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(54) **Control of fuel supply to a heating apparatus**

(57) Assembly for controlling the feed of fuel to a heating apparatus having an air passage (1) with a sluice located therein, formed by or comprising a valve (15, 45, 75) which is movable for varying the air passage and fuel-metering means (16, 17) communicating with a portion of the air passage in the area or downstream of the sluice for metering the fuel supply depending on pressure prevailing in the area or downstream of the sluice, a burner (5), a discharge channel (6), and a fan (3) for driving an air flow (7, 8, 11, 68) through the air supply channel (1). As the valve (15, 45, 75) is arranged for limiting the air passage (1) in response to the fall of a pressure drop over that valve (15, 45, 75) below a specific value, heat loss caused by air displacements when the fan (3) stands still is prevented without using a separate valve, and an enlargement of the work area of the heating apparatus is obtained.

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Description

The invention relates to an assembly for controlling fuel supply according to the preamble of claim 1, and to a heating apparatus according to the preamble of claim 8.

Such assembly and such heating apparatus are known from DE-U-295 04 705. De feed of air and fuel required for combustion are proportionally controllable for adapting the power of the apparatus to the heat delivery needed. In this assembly and in that heating apparatus, the valve which forms part of the sluice for generating a reduced pressure on the basis of which the fuel metering can be controlled, is coupled to a temperature-dependent setting member for operating the valve depending on a detected temperature. This enables influencing the air supply depending on the temperature-dependent density of the air.

Drawbacks of such assembly and such heating apparatus are that it has a relatively limited power range and that when the fan is switched off, a thermal draft is created, causing the loss of heat present in the system.

DE-A-24 03 083 discloses an apparatus for controlling the air/fuel ratio for a burner, wherein an adjustable throttle valve is arranged in the air supply, which throttle valve is coupled to a control valve for controlling the supply of fuel depending on the set position of that throttle valve. In order to keep the pressure drop over the throttle valve constant, a fan with a suitable characteristic is used or a second throttle valve is provided downstream of the first throttle valve, which second throttle valve, in response to a deviation from the measured pressure drop over the first throttle valve, is set such that the pressure drop over the first throttle valve is always constant. Hence, the second throttle valve closes according as the pressure drop over the first throttle valve is greater, and opens if the pressure drop falls out, for instance because the fan is switched off. A drawback of this apparatus is that either the actual pressure drop over the throttle valve is not known, because it is not measured, or a separate, second throttle valve is required for readjusting the pressure drop over the first throttle valve, which has a cost-increasing effect and causes additional air resistance. Further, no valve is present which closes automatically if the fan switches off, and the power range is limited and the throttling losses at low powers are relatively high, because in each case, at least approximately the same pressure drop prevails over the adjustable throttle valve.

In EP-A-0 050 506, a burner is described whose air supply comprises a valve operated depending on the relationship between the pressure directly downstream of that valve and the pressure downstream of the burner in order to keep the balance between supply and discharge pressure constant. In response to thermal draft when the burner is switched off, the valve closes and thus prevents heat losses. However, this valve operation does not provide the increase of the power range within

which the burner can operate with a sufficiently accurately controlled air/fuel ratio.

DE-U-94 01 894 and US-A-4 353 349 describe valves for use in a suction channel of a combustion installation which open in response to a pressure drop over the valve and close in response to a fall of the pressure drop below a specific value. However, such valves form an extra provision which has a cost-increasing effect and increase the air resistance in the supply pipe.

The object of the invention is to increase the power range of an apparatus having a burner and a fan for the supply of combustion air, and to limit heat losses when the fan is switched off, without the addition of separate valves.

According to the present invention, this object is attained by designing an assembly for controlling the supply of fuel as indicated in the characterizing part of claim 1, or by designing a heating apparatus as indicated in the characterizing part of claim 8.

By arranging the valve, which forms part of or constitutes the sluice, for limiting the air passage in response to the fall of a pressure drop over that valve, heat losses caused by thermal draft can be prevented without the addition of a separate valve for this purpose and the attendant costs and increase of the air resistance, because the valve is integrated into a sluice which also serves to create a pressure drop which is used as input variable for metering the fuel. Further, due to the valve which in response to the decrease of the pressure drop limits the air passage, the air flow rate at a given minimal, reliably measurable pressure drop over the valve is reduced, as a result of which the power range within which fuel can be metered sufficiently accurately is extended at the lower end. The minimal heat delivery that can be effected by the heating apparatus without intermittently switching off is thereby reduced.

Further, in comparison with apparatus wherein the fuel metering is controlled depending on the position of a throttle valve at a given, supposed or measured pressure drop over that throttle valve, there is achieved the advantage of reduced throttling losses at low powers.

Particular elaborations of the invention are laid down in the dependent claims.

