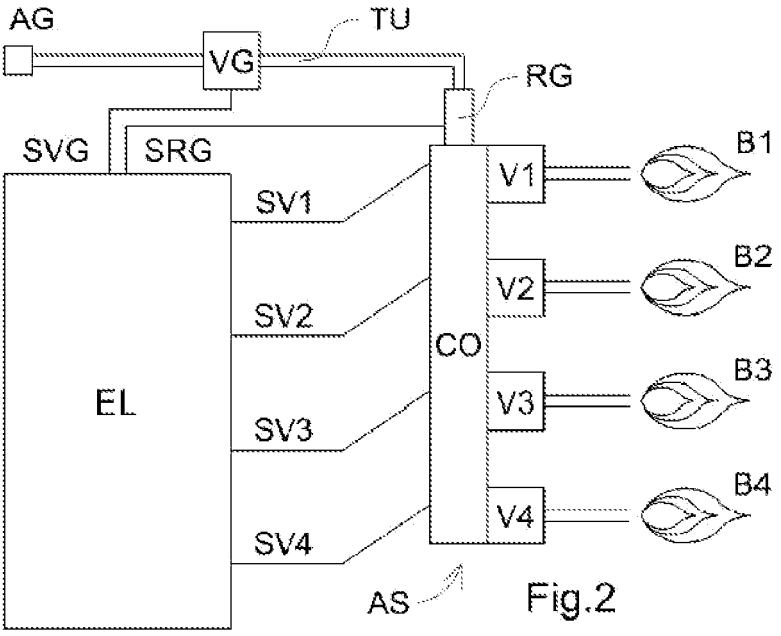
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Fig.2

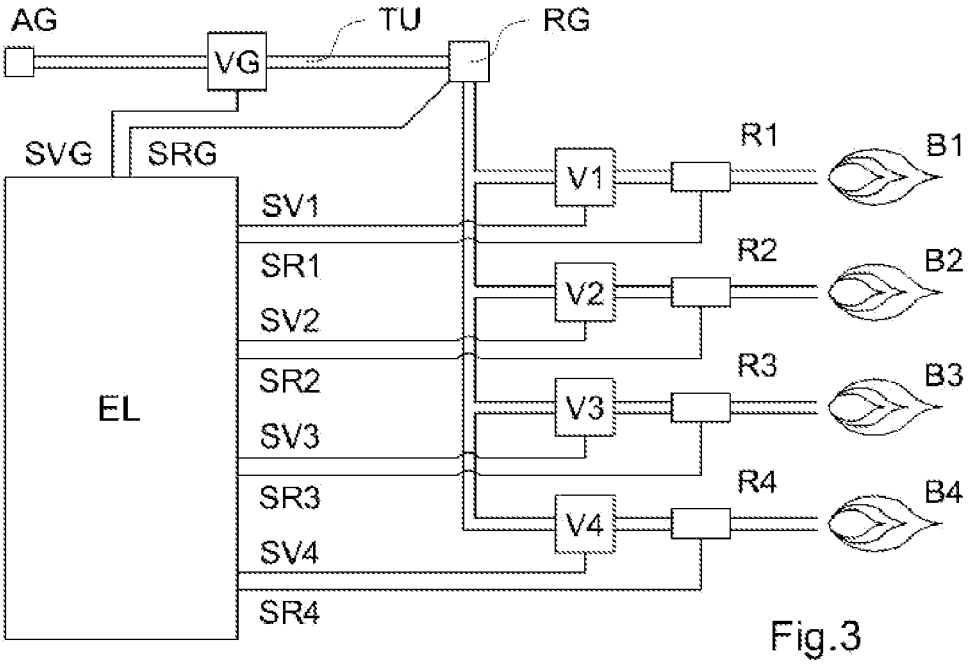
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Fig.3

