Patent:
University of Leeds (McIntosh, AC & Beheshti, N) (2006) Fire Extinguisher. WO 2007/034226 (29.03.2007 Gazette 2007/13).

WO 2007/034226 (29.03.2007 Gazette 2007/13)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 942 995 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
15.08.2012 Bulletin 2012/33

(21) Application number: **06794573.3**

(22) Date of filing: **26.09.2006**

(51) Int Cl.:
A62C 35/02 *(2006.01)*

(86) International application number:
PCT/GB2006/003568

(87) International publication number:
WO 2007/034226 (29.03.2007 Gazette 2007/13)

(54) FIRE EXTINGUISHER

FEUERLÖSCHER

EXTINCTEUR D'INCENDIE

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(30) Priority: **26.09.2005 US 720716 P**

(43) Date of publication of application:
16.07.2008 Bulletin 2008/29

(60) Divisional application:
11162137.1 / 2 343 104

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EP 1 942 995 B1

Description

BACKGROUND

[0001] The present invention relates to a extinguisher and method for extinguishing fire.

[0002] There is a need in a number of industries for mass ejection devices. That is to say, devices which will send out a spray of liquid and liquid vapour at a fixed or variable rate and over a desired distance. Preferably there is a need for a spray of liquid and liquid vapour to occur at a fast rate and over a great distance. In such systems the term "throw" is often referred to as a characteristic of a spray. The throw of material is defined as the distance travelled divided by the length of a chamber from which the spray is ejected.

[0003] Various examples of mass ejection devices are known such as fire extinguishers, ink jet printers, air bag igniters, fuel injectors for motor engines and gas turbines, etc. In each of these there are specific problems associated with the device in question, however, for each applied technology there is a continuing desire to be able to eject liquid and liquid vapour quickly and over a large distance.

[0004] By way of example of a problem specific to an application of mass ejection systems, reference is made to a gas turbine reigniter. In the igniter of a gas turbine, the conventional approach to reignite gas in a combustion chamber is to pass a current between two electrodes of a reigniter and create for a short while a mixture of electrically charged radicals. This is illustrated more clearly in Figure 1 in which a conventional reigniter 10 is shown including an outer electrode 11 which is generally cylindrical in shape with an internally located pellet 12. A central electrode 13 is located within the pellet and by passing a current between the two electrodes 11, 13 a mixture of electrically charged radicals (that is when the gas molecules split temporarily into charged components referred to as a plasma). This plasma only lasts for a fraction of a second before recombining and losing its charge. The charge is then used to ignite combustion in a main combustion chamber of the main engine. A problem with such known reigniters is in getting the mixture to be ejected as ejected material via the exit orifice 14 far enough and to remain charged long enough to perform its objective function. The ejected material 15 has been used to ignite the kerosene or other usual gas turbine engine fuel.

[0005] By way of a further example of a problem specific to an application of mass ejection systems, reference is made to a fire extinguisher. A conventional fire extinguisher, whether handheld device or fixed sprinkler system, will eject water by a high pressured water forced through a nozzle. The problem with this method for suppressing and extinguishing fires is that generally large amounts of water are required, and the large amounts of water can be very damaging to the environment in which the fire has broken out. Also there is a requirement to provide extinguishment rapidly when a decision is made. Also deployment of the extinguisher should be directed either generally or in one or more specific directions.

[0006] An example of a fire suppressing apparatus is disclosed in GB2202440/ and US 5,678,637 A1.

SUMMARY OF THE INVENTION

[0007] It is an aim of the present invention to at least mitigate the above-mentioned problems.

[0008] It is an aim of embodiments of the present invention to provide an apparatus and method for providing a fire extinguisher.

[0009] According to a first aspect of the present invention, there is provided an apparatus for extinguishing a fire as described in claim 1.

[0010] According to a second aspect of the present invention, there is provided a method for fighting fires as described in claim 13.

[0011] Preferably said means for increasing pressure comprises a heating element arranged to heat the body of liquid located in the chamber.

[0012] Preferably said inlet valve is arranged to open to allow liquid to be introduced into the chamber subsequent to the contents of the chamber previously being ejected via the opening of the exit valve.

[0013] Preferably said chamber further comprises a narrow neck region along which liquid and vapour is ejected.

[0014] Preferably the liquid and vapour are ejected via a vapour explosion process when the exit valve opens.

[0015] Preferably said liquid is water.

[0016] Preferably said exit valve is set to open at 1.1 bar pressure.

[0017] Preferably said means for increasing pressure comprises means for heating the liquid above its boiling point at atmospheric pressure.

[0018] Preferably said chamber diameter is in the range of 1 mm to 1 metre.

[0019] Preferably said chamber is spherical in shape.

[0020] Preferably said chamber is heart-shaped.

[0021] Preferably said exit valve is located at an apex region of said heart-shaped chamber.

[0022] Preferably said chamber is substantially cylindrical in shape.

[0023] Preferably the method further comprises the steps of heating liquid located in the chamber via a heating element previous to the step of opening the exit valve.

[0024] Preferably the method further comprises the steps of determining when a predetermined parameter is satisfied and opening the exit valve responsive thereto.

[0025] Preferably the method further comprises the steps of heating the liquid in the chamber to a temperature above its boiling temperature at the pressure of gas located at a downstream position from the exit valve.

[0026] Preferably the liquid and liquid vapour are ejected via a vapour explosion process.

[0027] Preferably the liquid and liquid vapour are ejected as a spray having a throw greater than 20.

[0028] Preferably said liquid and liquid vapour are ejected as a spray having a throw greater than 100.

[0029] Preferably said chamber is manufactured from a metallic material.

[0030] Preferably said means for increasing pressure comprises a heating element located within the chamber.

[0031] Preferably the apparatus further comprises a power source for the heating element.

[0032] Preferably said chamber is substantially cylindrical in shape and has a neck region at an exit end, the exit valve being located in the neck region.

[0033] Preferably a cross section of the orifice has a diameter less than a cross section of the neck region.

[0034] Preferably the method further comprises the steps of:

> heating liquid located in the chamber via a heating element previous to the step of opening the exit valve.

[0035] Preferably an ejected material directing nozzle is directed in a downstream location with respect to said exit valve for directing liquid and liquid vapour ejected from the ejection chamber in a desired direction.

[0036] Embodiments of the present invention provide an apparatus for extinguishing a fire which can either be portable or fixed, for use internally in buildings or vehicles, which, once triggered, can operate very rapidly to eject fire suppressant material at the heart of a fire. The use of spray has been found to be beneficial when fighting fires.

Also a method for fighting fines is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] Embodiments of the present invention will now be described hereinafter, by way of example only, with reference to the accompanying drawings in which:

- Figure 1 illustrates a prior art gas turbine reigniter;
- Figure 2 illustrates apparatus for ejecting material;
- Figure 3 illustrates an alternative embodiment of apparatus for ejecting material:
- Figure 4 illustrates a further alternative embodiment of apparatus for ejecting material;
- Figure 5 illustrates a combustion engine;
- Figure 6 illustrates a fuel injector:
- Figure 7 illustrates a gas turbine;
- Figure 8 illustrates a gas turbine reigniter;
- Figure 9 illustrates a pilot igniter;
- Figure 10 illustrates a propulsion system for a vehicle;
- Figure 11 illustrates combustion in a combustion chamber;
- Figure 12 illustrates an air inlet;
- Figure 13 illustrates a hand held fire extinguisher,
- Figure 14 illustrates a sprinkler type fire extinguisher;
- Figure 15 illustrates a hose type fire extinguisher;
- Figure 16 illustrates how a device can be used to deliver medicaments;
- Figure 17 illustrates an end of an endoscope;
- Figure 18 illustrates how a medicament can be delivered;
- Figure 19 illustrates how a device can be used as a portable nebulizer; and
- Figure 20 illustrates how the chambers of the various described devices may be shaped.