Hereinafter, further objects, constructions, effects and advantages of the invention are specified on the basis of exemplary embodiments, with reference to the accompanying drawings. In these drawings:

Fig. 1 is a diagrammatic representation of an example of a heating apparatus according to the invention;

Fig. 2 is an enlarged, cutaway representation of a gas-control unit of the gas apparatus according to Fig. 1;

Fig. 3 is an enlarged, cutaway representation in side elevation of a valve of the heating apparatus according to Fig. 1;

Fig. 4 is a frontal representation of the valve accord-

ing to Fig. 3;

Fig. 5 is a cutaway representation in side elevation of an alternative valve;

Fig. 6 is a frontal representation of the valve according to Fig. 4;

Fig. 7 is a cutaway representation in side elevation of another alternative valve; and

Fig. 8 is a frontal representation of the valve according to Fig. 7.

The heating apparatus shown fully and partially in Figs. 1-4 is built up from an air supply channel 1, a gas supply channel 2 constituting the fuel supply channel, a fan 3, a mixing nose 4, a burner 5 and a discharge channel 6, a downstream portion of which extends coaxially in the air supply channel 1. Heating apparatus of such construction are known per se and generally commercially available. For this reason, the general design of the heating apparatus is described only succinctly. In operation, the flow direction of air and different gases is as indicated by arrows 7-14.

Located in the air channel 1 is a sluice 15 and the apparatus comprises a pressure transmission line 16 via which line a fuel metering member in the form of a gas control unit 18 communicates with portions of the air supply channel 1 upstream of the sluice 15. The gas supply channel 2 ending downstream of the sluice 15 also constitutes the pressure transmission line via which the gas control unit 18 communicates with portions of the air supply channel 1 downstream of the sluice 15 for transmitting the pressure in that portion of the air supply channel. It is true that during the delivery of gas, pressure prevailing directly downstream of the gas control unit 18 in the gas supply channel 2 is to a slight degree partially influenced by the inflow of gas, but this can be taken into account during the adjustment of the gas control unit 18.

In general, it is also possible to cause the gas control unit to meter depending on the pressure drop between other areas, for instance directly on either side of the sluice. However, it is also possible to use the pressure drop between areas at a greater distance on either side of the valve, or exclusively the reduced pressure downstream of the valve, as basis for the fuel metering. Of course, the difference between the pressure directly upstream of the valve and the pressure at a greater distance downstream of the valve or vice versa can also serve as input variable.

In operation, the pressure transmission line 16 and a pressure transmission channel 19 for transmitting the pressure in the gas supply channel 2 upstream of a metering valve 28 of the gas control unit 18 cooperate for passing gas via the metering valve 28, depending on the pressure drop over the sluice 15.

The gas control unit comprises a primary on-off valve 29 which is urged into a closed rest position by a spring 30. Via a bell crank 31, the valve is coupled to an electromagnet 32.

The metering valve 28 located downstream of the primary on-off valve 29 in the gas supply channel 2 is likewise urged into a closed rest position by a spring 33 bearing against a face 34 of a guide 35. The valve 28 has a valve disk 36 which, in closed condition, butts against a valve seat 37. From the valve disk 36, a valve rod 38 extends to an operating disk 39 supported by a diaphragm 40. The diaphragm 40 closes a space 41 from the gas supply channel 2. This space 41 communicates with a chamber 42 which, via the pressure transmission channel 19, communicates with a portion of the gas supply channel 2 upstream of the metering valve 28. The secondary on-off valve 43 is connected, via a bell crank 44, to an electromagnet 46. Integrated into the electromagnet 46 is a spring 47 which keeps the valve 43 closed when the electromagnet 46 is not energized.

The chamber 42 further communicates with the portion of the gas supply channel 2 downstream of the metering valve 28 via an aeration opening 48 and via a compensation channel 49, closable by a settable diaphragm valve 50.

When the heating apparatus is controlled for delivering heat, the fan 11 is set in motion and the electromagnets 32, 46 are activated for opening the primary and secondary on-off valves 29, 43 against the pressure of the springs 30, 47. Now, the space 41 is pressurized via the channel 19 and the chamber 42. Since the operating disk 39 has a larger surface area than the surface area enclosed by the valve seat 37 of the metering valve 28, a net force is hereby exerted on the metering valve 28 in opening direction, which force depends on the excess pressure in the space 41 and the reduced pressure in the gas supply channel 2 downstream of the metering valve 28. The stronger the reduced pressure, the more gas is passed. To compensate for the reduced pressure upstream of the sluice, which reduced pressure also influences the air flow rate at a given reduced pressure in the gas supply channel 2 downstream of the metering valve 28, and fluctuations in the supply pressure of the gas, excess pressure can be blown off via the diaphragm valve 50 from the chamber 42 to a portion of the gas supply channel 2 downstream of the metering valve 28, as a result of which the metering valve 28 closes slightly and the gas metering is adjusted. The operation of the diaphragm valve 50 can be adjusted with an adjusting screw 52.