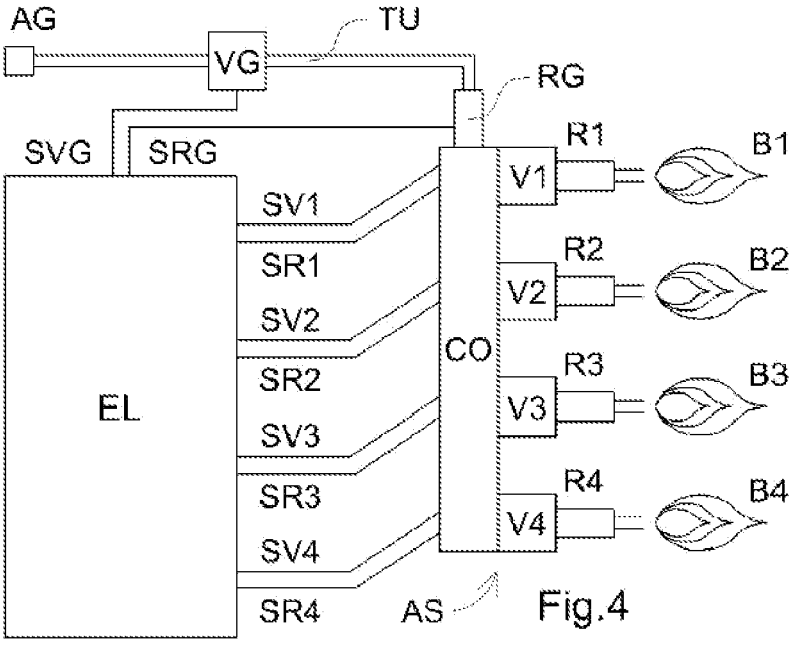
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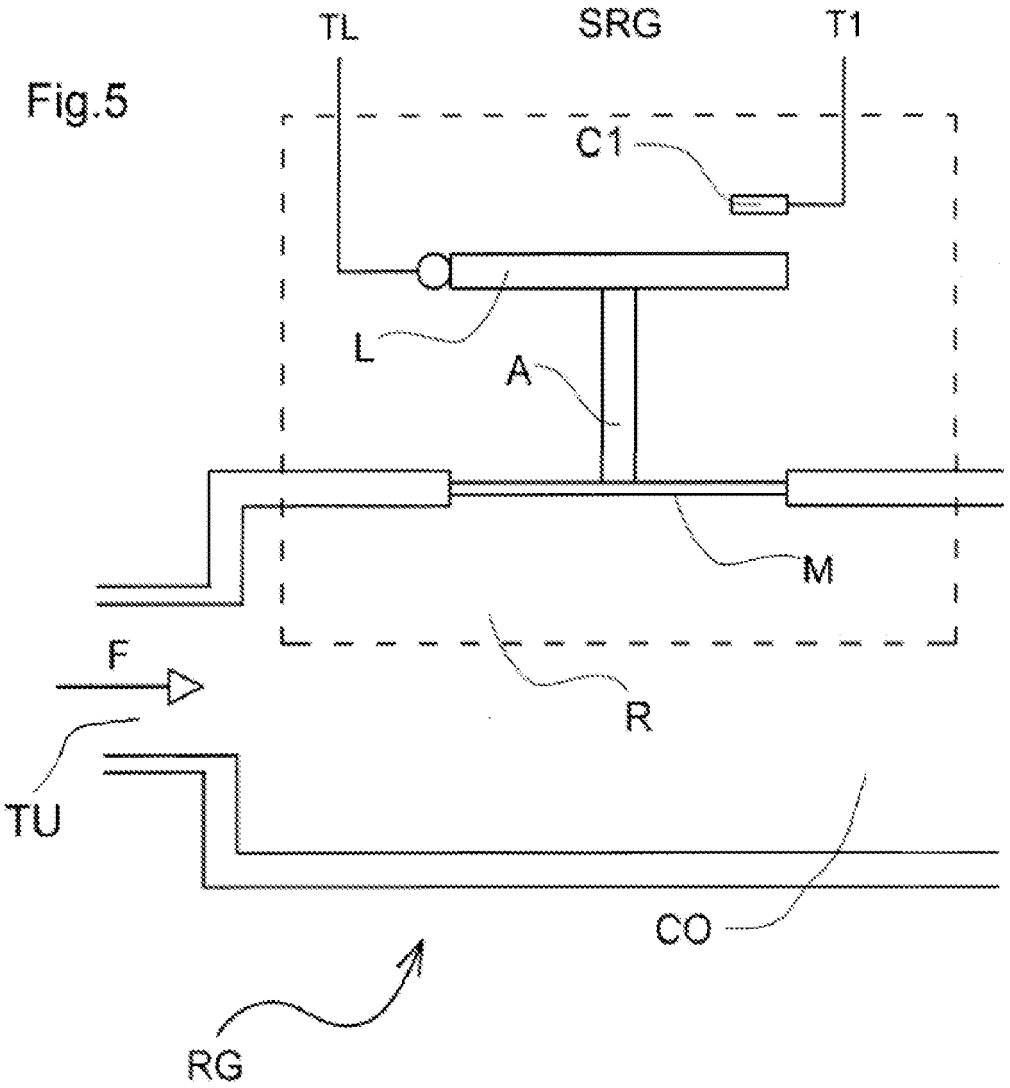
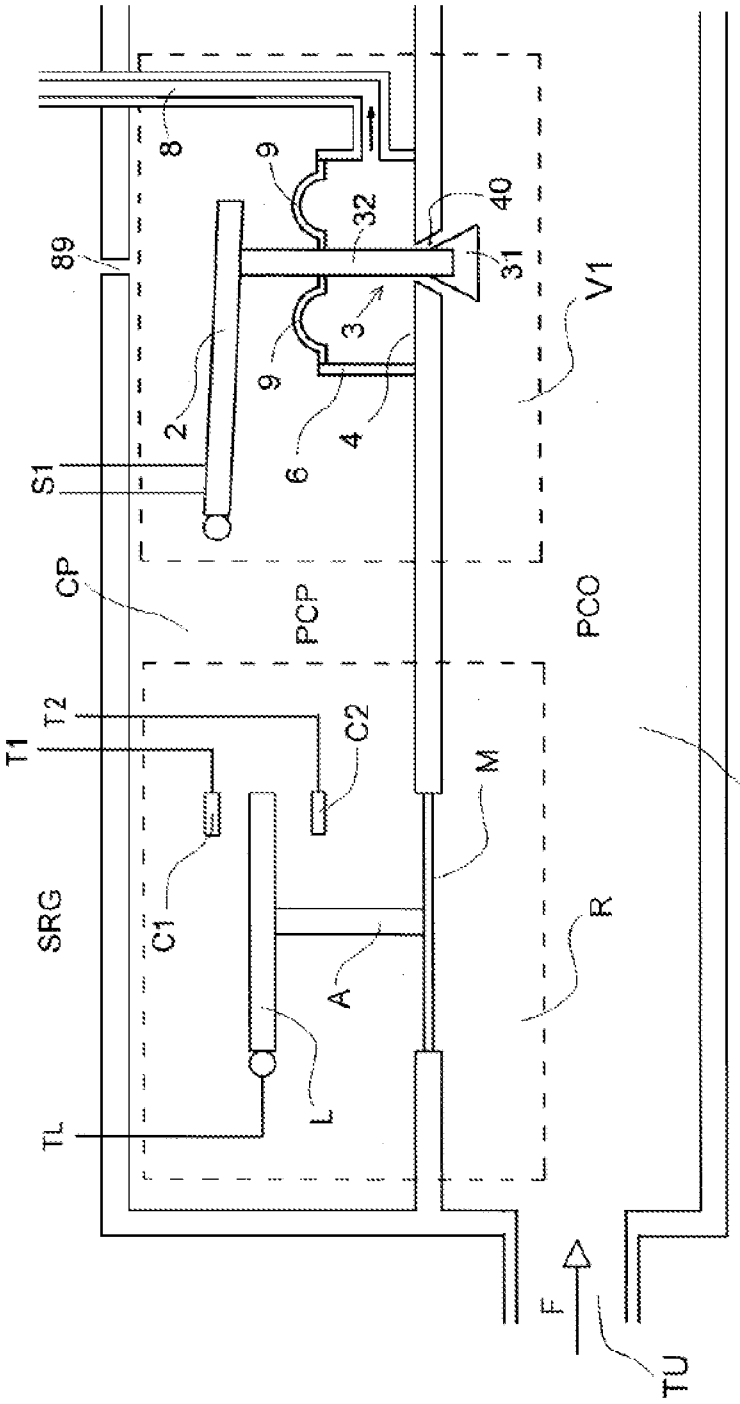
Fig.4

Fig.5

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89
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40
31
V1
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S1
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T2
T1
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M
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SRG
R
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CO
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TL
F
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RG

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 10 15 4874

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Place of search	Date of completion of the search	Examiner
Munich	11 July 2011	von Mittelstaedt, A

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