It is to be noted that figures 1,5-12 and 16-21 do not represent embodiments according to the invention. These figures serve, illustrative purposes only.

DETAILED DESCRIPTION

[0038] In the drawings like reference numerals refer to like parts.

[0039] Figure 2 illustrates an ejection system 20 for ejecting liquid and liquid vapour via a vapour explosion process. An ejection chamber 21 is formed in a generally cylindrical shape from a material such as steel or other rigid material which is able to withstand substantial pressure and temperature changes. . At a first end region of the chamber 21, signified by reference numeral 22, an inlet valve 23 is located so as to allow a selected liquid such as water to enter the central region 24 of the chamber via an associated inlet pipe 25. At a further end region 26 of the chamber 21 is located an exit valve 27 which opens to allow material to be ejected from the chamber region 24 through a nozzle region 28.

[0040] A heating element 29 is provided by an electric heater located in the ejection chamber. The electric heater is connected to a power source (not shown) so that when turned on the heater operates to heat up a body of liquid located in the region 24 of the chamber. It will be understood that (some of which are described hereinbelow) other ways of raising the pressure and temperature of liquid in the ejection chamber may be provided.

[0041] As shown in Figure 2, the pressure of a liquid in the central region 24 of the chamber may be increased by heating the liquid in it. Prior to this stage the exit valve 27 is closed to prevent outgress of liquid. The inlet valve 23 is opened to allow liquid water to enter the chamber until the chamber is full or contains a predetermined quantity of liquid. The inlet valve is then closed sealing the body of liquid thereby located in the chamber. The heater element then operates to heat the liquid. As a result of this the liquid expands due to thermal expansion raising the pressure of the liquid inside the chamber. Whilst the heating can be done by heating elements, it would of course be possible to have a preheated liquid supply at the inlet to the chamber under high pressure. If this technique is adopted the pressure rise in the chamber is performed by a pump (not shown) which is feeding the liquid supply into the chamber through the inlet valve. By heating the water the pressure in the chamber therefore rises. Also, the temperature rises. The exit valve is controlled so that the valve "blows" so as to open at a predefined/predetermined pressure. The pressure can be monitored by one or more pressure sensors such as pressure transducers located in the chamber or close to the chamber. The water or other liquid in the chamber is thus heated by an electrical element (much like an electric kettle) and then rises to a boiling temperature well above its boiling temperature at atmospheric pressure. The boiling point represents a saturation point and it will be appreciated that this is determined by the relationship between pressure and temperature of the particular liquid used. It is advantageous that the liquid in the ejection chamber is close to, equal to or above its saturation point at a pressure which is the pressure downstream of the exit valve of the chamber. The temperature raises above the boiling temperature at atmospheric pressure because the water is kept in the chamber by both an inlet valve which closes prior to the water being heated and an exit valve which only allows a release once the system has reached a particular pressure. At this pressure and temperature, which may be referred to as a trigger pressure and trigger temperature respectively, the valve blows in a similar way to a pressure cooker. A vapour explosion then takes place which causes a combination of liquid and liquid vapour (if the liquid is water the liquid vapour would be steam) to exit from the chamber. When the exit valve opens the steam and water mixture is ejected via the opening 28.

[0042] When the exit valve opens initially a first phase to be ejected is a liquid phase in the form of shattered liquid in a spray. This ejection occurs in a matter of microseconds subsequent to the exit valve opening. This extremely rapid ejection of liquid has particular advantages. A few microseconds later a mixture of liquid and liquid vapour is ejected. Some microseconds later a mixture containing slightly less liquid and more vapour is ejected.

[0043] However this initial liquid discharge can be altered or totally removed when higher trigger temperatures for the same ambient pressure are used. On the other hand lowering the trigger temperature can lead to situations where practically only atomised liquid is ejected. In this way the proportion of liquid and vapour can be selected by varying one or more parameters associated with the ejection chamber. Selectively varying one or more parameters such as temperature or pressure can also be used to selectively control drop size in the ejected material.

[0044] As material is ejected from the ejection chamber, the pressure drops. When the pressure has dropped back to an ambient or second predetermined pressure, which may be referred to as the closure pressure, the exit valve is closed and the inlet valve opened again to introduce new liquid material into the chamber. This restarts the cycle. Consequently a repeated cycle of steam/water mixture or other liquid/liquid vapour is exhausted from the outlet once sufficient pressure is generated by heating up the new supply of liquid water.

[0045] The size of the chamber can vary and may, for example, be less than a centimetre in diameter. For example, the chamber may even be at the nano size to mm diameter. Alternatively, the chamber may be a metre or more in diameter. It will be appreciated that as the size of the chamber increases, the frequency of the blasts will reduce since the time taken to increase the pressure will increase appropriately. It will be understood that as the size of the chamber is increased according to specific uses, larger pumps and/or valves will be required.

[0046] Preferably the, inlet valves can be controlled to maximise the proportion of liquid ejected from the chamber. This can be achieved by selecting the diameter of the inlet port to be almost equal, or equal to that of the exit or exhaust port, this should ensure that too much liquid does not get into the chamber.

[0047] Figure 3 illustrates an alternative ejection apparatus which shares many features in common with the apparatus shown in Figure 2. The apparatus illustrated in Figure 3 uses a heat exchanger 30 which encloses a side wall portion of the chamber to heat liquid in the chamber. This manner of heating liquid is particularly advantageous when the liquid ejected is not water but is a fuel which is subsequently burned. The generation of this heat at a location downstream of the exit valve can be used to heat the heat exchangers and thus heat the liquid in the chamber.

[0048] To enable faster refilling of liquid in the chamber, a return port and valve can be added to the chamber as shown in Figure 4. The return port and valve 401 allow for some of the liquid and vapour in the chamber 402 to return to the reservoir 403 when the inlet valve 404 is opened for replenishment. The addition of the return port and valve 401 should help enable sufficient fresh liquid to be added to the chamber 402 to compensate for the ejected mass and therefore avoid lack of liquid in the chamber 402 after consecutive ejections. In the case of usage of pipelines (such as with fire fighting sprinklers) as a reservoir the return port 406 connected to the return valve 401 may be connected to a different pipeline at a lower pressure than the supply pipeline 403 and preferably be at ambient pressure.

[0049] A chamber can be used having an internal diameter of 25mm and a length of 32mm. Two or more separate heaters could be inserted into the chamber. The first, a helical coil located near the walls of the chamber with length of 28mm, external diameter of 21 mm, internal diameter of 15mm and power of 500W. The second, a cartridge heater located near the centre of the chamber with length of 25mm, diameter of 1 cm and power of 200W. With these specifications, repetitive steam/water spray ejections of up to 5Hz is possible. Higher frequencies would lead to a pure liquid un-atomised jet since the cold water fed to the chamber for refill after each blast does not have enough time to be heated by this heat power to above the boiling point. The reservoir can therefore be kept at a higher temperature, for example about

75°C to shorten the heat up in the chamber between ejections, and consequently allowing for an increase in the frequency of ejections.