In this manner, in operation, gas is passed by the gas control unit 18 in a metered manner depending on, inter alia, the pressure drop over the sluice 15.

In principle, instead of controlling the metering by means of the metering and compensating valves operated by the pressure differences, it is also possible to control the metering depending on pressures upstream and downstream of the sluice, measured by pressure sensors. However, in this regard it is problematic that the measuring range of pressure sensors that are obtainable at prices that are acceptable for such appli-

cations, is fairly limited. If this problem is overcome through the development of pressure sensors or if, for instance, the use of several pressure sensors for different measuring ranges connecting to each other is or becomes economically attractive, scanning the pressure in such a manner may be or become advantageous.

The burner 5 communicates with the air supply channel 1 and with the gas supply channel 2 and is located downstream of the two channels 1, 2 and a mixing nose 4, so that in operation, a gas/air mixture to be combusted reaches the burner 5 and is processed by the burner 5.

The discharge channel 6 for discharging gases resulting from combustion communicates with the burner 5 and is located downstream thereof. The first portion of the discharge channel 6 is designed as a part of a heat exchanger, not shown.

Incorporated into the air supply channel 1 is a fan 3 for generating and maintaining an air flow through the air supply channel 1, the mixing nose 4, the burner 5 and the discharge channel 6. Depending on control signals received from an external thermostat system, the fan 3 is controllable by a control unit, not shown.

The burner 5 communicates with the environment exclusively via the supply and discharge channels 1 and 2. In addition, the burner 5 communicates with the gas supply channel 2 for feeding gas from a gas provision, such as a gas tank or a branch from a gas distribution network.

The sluice 15 is arranged as a valve for closing off the air supply channel 1.

In operation, the valve 15 is closed as long as the fan 3 is switched off and, accordingly, stands still or at least does not maintain an air flow in the direction of the arrows 7-14. As soon as the fan 3 is switched on, a pressure drop over the valve 15 is created, in response to which the valve 15 opens and air is fed as indicated by the arrows 7, 8, 11. The generated pressure drop over the valve 15 is transmitted to the gas control unit 18 which, depending thereon, passes gas to the air supply channel 1.

The fed air and the fed gas are mixed in the mixing nose 4 to form a highly homogeneous mixture having - owing to the accurately metered gas delivery by the gas control unit - the proper mixing ratio, resulting in a combustion with very slight CO, NO and NO_x emissions. After having cooled in the above-mentioned heat exchanger, the combustion gases are discharged via the discharge channel 6 (arrows 12, 13, 14), and in the portion of the discharge channel 6 extending coaxially with the air supply channel 1, residual heat is transferred to air fed via the air channel 1.

When no heat is demanded anymore and the fan 3 is switched off, the pressure drop over the valve 15 falls out at least substantially. In response thereto, the valve 15 closes again. The closing of the valve 15 prevents the possible formation of a substantial air flow through

the heating apparatus by thermal draft caused by hot air in the heating apparatus (or by whatever cause), whereby heat is given up from that apparatus to the environment and the apparatus and a medium or product to be heated present therein are cooled. By integrating the valve 15 with the sluice, a separate sluice can be saved and extra air resistance that would be caused by a valve supplementing the sluice is avoided.

In principle, the valve could be actively operated in response to the detected pressure drop. However, in the heating apparatus shown, a very simple construction is obtained in that the valve 15 shown is of passive construction and is itself reactive for closing off the air passage if the pressure drop in flow direction drops below a specific value. Hence, no active drive of the valve is required, which limits the manufacturing costs and chances of failure. If the thermal draft occurring after the fan has been switched off is in the same direction as the flow direction of air when the fan is switched on, it is important that the closing force of the valve is greater than the pressure difference, caused by the thermal draft, between areas on either side of the valve.

The valve shown in Figs. 3 and 4 comprises a spring 20 urging a valve body 21 springily towards its closed position if the valve 15 is in open condition. The use of a spring offers the advantage that the construction can be light, that there is more freedom as regards the opening characteristic of the valve and that adjusting possibilities can readily be provided. However, it is also possible to urge the valve into its closed position in another fashion, for instance by means of the weight of the valve body or a part coupled thereto.

As regards the construction of the valve according to Figs. 1, 3 and 4, it can furthermore be observed that it further contains a support structure 22 with a guide bore 23, through which guide bore a support pin 24 extends, which support pin carries a support 25 for the spring 20 and which is adjustable relative to the support structure and a valve seat 27 by means of an adjusting ring 26. In Fig. 1, the valve 15 is shown in open condition and in Fig. 2, the valve 15 is shown in closed condition. In the valve 15 shown, the spring 20 is located downstream of the valve body 21, but the spring 20 may also be located upstream of the valve body 21.

According as the pressure drop over the valve 15 is greater, the valve 15 opens further. Releasing said air passage to a greater or lesser degree, depending on the pressure drop, offers the advantage that at low air flow rates, greater reduced pressures occur which can be detected more accurately. Further, at a given band width within which pressures can be measured sufficiently accurately or can be used for metering gas or another fuel, the air flow rate can be controlled within a greater band width. This enables having the heating apparatus operate at a lower minimum power. The relationship between the pressure drop over the valve and the flow rate of the passing air can be influenced particularly aptly if the position of the valve adjusts itself step-

wise. Particularly advantageous is a stepless adjustment of the valve position, because in that case, in addition to scanning a pressure in the area of or downstream of the sluice, no provisions for scanning the momentary position of the valve are needed.

As the valve 15 is adjustable for adjusting the relationship between pressure drop and valve position, manufacturing tolerances can readily be taken up and the valve can moreover be used for adjusting the air/fuel ratio, for instance for adapting it to different fuels having different calorific values.

A particularly efficient construction, however, can also be obtained if the scanning means for scanning a pressure drop over the sluice are designed as a scanner for scanning the position of said valve. The degree to which the valve opens in response to the strength of the air flow and, accordingly, the pressure exerted thereon is then used as measure for the amount of passing air, for instance in the form of a potentiometer. Pressure sensors can then be left out, if necessary.

Although in the apparatus shown in Figs. 1-4, the valve 15 can close off the air channel 1 completely, it is also possible to construct the valve such that the air channel can be closed off only partially or substantially. Although in that case, no total blocking of thermal draft is obtained, it can in fact be partially or largely limited, which also results in a limitation, albeit a slighter one, of heat losses.

A non-complete closure of the air passage is advantageous for a reliable operation of the heating apparatus at very low air flow rates. The passage for passing air if the valve 15 is closed may for instance be designed in the form of a bypass which, in turn, may or may not also comprise a valve, preferably a more sensitive one. However, the passage may also be designed in the form of an opening between the valve body in closed condition and the valve seat. The valve can then be of such design that it remains closed if the apparatus operates in a lowest position or a lowest number of positions and opens only when the speed of the fan, and accordingly the generated reduced pressure, exceeds a specific limit.

It will be readily understood by anyone skilled in that art that within the framework of the present invention, many variants are possible, as is illustrated, by way of example, by the valves 45, 75 shown in Figs. 5-8.

Figs. 5 and 6 show an alternative construction of the valve integrated with the sluice, indicated by reference numeral 45. In this valve, the support structure for guiding and supporting the support pin 54 is integrated with the valve seat to form a plate 57 having bores 58, closable by the valve body 51.

In the valve 75 according to Figs. 7 and 8, the support structure is integrated with the valve seat to form a plate-shaped support 87 having openings 88. The valve body also forms the springy member, in that the valve body is designed as a flexible diaphragm 81, bendable back and forth in the direction indicated by arrows 89

between a position shown in full lines and a position indicated in broken lines. In the open position, air can pass as indicated by arrows 68. The diaphragm is held in position against the plate-shaped support 87 by a fastener 90.

Claims

1. An assembly for controlling fuel supply depending on amounts of air fed to a heating apparatus, comprising an air passage (1) having a sluice which is at least partly formed by a valve (15, 45, 75) movable for varying the air passage in the area of the sluice, and fuel-metering means (16, 17) communicating with a portion of the air passage in the area or downstream of the sluice for the metered supply of fuel depending on a pressure prevailing in said portion of the air passage in the area or downstream of the sluice,
characterized in that the valve (15, 45, 75) is arranged for limiting the air passage (1) in response to the fall of a pressure drop over said valve (15, 45, 75).
2. An assembly according to claim 1, wherein said valve (15, 45, 75) is arranged for substantially closing the air passage (1).
3. An assembly according to claim 1 or 2, wherein said valve (15, 45, 75) is reactive for releasing the air passage (1) more, in response to an increase of the pressure in said portion of the air passage in the area or downstream of the sluice and for throttling the air passage (1) in response to a decrease of the pressure in said portion of the air passage in the area or downstream of the sluice.
4. An assembly according to any one of the preceding claims, wherein the valve (15, 45, 75) is of passive design.
5. An assembly according to any one of the preceding claims, wherein said valve (15, 45, 75) in open condition is springily urged towards its closed condition.
6. An assembly according to claim 2 or 3, wherein said valve (15, 45) is adjustable for adjusting the relationship between the pressure and the position of said valve (15, 45)
7. An assembly according to any one of the preceding claims, further comprising a passage for passing air if said valve is closed.
8. A heating apparatus, comprising:

an air supply channel (1) having a sluice which

is at least partly formed by a valve (15, 45, 75) movable for varying the air passage in the area of the sluice;