[0050] Figure 5 illustrates a fuel injector unit 50. A combustion engine 51 is illustrated in an intake stage (shown in Figure 5A) and an exhaust phase (illustrated in Figure 5B). The combustion engine includes a cylindrical combustion chamber 52 closed at a first end by a tight-fitting piston 53 which is arranged to slide within the chamber. The movement of the piston varies the volume in the chamber 52 between the closed end of the chamber 54 and a combustion surface 55 of the piston. An opposed side of the piston connects to a crank shaft 56 via a piston rod 57. The crank shaft transforms the reciprocating motion of the piston into rotary motion.

[0051] The combustion engine illustrated in Figure 5 is a four stroke internal combustion engine, however, it will be understood that they are not restricted to use of fuel injectors with such types of engine. Rather a four stroke internal combustion engine is referred to here by way of example only. On the first downward stroke of the piston, fuel is injected via the fuel ejector 50 into the combustion chamber 52.

[0052] Prior art fuel injectors use electro-mechanical nozzles and a pre-pressurised fuel to produce a finely atomised spray. Fuel is pressurised within a chamber and an electromagnetic coil lifts a needle of its seal so fuel can squeeze through the nozzle's aperture through an intake valve. Control of the timings of the release of this pressurised liquid is controlled by electronics. This has the disadvantage of costly and complex materials which are prone to error and require many working parts. We overcome this by replacing the known fuel injector systems with an ejection chamber 50 which ejects liquid fuel and liquid fuel vapour into the combustion chamber 52 via a vapour explosion process as noted above. The vaporized fuel and liquid fuel is ignited via an ignition element such as a spark plug 58.

[0053] A fuel injector system is shown in more detail in Figure 6. The fuel injector 50 comprises an ejection chamber 21 defining a space 24 within which liquid fuel can be input via an inlet valve 23. A return port and valve may be incorporated thus enabling for faster refilling of liquid within the chamber. It will be understood that such a return port and valve could be used in any system described herein. A heating element 29 is used to heat a body of liquid located inside the ejection chamber subsequent to its introduction through the inlet valve. An exit valve 27 constrains the liquid within the chamber until a predetermined pressure is reached. This pressure is greater than atmospheric pressure or the pressure experienced by ejected material downstream (that is to say to the lefthand side shown in Figure 6). In this way liquid in the chamber can be heated above the boiling point temperature which will be experienced when the exit valve is opened. When the exit valve is thus opened the pressure will drop thus causing the liquid in the ejection chamber to boil rapidly and in an explosive manner due to its elevated temperature above its natural boiling point. It will be noted that for certain fluids, for example, for kerosene and gasoline, the fluids are themselves multi-component fuels which include different hydrocarbons. Each of these has a different boiling point. For gasoline, for example, the boiling points range from 117°C (for the most volatile component) to 200°C for the heaviest component and for kerosene the boiling points range from 150°C to 300°C. In order to have optimum performance it is preferable that the temperature should be kept above the higher boiling point to make sure that all components are going to vaporize. This is, of course, not necessary. For example, where one knows which component has the dominant concentration, then that components boiling point may be used to fix the temperature ensuring that the rest of the fuel will boil. It will be appreciated that at higher temperatures for the same given pressure the spray will be finer and a proportion of vapour of the ejected material will be greater. It will be appreciated that the temperatures given here are examples of the corresponding boiling (saturation) points at atmospheric pressure. These will be very different at elevated pressures and reference may be made to known databases of thermophysical properties of materials to obtain working pressures. A nozzle 60 provides a narrowing of a neck region 28 and ejected liquid and liquid vapour are ejected through an opening 61 into the combustion chamber 52 of the combustion engine.

[0054] The heat required to bring the fuel to the designated temperature can be partially or totally obtained from the heat produced by the engine. Since the injector can be located within or near the combustion-chamber of the engine which when in operation will be very hot, the vapour explosion chamber can be designed in a way that it absorbs as much heat as is needed from the engine. This heat or thermal energy can be obtained through the chamber walls of the injector, through a heat exchanger going into the chamber, or a combination of the two techniques. Additionally, the inlet fuel pipe can go through, or be adjacent to, the hot parts of the engine body to heat up the fuel nearer to the designated temperature. However, it is preferable to keep this temperature below the saturation temperature of the lightest component of the fuel to avoid unfavourable cavitations in the pipeline.

[0055] An advantage of applying the above-described vapour explosion technology to fuel injection systems is to greatly enhance the throw of the devices and consequently the response of the engines to an increased power output. For an average sized family car, according to known prior art techniques, a normal operating range is 2,000-6,000 rpm with a Formula I car attaining perhaps 17,000 rpm. In accordance with the above-described vapour explosion technology, a time taken for one cycle of a fuel injector which comprises a short ejection phase, followed by a longer refilling and repressurising phase, can be around 5 milliseconds or less. The rate of fuel injection is thus around 12,000 injections per minute. In a common four stroke engine there are typically two revolutions per injection and therefore 24,000 rpm could, in theory, be achieved. In order to avoid disintegration of the engine, some form of limiting constraint may therefore be utilised to slow down the ejection process. The process of ejecting fuel from the chamber of the injector can be controlled by selecting a parameter or multiple parameters of the ejection process, such as the period of time that the exhaust valve is open for, the temperature and pressure of the fuel injection chamber, and the pressure of the combustion chamber of the engine. It will be appreciated that other parameters may be controlled to provide desired results.

[0056] Further advantages of applying the vapour explosion technology for the purpose of fuel injection include:

1. A considerable fraction of the fuel spray volume will be taken by the fuel vapour immediately after emerging from the nozzle. This promotes the ignition and burning rate of fuel and thus provides higher acceleration of the engine.

2. The fuel spray can easily have smaller drop sizes in comparison to most conventional atomisers. This enhances ignition and burning velocity which in turn enhance the acceleration of the engine. Smaller droplets also lead to more complete combustion, fewer amounts of pollutants and better fuel economy.

3. Use of vapour explosion can greatly enhance the 'throw' of these devices, and consequently the response of the engines to an increased power output.

4. Work can be carried out at much lower pressures than conventional atomisers since a high fraction of the volume inside the nozzle is fuel vapour and due to vapours lower density lower pressures can be used to make the fuel move at the same ejection velocities. These lower pressure ejections are practically achieved by making use of the high ratio of thermal energy to mechanical energy in atomising the liquid. This in turn can enhance the engine efficiency since the thermal energy in most cases is readily available from the combustion itself and is usually taken away as a loss by the cooling system and this could have lower energy losses compared to purely mechanical energy usage.

5. Very wide angles for the spray can be utilised even with very simple nozzle designs, such as plain orifices. Wide angle spray is very favourable in most combustion systems as it can give better mixing with air and higher burning rates.

6. The pressure build-up in the atomiser can be produced either solely by the thermal expansion of the fuel or by a combination of this with the supply pressure of a fuel pump. Thus, even less mechanical energy is needed.

[0057] Figure 7 illustrates a gas turbine reigniter. Figure 7 illustrates a gas turbine 70 comprising three main sections. These are the compressor 71, combustor 72 and turbine 73. Outside air is drawn into the engine by the action of the compressor. The air is mechanically compressed by the motion of the compressor blades consequently the pressure and temperature of the air increases with the corresponding decrease in volume. The mechanical energy used to compress the air is thus converted into kinetic energy in the form of compressed air. The compressed air is then forced through into the combustion section into which fuel is injected via a fuel injector 74. The fuel injector may be of a conventional type or may be of a type previously described hereinabove. A fuel reigniter 75 is then used to ignite the fuel converting the chemical energy into thermal energy in the form of hot expanding gas. Fuel is repeatedly injected into the combustion section to ensure continuous combustion. Rather than repeated injection, fuel may be constantly injected. Volume of gas and temperature increase while the pressure remains substantially constant through the combustor chamber 66. The hot expanding gas's thermal energy is converted to mechanical energy as the turbine 73 is rotated by virtue of the gas acting on fins 77 of the turbines. Hot exhaust gas then exits out via a front end 78 of the gas turbine. The output turbine is connected to the compressor blade thus helping to power the compression of air.

[0058] As noted above, known reignition devices (for example as shown in Figure 1) include complex plasma arrangements to reignite material in the combustion chambers 76 of gas turbines. It will be appreciated that the combustion chamber may contain many fuel injectors distributed throughout the chamber in an advantageous manner and one or more fuel reigniters may be provided to reignite fuel injected by each of the injectors. Alternatively, it will be understood that the locations of the fuel injectors may be carefully designed so that less than one reigniter is required per injector. Gas turbines have many applications such as jet engines in the aerospace/nautical industries, engines for land vehicles, as well as electrical power generation using land based gas turbines. Some land based gas turbines can use igniter technology to help the turbine run at low Nitrogen Oxide (NOx) conditions, This helps stability of combustion within the turbine.

[0059] Figure 8 illustrates a gas turbine reigniter 80 in more detail. An outer electrode 81 which is substantially cylindrical in shape forms a side wall for an ejection chamber. At a first end region 82 an inlet of liquid fuel enters via an inlet valve 83. Input fuel enters a central chamber region 84. The input fuel flows through a hole in an inner electrode 85. It is worth noting that as with other systems hereindescribed a return port and valve could be incorporated within this system to enable faster refilling of liquid to the chamber. At a further end 86 of the ejection chamber, an exit valve 87 is located which prevents outgress of the input liquid fuel. When the exit valve 87 is opened liquid and liquid vapour are ejected via a nozzle 88. A central semi-conductor pellet separates the outer and inner electrodes. This element 89 is used to create charged particles to heat the liquid fuel in the chamber. As one or more pressure sensors detect the pressure in the chamber reaching a predetermined value, a current is passed through.

[0060] The reignition device is advantageous over conventional reignition devices as a long flame is produced as a short sharp burst rather than a short flame produced continually, the latter being wasteful and less effective. Furthermore, the very fine drops and the high fuel vapour content in the spray makes it easier to ignite and keep the flame on.

[0061] Figure 9 illustrates an application of the vapour explosion technology in which a pilot flame igniter is provided. In this sense Figure 9 illustrates a pilot flame ignition ejection system 90. Flame ignition systems are required for many applications such as in boilers or furnaces or domestic appliances, or domestic gas applications. Prior art ignition systems generally consist of an electronic circuit that produces a spark which consequently lights the fuel. The pilot flame igniter 90 includes a fuel chamber for storing a body of liquid introduced through an inlet valve 23. A heating element such as electric heater 29 heats the fluid as above-described which is allowed to exit the exit valve 27 when a predetermined threshold pressure is reached within the chamber. Liquid fuel and liquid fuel vapour is ejected through a nozzle 91 repeatedly as repeated vapour explosion processes take place rapidly. By virtue of the vapour explosion the fuel vapour and liquid fuel is discharged with a large throw, that is to say, over a large distance away from the nozzle 91. This may be ignited initially by an ignition element (not shown) so that a flame 92 is constantly provided to light further ignitable material. It will be appreciated that the ejection system 90 for the pilot flame provides a repeating ejection process. During an initial stage immediately after opening of the exit valve, ejected material is substantially in the form of a shattered liquid. Subsequent to this, by some tens of microseconds, the ejected material is a mix of liquid and liquid vapour. Still later the ejected material is predominantly vapour. When the exit valve closes so as to allow recharging of the ejection chamber the flame will be unanchored. The dead time caused by the closing of the exit valve is selected so as to be long enough to enable refuelling of the ejection chamber but not so long that the flame bums all fuel and dies. The result will be a pilot igniter having a flame which may perceptively dance up and down but which will not be extinguished.

[0062] Figure 10 illustrates a sysem in which an ejection chamber 10 is used to propel a vehicle 10. The vehicle 10 is shown as an unmanned aerial vehicle (UAV). Such vehicles are remotely piloted or self-piloted aircrafts that can carry cameras, sensors, communications equipment or other loads. It will be appreciated that these systems can be used to propel other types of vehicle. The UAV includes a vehicle body 10 which includes two wing sections 10 which provide lift for the vehicle. Propulsion is provided by burning liquid fuel and fuel vapour ejected from the ejection chamber system 10 in a combustion chamber 10. There are many types of UAV. Some are the size of a small plane and fly at high altitudes capable of recording and relaying large amounts of information back to a base station. Some vehicles are light enough to be carried by a single human and launched by hand. Micro air vehicles are those vehicles defined as having no dimension larger than 15 cms (6 inches). Such systems are also applicable to micro air vehicles or smaller.

[0063] The mass ejection chamber 10 ejects liquid fuel and liquid fuel vapour from a nozzle 10 as described hereinabove. Air is drawn into an air intake 96 and passes down inlet passages 10 where the air mixes with the fuel which is ignited by an ignition element 10, such as a spark igniter. The combustion chamber 10 constrains the combustion process and includes at least one exit orifice 10 through which burnt combustion gases and flame can escape. Propulsion is achieved by the expanding hot exhaust gases. The vapour explosion chamber 10 is of a small size so that the overall dimension of the device may be of the order of 5-10 cms in length.

[0064] Solar panels 1100 are provided to provide an energy source for the heating element and control of the igniter element 10 if required. Alternatively, an onboard light weight battery may provide the power source. As a further alternative, continuous heat exchange from the exhaust gases can provide the energy to heat inlet fuel.

[0065] Figure 11. illustrates a cycle in the vapour explosion chamber as shown in Figure 10. In this example the vapour explosion chamber 10 and combustion chamber are 330 microns and 370 microns in diameter and 300 microns and 700 microns in length respectively. A hydrocarbon liquid fuel is vaporized in the vapour explosion chamber and the vapour is ejected from the chamber through a nozzle to the combustion chamber where it mixes with air. The air is introduced through a further inlet as shown more clearly in Figure 12. Via an ignition device, which may be heat or flame from a preceding cycle (as shown) or a separate igniter element such as a spark igniter, the combustion is triggered and within some microseconds a flame is filling the combustion chamber. In these figures the colour/shade contours of temperature are given at different times showing the development of a flame and corresponding temperature changes over time. Since the pressure relief exit valve has to be closed for some milliseconds between each cycle for fuel replenishment in order to keep a stable flame in the combustion chamber, it is preferable to use more than one and most preferably between 3 and 10 vapour explosion devices to eject fuel into the combustion chamber. The vapour explosion devices are positioned in a way that they inject at an identical or close to identical point in space and in the same direction but having equal or otherwise selected time delays with respect to each other in the beginning of their injection times.