a fuel supply channel (2) having a fuel-metering system (18) communicating with a portion of the air supply channel (1) in the area or downstream of the sluice and arranged for the metered delivery of fuel depending on a pressure prevailing in said portion of the air supply channel (1) in the area or downstream of the sluice;

a burner (5) communicating with said air supply channel (1) and with said fuel supply channel (2) and located downstream of said channels (1, 2);

a discharge channel (6) for discharging gases produced during combustion, said discharge channel (6) communicating with said burner (5) and being located downstream thereof; and

a fan (3) in said air supply channel (1) for generating and maintaining an air flow (7, 8, 11, 68);

characterized in that the valve (15, 45, 75) is arranged for limiting the air passage (1) in response to the fall of a pressure drop over said valve (15, 45, 75).

9. A heating apparatus according to claim 8, further comprising a passage for passing air if said valve (15, 45, 75) is entirely closed.

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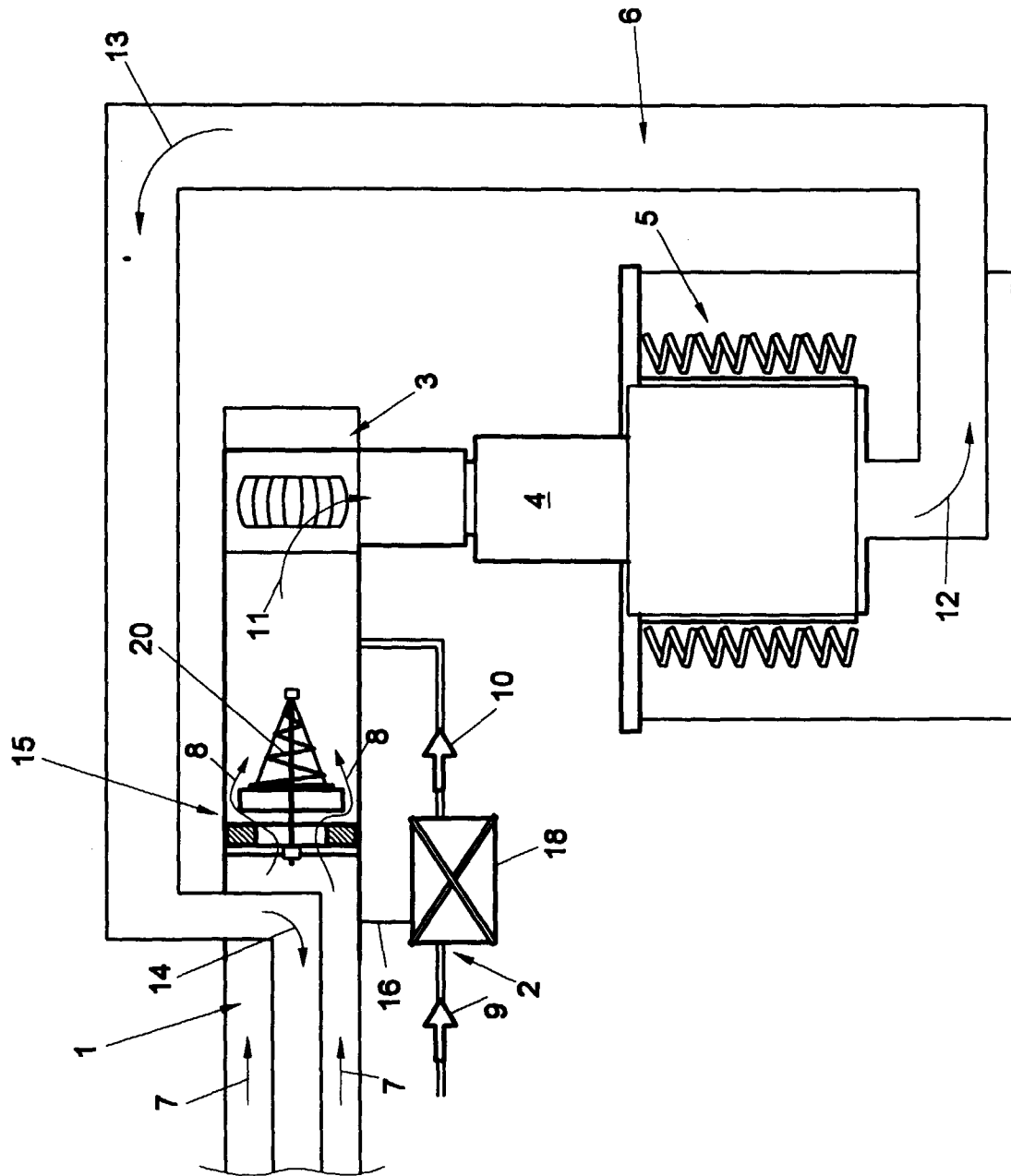
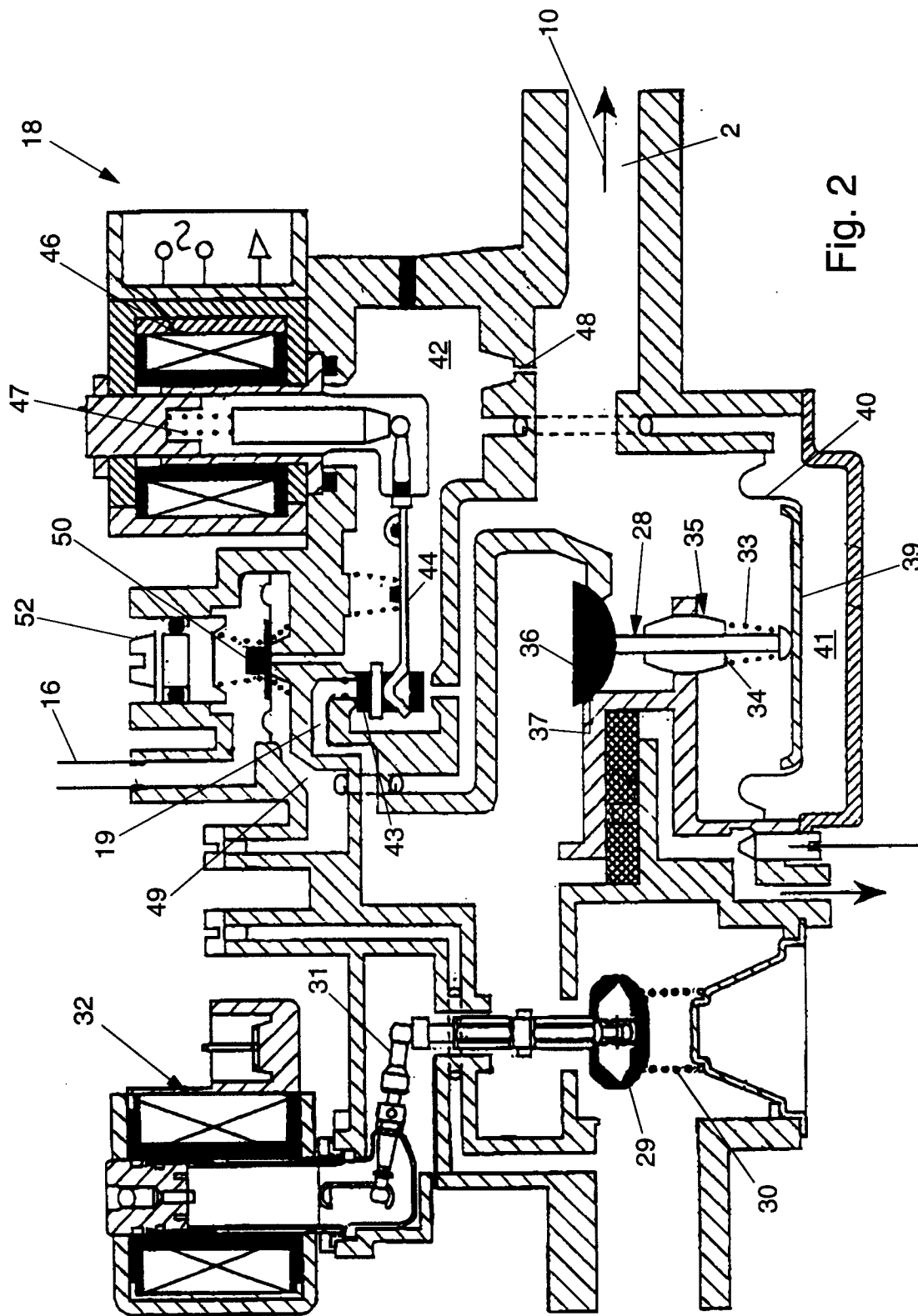