[0066] Figure 13 illustrates an ejection system 1300 for ejecting fire suppressing liquid and fire suppressing liquid vapour via a vapour explosion process in accordance with an embodiment of the present invention. An ejection chamber 1301 is formed in a neck region 1302 of the fire extinguisher 1300. A fluid reservoir 1303 contains a large quantity of liquid fuel suppressant such as water. A handle 1304 is used to activate the fire extinguisher by a user when the existence of a fire is determined. Activation of the handle initiates a control unit 1305 to produce drive units for controlling opening and closing of an inlet valve 1306 and outlet valve 1307. A return port and valve could also be incorporated within this system to enable faster refilling of liquid to the chamber. Liquid and liquid vapour are ejected from the chamber 1301 in the direction shown by arrow A in Figure 13. Drive signals from the control box 1305 are also used to control a power source 1308 which controls an electric heater in the chamber 1301. The heater can be used to increase the pressure of liquid in the ejection chamber 1301 as described hereinabove. The liquid reservoir 1303 is also pressurised so that liquid is rapidly replenished in the chamber. The pressure can be so great as to increase the pressure of the liquid in the ejection chamber above atmospheric pressure.

[0067] Figure 14 and Figure 15 illustrate two further embodiments of the present invention in which the vapour explosion device is used for ejecting fire suppressing liquid and fire suppressing vapour. Figure 14 shows a vapour explosion device embodied as a steam sprinkler type fire extinguisher. In practice one or more vapour explosion device based fire suppressing/extinguishing sprinklers are fixed within a building and triggered by a fire detection system. A central fire detection system may be used for all sprinklers in the building or each sprinkler could have an individual sensor to allow fire suppressant to only be released at the location at which the fire is present. The system may be zoned. When a fire is detected and the extinguishing liquid is water, the sprinklers eject steam and a mist of water droplets into the environment in repetitive pulses at a specific predetermined frequency value; this could be between 0.5-5Hz or even higher depending upon the design and specific application. As shown in figure 14, a sprinkler consists of a reservoir 1401, a vapour explosion chamber 1402 in accordance with the chambers outlined previously, and optionally a small pump to apply pressure to the fire suppressing liquid to help the chambers refill quickly enough for the required frequency of blasts. A single reservoir could connect to all or a specific group of sprinklers within the environment in which the sprinkler or sprinklers are located. Furthermore, such a reservoir could be a pressurised water pipe possibly alleviating the need for a pump for each sprinkler.

[0068] Figure 15 shows a system for ejecting fire suppressing liquid. In this embodiment the vapour explosion device is used within a hose type extinguisher. The vapour explosion chamber 1501 is fitted at the tip of a hose pipe 1502. The hose pipe 1502 acts as a pressured reservoir, and provides the fire suppressing liquid to the vapour explosion chamber 1501 which blasts steam out repetitively. Power can be supplied to the vapour explosion device either by a battery attached to the vapour explosion device or a power line connection which may be attached along the hose in parallel.

[0069] In all three embodiments of the present invention which are disclosed as an apparatus for extinguishing a fire , the fire suppressing liquid may be water or it may be any other suitable liquid for suppressing fire.

[0070] The vapour explosion device can be advantageous in many ways over conventional water based fire suppressing devices. Firstly, vapour has a much larger surface area than the equivalent amount of water, vapour is therefore able to absorb much more heat and therefore suppress the fire better. Furthermore the vapour may engulf the fire like a mist, restricting oxygen flow to the fire and therefore suppressing the fire further. In contrast water would flow straight over the fire, only restricting oxygen flow for a very short period of time. A further advantage is that suppressing or extinguishing a fire with water vapour produced by the vapour explosion device rather than water requires the use of far less water. Using less water is not just advantageous economically and environmentally but it also means that the process of extinguishing a fire will cause less damage to the environment in which the fire has broken out.

[0071] Figure 16 illustrates how the vapour explosion technology can be applied to provide a medical drug delivery apparatus and method or apparatus and method for clearing a blockage in a patient. Figure 16 illustrates an endoscope 1600 which has a flexible and manoeuvrable shaft 1601 which may be located in an intestinal track or respiratory system or cardiovascular system portion of a human body. A distal end region 1602 of the flexible shaft 1601 includes a flexible tip 1603. The tip allows an end stop device 1700 (shown more clearly in Figure 17) to be manoeuvred with respect to a patient's body and allows the end of the shaft to be positioned by a surgeon. A proximal end 1604 of the shaft 1601 terminates in an endoscope body portion 1605 which includes an eye piece 1606 and openings 1607 for auxiliary equipment. A further cable 1608 connects the endoscope body 1605 to an input connection 1609 which supplies any required light, air, water or other needed utility to the endoscope.

[0072] As shown more clearly in Figure 17, the end of the endoscope 1700 includes a light 1701 for illuminating a region surrounding the end of the endoscope for a surgeon and a camera 1702 for providing visual images of the region of the patient. The signals from the camera 1702 may be provided to the eye piece 1606 or outputting signals via the connection 1609 or via an opening 1607 so that images are displayed on a display, such as an LCD screen.

[0073] The end 1700 of the endoscope 1600 also includes a medicament delivery chamber 1800 as seen more clearly in Figure 18. Power and control signals are supplied to the medicament delivery chamber 1800 via controller 1703. The liquid vapour material ejected from the chamber 1801 may be used according to a number of methodologies. In one of these, the endoscope may be manoeuvred to a location where medicament is to be dispensed at a particular location. Liquid may then be input into the chamber 1801 (or may already be so inserted) by opening inlet valve 1802 and then a heater unit 1803 energised to raise the temperature and pressure of the liquid medicament. The medicament can then be dispensed when the pressure and/or temperature reaches a predetermined value ejecting vaporised medicament and liquid medicament at a desired location. As with all of the above-described systems, the ejection cycle may be repeated many times if desired.

[0074] As an alternative, the liquid and liquid vapour ejected material can be used to clear a blockage in arteries and/or veins or the like. In this sense devices can be used in the bloodstream at blockages (such as in restricted blood flow disease due to furring of the arteries). In this case a water based or other neutral solution ejected by the above-mentioned techniques may be applied longitudinally along the line of a blocked vein/artery to thereby unblock the blockage. This is in addition to or replaces the present methodology which uses an expanding tube/balloon to clear the offending passage.

[0075] According to Figure 16, a camera operated by a doctor is attached to a nano vapour explosion device and used to put a drug in exactly the right spot where a malfunction has taken place. Devices are not restricted to intestinal use but rather could be used also in a respiratory system of the main tracheal tubes and in the blood environment may have applications in the cardiovascular system.

[0076] Although the systems described with respect to Figures 16 to 18 have been described relating to the use of endoscope-like devices, they are not so restricted. Rather, they can be used to deliver drugs at the desired locations by introducing a device in the form of a pill-like device which then moves on its own, for example through the bloodstream or the intestinal track and which is tracked by X-ray machinery with a dye and a scanning system so that an operator sees on the screen where the device has got to. A wireless signal may be then transmitted to the device in the human body when a doctor determines that the device is at a desired location. The device would then eject drug or merely liquid to either deliver medicament or open a blocked passage at a desired location.

[0077] A further application of a vapour explosion device is as part of a respiratory drug delivery system. Respiratory drug delivery systems are used to deliver drugs directly to the respiratory system to treat numerous respiratory diseases such as asthma, cystic fibrosis, and chronic obstructive pulmonary disease (COPD). Additionally, in recent times it has been realised that the lungs can be used as a portal of entry for systematic drug therapy, for example, inhaled insulin has been successfully administered and is likely to become an alternative routine treatment to injecting insulin in the therapy of diabetes.

[0078] There are three main types of respiratory drug delivery systems, metered dose inhalers, dry powder inhalers and nebulizers. Pressurised metered dose inhalers release a metered volume or specific value of pressurised fluid into a patient's airways. On release the fluid evaporates rapidly leaving the drug in dry form suitable for inhalation. Dry powder inhalers contain a dry powder which is dislodged when the patient inhales air through the inhaler, the force of the inhalation then carries the dry powder into the patient's lungs. Both metered dose inhalers and dry powder inhalers will give out a predetermined amount of drug in one inhalation, the patient will take a certain amount of these doses during a day. A third type of respiratory drug delivery system is the nebulizer which converts medicine stored in liquid form into a gaseous suspension of medicine particles, such as an aerosol or mist. The patient will breathe in this mist and the drug is delivered into the respiratory system. There are two main types of nebulizer, jet nebulizers and ultrasonic nebulizers. Jet nebulizers work by applying pressurised gas through a narrow opening which creates a negative pressure upon a medicine reservoir, which draws particles of the drug solution from its reservoir forming a mist for the patient to inhale. Ultrasonic nebulizers use a rapidly vibrating piezoelectric crystal which forms a fountain of liquid from which the mist rises. Nebulizers slowly convert the liquid medicine into a mist over a period of about 15 minutes, during which time the user will be continually inhaling the medicine in mist form. Nebulizers deliver much stronger doses of medicine and are therefore usually used for patients with severe respiratory problems.

[0079] A vapour explosion device may take liquid from a reservoir and output a vapour mist. The reservoir contains a medicine and thus medicine can be administered in the form of mist suitable for inhalation. The explosion device emits vapour (or mist) in short sharp bursts, the volume of vapour released corresponding to the amount of liquid put into the vapour explosion chamber. Therefore, the device can be used to administer single units of medicine in a vapour form similar to a metered dose inhaler. A further feature is that it can continually emit bursts of vapour in very quick succession. Therefore devices can be used to administer medicine continually for a set period of time like a nebulizer. Furthermore, as the vapour explosion device can perform the function of both these types of respiratory drug delivery, a multi-functional system capable of delivering both single units of medicine vapour and continual bursts of medicine vapour may be provided.

[0080] A vapour explosion device based respiratory drug delivery system is advantageous over prior art respiratory drug delivery systems in that it has a very long throw, a wide angle spray and the spray it creates has a very small drop size. The long throw and wide angle spray allows for the medicine to get further into the respiratory system and it is well spread out therefore more likely to be better carried by a patients inhalation. Furthermore, the small drop size provides better absorption of the medicine by the respiratory system. Drop sizes of 1-5μm are ideal as larger ones often deposit proximal to the airways, while smaller particles have poor deposition and are largely exhaled.

[0081] Figure 19 illustrates how a vapour explosion device could be embodied as a portable nebulizer. The portable nebulizer comprises a vapour explosion chamber, with inlet valve 1902, exhaust valve 1903 and optional return valve 1904. The chamber is heated via a heating element powered by a battery 1905 or other such power source, and supplied with suitable fluid via a medicine reservoir 1906. The portable nebulizer could also be powered by a mains power supply as well as or instead of a battery. The reservoir 1906 can have a fixed amount of liquid within it, a spring 1907 and moving piston 1908 can be used to apply pressure to the reservoir 1906 to enable fast refill of the vapour explosion chamber 1901. Alternatively, medicine can be stored in a pre-pressurised storage device which may be detachable from the nebulizer, allowing for easy replenishment of medicine by replacement of the storage device. The liquid within the reservoir may be pure medicine or medicine suspended within a carrier liquid. A user control interface 1911 allows the user to control the nebulizer, a control circuit 1910 may then process input signals from the user control interface and control the nebulizer responsively.

[0082] The process of vaporising the medicine in accordance with the portable nebulizer of Figure 19 starts by passing medicine from the medicine reservoir 1906 through the inlet valve 1902, filling up the chamber 1901. When a predetermined amount of medicine is within the chamber, all valves will be closed and the heater will heat up the chamber until a trigger temperature and pressure are reached to enable the exhaust valve to open. The exhaust valve then opens and a vapour or mist is emitted along mouthpiece 1909. The distance between the outlet valve 1903 and the end of the mouthpiece is made sufficiently long for the mist to cool before it reaches the end of the mouthpiece and the patient then inhales the drug. This ejection process would then be repeated at a specific frequency, either for a predetermined period of time or until a predetermined amount of medicine has been vaporised. The size of the chamber 1901 or the amount of liquid put into the chamber will correlate to the amount of liquid required to be emitted by each burst of spray.

[0083] Figure 20 shows a desktop nebulizer which comprises three main constituent parts, a nebulizer main body 2001, a vapour explosion device 2002 and a medicine transportation pipe 2003 which connects the first two constituent parts together. The nebulizer main body includes a medicine reservoir 2004 which can contain a heating element 2005 to keep the medicine at a temperature close to but below a temperature required by the vapour explosion device, the heating element is powered by a power source 2006. The reservoir has a reservoir inlet to allow for refilling of medicine to the reservoir, and a reservoir pump 2008 to pump medicine out of the reservoir. The pump provides pressurised medicine to the medicine transportation pipe 2003 to enable fast refilling of the vapour explosion device. The vapour explosion device as shown in Figure 20 works in accordance with previous vapour explosion devices, with inlet valve 2009, exhaust valve 2010, vapour explosion chamber 2011, heater 2012 and heater power source 2013, with medicine being released in vapour form from a mouthpiece 2014. A return port and valve could be incorporated within the present device to help refill the chamber faster. A user control interface can be mounted on the nebulizer main body 2001 to allow for the user to control the nebulizer. A control circuit 2016 is shown within the nebulizer main body for the purpose of processing input signals from the user control interface 2015 and controlling the nebulizer responsively. A control line 2017 can be placed parallel to the medicine transportation pipe 2003 to connect the control circuit 2016 to the vapour explosion device. It is worth noting that the heater power source 2013 could be a battery or mains power supply supplied via a power line from the nebulizer main body.

[0084] Figure 20 shows the medicine reservoir 2004 as a refillable reservoir. In this system the amount of medicine required by the patient could be placed in the reservoir and then the nebulizer could run until all has been ejected. Alternatively the reservoir could be filled to the maximum and then the nebulizer could emit a predetermined amount of medicine. It should be understood that a refillable reservoir is not necessary and a pre-packed container of medicine could alternatively be used. Furthermore, a pressurised container could be used, thus not requiring a pump.