Fig. 1



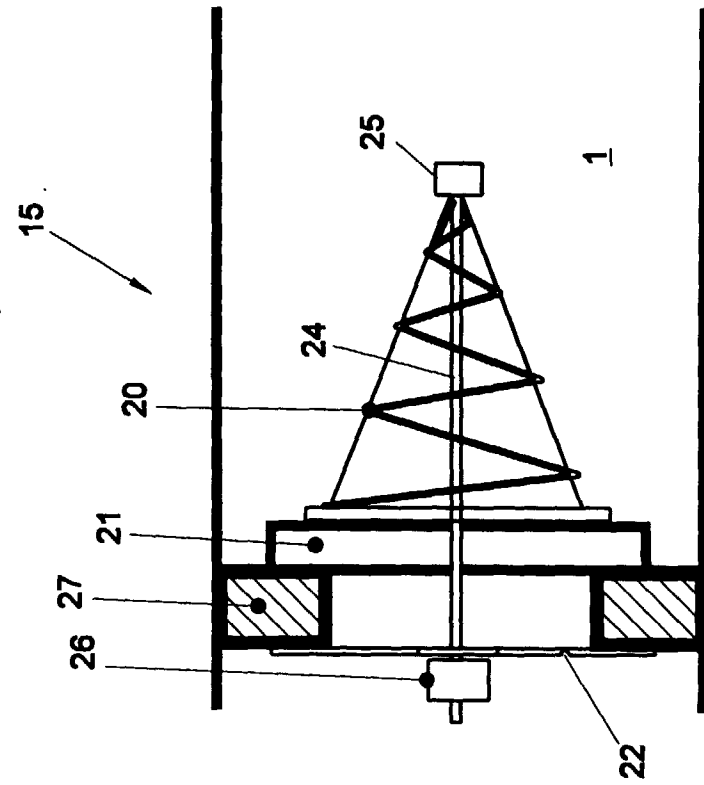


Fig. 3

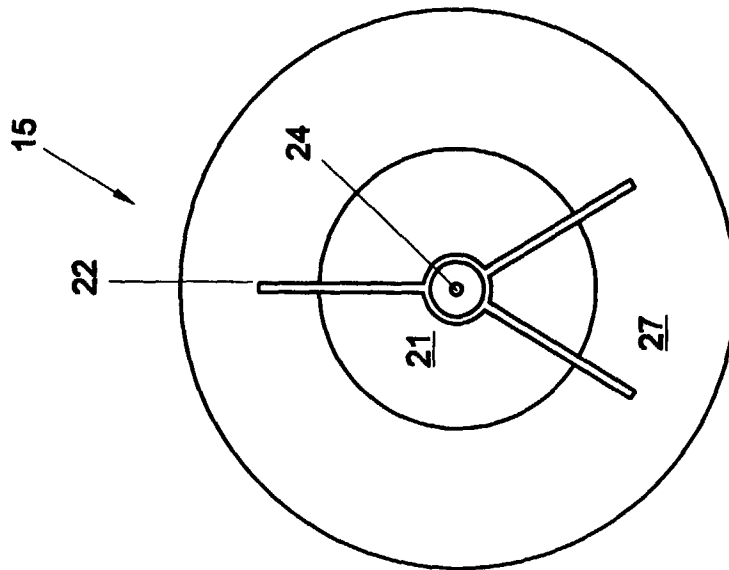


Fig. 4

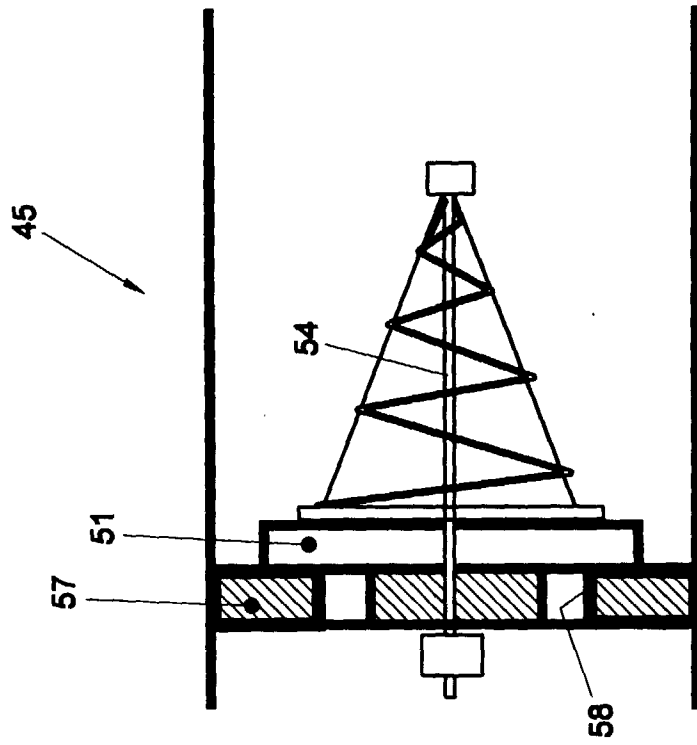


Fig. 5

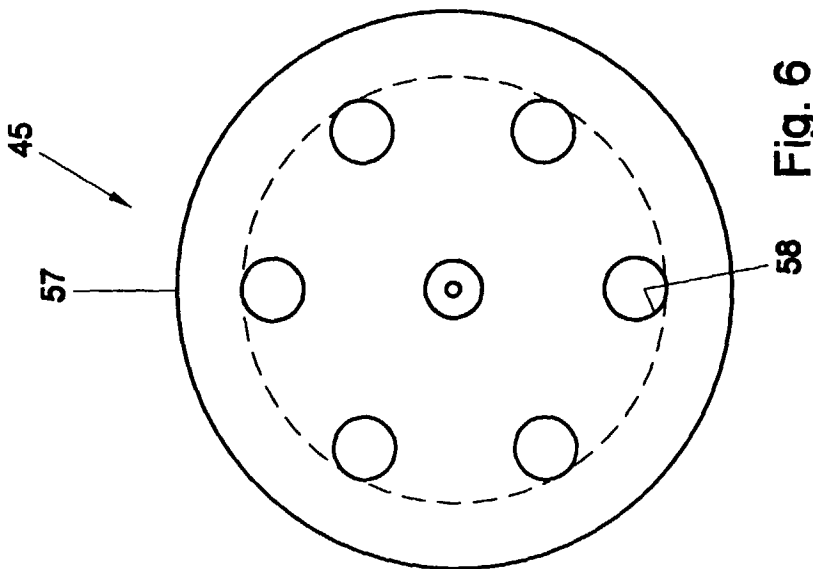


Fig. 6

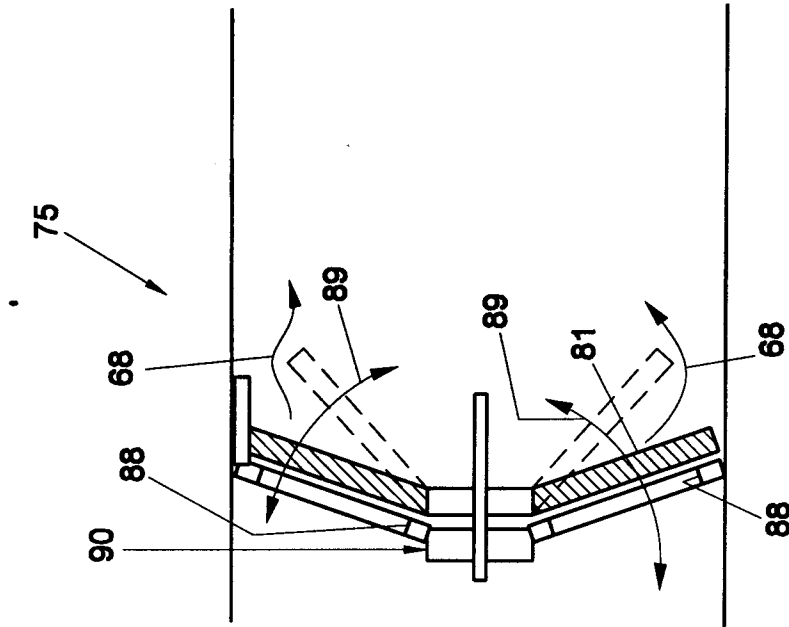


Fig. 7

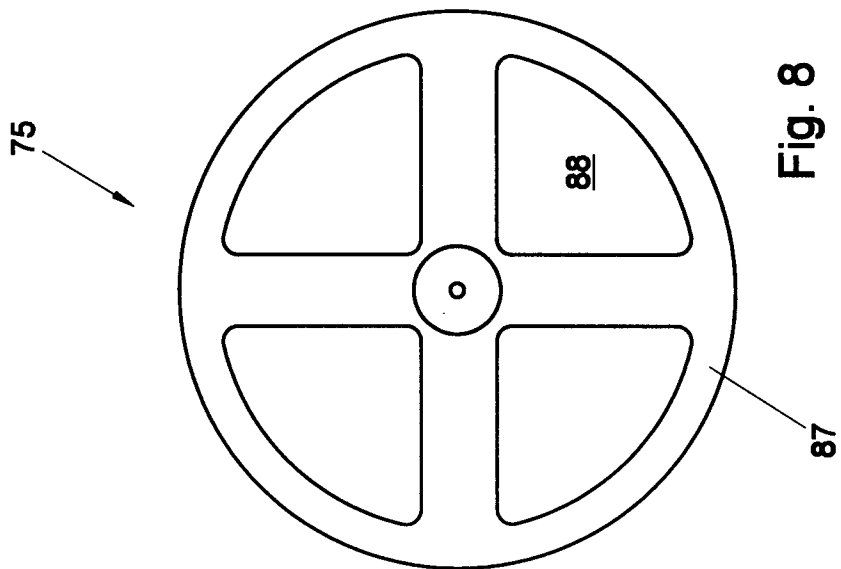


Fig. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 98 20 2331

DOCUMENTS CONSIDERED TO BE RELEVANT			
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A	EP 0 505 714 A (ROBERT BOSCH) 30 September 1992 * figures * ---	1,4,8	
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A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 432 (M-1026), 17 September 1990 & JP 02 169920 A (RINNAI CORP), 29 June 1990 * abstract; figure * -----	7	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 October 1998	Examiner Kooijman, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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