[0085] Figure 21 shows a metered dose inhaler. This shows a vapour explosion chamber 2101 which receives medicine from a medicine reservoir 2102 through an inlet valve 2103. The amount of medicine within the vapour explosion chamber corresponds to the dose required by the user. When a user presses the control button 2104, a control circuit 2105 controls a heating element 2106 along with the inlet valve 2103 and exhaust valve 2107 to emit medicine in vapour form through the mouthpiece 2108 for the user to inhale. The heating element 2106 is powered by a power source 2109 which may be a battery or a connection to a mains power supply. The medicine reservoir 2102 in Figure 21 is shown as a pressurised container for providing pressurised liquid to the inlet valve 2103 to enable fast refilling of the vapour explosion chamber 2101. It is should be understood that refillable medicine reservoirs could alternatively be used, as could unpressurised containers. A return port is not shown in Figure 21 but could also be incorporated.

[0086] It will be appreciated that devices may also be utilised to provide a needleless injector.

[0087] In all applications of a vapour explosion device used as part of a respiratory drug delivery system the patient can receive the drug either through a mouth piece which would sit inside the mouth or a face mask which would sit on the face over the mouth and/or nose. The medicine could also be delivered directly into any other part of a patient's respiratory system.

[0088] For all respiratory drug delivery applications the trigger temperature for the chamber 1901 needs to be above the boiling point of the liquid or liquids within the chamber to ensure maximum explosion of liquid from the chamber. The trigger temperature is recommended to be approximately 20-30°C above the boiling point of the liquid within the chamber with the highest boiling point to ensure that a very fine spray best suited to this application is produced. The trigger pressure can be as low as 4-6 bars although the device would work at other pressures. The diameter of the exhaust nozzle may be best suited to this application if within the range of 0.05-0.5mm.

[0089] To maximise the delivery of medicine and minimise the waste of medicine in a vapour explosion device based nebulizer a breath actuated delivery system could be incorporated in which an electronic detection system or mechanical valve system is used to determine when the user is inhaling, and then only emit medicine when the user inhales so that medicine is not wasted during exhalation. Such functionality can be achieved manually but many people find it difficult to coordinate their breathing with the switching of the nebulizer. It is worth noting that, such sensing could also be used in a metered dose system, as people often find it difficult coordinating the ejection of medicine with inhalation.

[0090] It will be appreciated that the heating element by which liquid is raised above its saturation point in the ejection chamber may be chemical in nature. That is to say two components may be provided which, when combined, provide an exothermic reaction generating sufficient quantity of heat so as to 'boil' the liquid. A user would activate the two components just before use and then wait until discharge was ready. This could be identified in a number of ways such as a user display illuminating or making a noise. material being visibly ejected or a predetermined time elapsing.

[0091] Although devices described with respect to Figures 19 to 21 have been described relating to particular respiratory drug delivery systems, they are not so restricted.

[0092] Figure 22 illustrates a liquid and liquid vapour explosion chamber 2200 which may be utilised according to any of the above-described systems. It will be understood that devices are not restricted to use with substantially cylindrical shaped ejection chambers. Rather, unusual shapes or spherical shapes or, as in the case of Figure 22, heart-shaped chambers having an inlet valve 2201, exit valve 2202 and heater element 2203 may be utilised.

[0093] Embodiments of the present invention provide fundamental core technology relating to the use of an ejection chamber which ejects target matter via a vapour explosion process. By ejecting material via an explosive process the distance traversed by the spray of liquid and liquid vapour is greatly increased relative to known ejection systems. Also ejection occurs very rapidly and with a small chamber in the order of tens of microseconds.

[0094] According to embodiments of the present invention, pressure in a chamber is increased by heating liquid in it. The liquid expands due to thermal expansion and therefore provides a higher pressure. Heating is achieved by electrical heating element or by other means such as via heat exchangers transferring heat from a local heat source into the liquid. All of the embodiments of the present invention described above can be modified so that instead of heating liquid in an ejection chamber, pre-heated liquid is supplied at an inlet to the chamber under high pressure. Pressure would be built up in the chamber by continuing to pump pre-heated liquid into the chamber. This could be achieved via an external pump able to pump at high pressure. At some predetermined pressure value above a pressure into which ejected material is to be ejected, the inlet valve would be closed and an exit valve opened. The instantaneous reduction in pressure would be calculated to instigate a vaporization process of the liquid by virtue of its elevated temperature with respect to its boiling temperature. Liquid and vapour would thus literally explode from the exit valve of the chamber.

[0095] In the case of using water as a working liquid, velocities of up to 20 metres per second from a chamber just under 1 mm in size with a chamber pressure of 1.1 bar and injecting into ambient for example atmospheric pressure (1.0 bar) can be achieved. In the case of a hydrocarbon liquid fuel being used, velocities of up to 100 metres per second can be achieved from a chamber about 2 cms in size and under a pressure of 10 bar injecting into a combustion chamber at 6 bar (in other words a 1 bar pressure difference between the ejection chamber and an adjacent combustion chamber).

[0096] Inlet and exit valves are electronically controlled based on the pressure in the various vessels which is monitored/measured via one or more sensors such as pressure transducers. When a certain pressure in the vessel is reached, the exit valve will open and when it falls below a second certain value the valve is closed. For the inlet valve this can either be opened and closed when certain higher limit and lower limit pressures are reached in the chamber or could open and close in a reverse fashion with respect to the exit valve. That is to say, when the exit valve is opened the inlet valve would be controlled to close and when the exit valve closes the inlet valve would open.

[0097] Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", means "including but not limited to", and is not intended to (and does not) exclude other moieties, additives, components, integers or steps.

[0098] Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0099] Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith.

Claims

1. Apparatus for extinguishing a fire, comprising:

an ejection chamber (1301) to hold a portion of a selected extinguishing liquid;
an inlet valve (1306) arranged to selectively open to transfer extinguishing liquid into said ejection chamber (1301).
an exit valve (1307) arranged to selectively open to eject extinguishing liquid from the ejection chamber (1301).
means for increasing the pressure of the extinguishing liquid in said ejection chamber (1301),
characterised in that
a controller (1305) electronically controls the inlet and exit valves (1306,1307) based on the pressure

in said ejection chamber (1301), said pressure being monitored by one or more pressure or temperature sensor, wherein the controller (1305) is arranged to open the exit valve (1307) when a predetermined first pressure in the ejection chamber reached and to dose the exit valve (1307) when the pressure in the ejection chamber (1301) falls below a predetermined second pressure, whereby, in use, extinguishing liquid and/or extinguishing liquid vapour are ejected from the ejection chamber (1301) via the exit valve (1307).

2. Apparatus as claimed in claim 1, further comprising:

a heater element disposed in said ejection chamber or proximate to said ejection chamber for raising a temperature of a liquid in said chamber.

3. The apparatus as claimed in claim 1 or claim 2, further comprising:

a pump member disposed in said ejection chamber or proximate to said ejection chamber for raising a pressure of a liquid in said ejection chamber.

4. The apparatus as claimed in any of claims 1 to 3 wherein said sensor comprises a temperature sensor.

5. The apparatus as claimed in any preceding claim wherein the liquid and/or liquid vapour are ejected via a vapour explosion process.

6. The apparatus as claimed in any preceding claim wherein the liquid and/or liquid vapour are ejected as a spray having a throw greater than 20.

7. The apparatus as claimed in any preceding claim wherein the liquid and/or or liquid vapour are ejected as a spray having a throw greater than 100.

8. The apparatus as claimed in any preceding claim wherein said liquid comprises water.

9. The apparatus as claimed in any preceding claim, further comprising:

a liquid reservoir for storing extinguishing liquid prior to transfer to said ejection chamber via said inlet valve.

10. The apparatus as claimed in claim 9 wherein said reservoir is portable and said apparatus further comprises a handle for holding said liquid reservoir.

11. The apparatus as claimed in claim 9 wherein said liquid reservoir is connected to said ejection chamber via a pipework arrangement, said pipework arrangement being connected to further chambers each arranged to eject extinguishing liquid and/or liquid vapour via a respective exit valve,

12. The apparatus as claimed in any preceding claim wherein said chamber has a capacity of at least 100 ml.

13. A method for fighting fires comprising the steps of:

providing an ejection chamber (1301) arranged to hold a portion of a selected extinguishing liquid;
selectively opening an inlet valve (1306) to transfer a portion of the liquid into the chamber (1301); selectively opening an exit valve (1307) to eject extinguishing liquid from the ejection chamber (1301);
increasing the pressure of the extinguishing liquid in said ejection chamber (1301);
characterised by
monitoring pressure in the ejection chamber

(1301) via at least one pressure or temperature sensor,
controlling the inlet and exit valves (1306, 1307) based on the pressure in said ejection chamber (1301);
selectively opening an exit valve (1307) of said ejection chamber (1301) when a predetermined first pressure in the ejection chamber (1301) is reached and selectively closing the exit valve (1307) when the pressure in the ejection chamber (1301) falls below a predetermined second pressure; and
ejecting extinguishing liquid and/or extinguishing liquid vapour from the chamber (1301) via the exit valve (1307) in a direction to fight a fire.

14. The method as claimed in claim 13, further comprising the steps of:

heating liquid to thereby increase a temperature of liquid held in the ejection chamber via a heating element disposed in or proximate to the ejection chamber.

15. The method as claimed in claim 14, further comprising the steps of:

heating liquid in the ejection chamber prior to the step of opening the exit valve.

16. The method as claimed in any of claims 13 to 15, further comprising the steps of:

increasing pressure in the ejection chamber via a pump member disposed in or proximate to said ejection chamber.

17. The method as claimed in any one of claims 13 to 16, further comprising the steps of:

preheating liquid supplied to the inlet valve prior to entry of the liquid into the ejection chamber.

18. The method as claimed in any one of claims 13 to 17, further comprising the steps of:

providing a portable fire extinguisher, comprising a reservoir and handle at a location where a fire is to be fought.

19. The method as claimed in any one of claims 13 to 17, further comprising the steps of:

providing a pipeline system including a plurality of ejection chambers secured to at least one supply pipe; and
automatically ejecting liquid and/or liquid vapour from associated exit valves corresponding to respective ejection chambers when an existence of a fire is identified.

Patentansprüche

1. Vorrichtung zum Löschen eines Brandes, umfassend:

eine Auswurfkammer (1301) zum Aufnehmen eines Teils einer ausgewählten Löschflüssigkeit,
ein Einlassventil (1306), das zum selektiven Öffnen vorgesehen ist, um Löschflüssigkeit in die Auswurfkammer zu transferieren,
ein Auslassventil (1307), das zum selektiven Öffnen vorgesehen ist, um Löschflüssigkeit aus der Auswurfkammer (1301) auszuwerfen,
Mittel, um den Druck der Löschflüssigkeit in der Auswurfkammer (1301) zu erhöhen),
dadurch gekennzeichnet, dass

ein Regler (1305) die Einlass- und Auslassventile (1306, 1307) basierend auf dem Druck in der Auswurfkammer (1301) elektronisch regelt, wobei der Druck durch einen oder mehrere Druck- oder Temperatursensoren überwacht wird, wobei der Regler (1305) vorgesehen ist, um das Auslassventil (1307) zu öffnen, wenn ein festgelegter erster Druck in der Auswurfkammer (1301) erreicht ist, und das Auslassventil (1307) zu schließen, wenn der Druck in der Auswurfkammer (1301) unter einen festgelegten zweiten Druck fällt, wodurch bei Gebrauch Löschflüssigkeit und/oder Löschflüssigkeitsdampf aus der Auswurfkammer (1301) über das Auslassventil (1307) ausgeworfen werden.

2. Vorrichtung nach Anspruch 1, ferner umfassend: ein in der Auswurfkammer oder in der Nähe der Auswurfkammer angeordnetes Heizelement, um eine Temperatur einer Flüssigkeit in der Auswurfkammer zu erhöhen.

3. Vorrichtung nach Anspruch 1 oder Anspruch 2, ferner umfassend:

ein in der Auswurfkammer oder in der Nähe der Auswurfkammer angeordnetes Pumpelement, um einen Druck einer Flüssigkeit in der Auswurfkammer zu erhöhen.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei der Sensor einen Temperatursensor umfasset.

5. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Flüssigkeit und/oder der Flüssigkeitsdampf nach einem Dampfexplosionsverfahren ausgeworfen werden.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Flüssigkeit und/oder der Flüssigkeitsdampf als Spray mit einer Reichweite größer als 20 ausgeworfen werden.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Flüssigkeit und/oder der Flüssigkeitsdampf als Spray mit einer Reichweite größer als 100 ausgeworfen werden.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Flüssigkeit Wasser umfasst.

9. Vorrichtung nach einem der vorhergehenden Ansprüche, ferner umfassend:

ein Flüssigkeitsreservoir zum Lagern von Löschflüssigkeit vor dem Transferieren in die Auswurfkammer über das Einlassventil.

10. Vorrichtung nach Anspruch 9, wobei das Reservoir tragbar ist und die Vorrichtung ferner einen Griff zum Halten des Flüssigkeitsreservoirs umfasst.

11. Vorrichtung nach Anspruch 9, wobei das Flüssigkeitsreservoir über eine Leitungsanordnung mit der Auswurfkammer verbunden ist, wobei die Leitungsanordnung mit weiteren Kammern verbunden ist, die jeweils vorgesehen sind, um Löschflüssigkeit und/oder Flüssigkeitsdampf über ein jeweiliges Auslassventil auszuwerfen.

12. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Kammer eine Kapazität von mindestens 100 ml hat.

13. Verfahren zur Brandbekämpfung, umfassend die Schritte:

Bereitstellen einer Auswurfkammer (1301), die zum Aufnehmen eines Teils einer ausgewählten Löschflüssigkeit vorgesehen ist,
selektives Öffnen eines Einlassventils (1306), um einen Teil der Flüssigkeit in die Kammer (1301) zu transferieren,
selektives Öffnen eines Auslassventil (1307), um Löschflüssigkeit aus der Auswurfkammer (1301) auszuwerfen,
Erhöhen des Drucks der Löschflüssigkeit in der Auswurfkammer (1301),
gekennzeichnet durch
Überwachen des Drucks in der Auswurfkammer (1301) über mindestens einen Druck- oder Temperatursensor,
Regeln der Einlass- und Auslassventile (1306, 1307) basierend auf dem Druck in der Auswurfkammer (1301),
selektives Öffnen eines Auslassventils (1307) der Auswurfkammer (1301), wenn ein festgelegter erster Druck in der Auswurfkammer (1301) erreicht ist, und selektives Schließen des Auslassventils (1307), wenn der Druck in der Auswurfkammer (1301) unter einen festgelegten zweiten Druck fällt, und
Auswerfen von Löschflüssigkeit und/oder Löschflüssigkeitsdampf aus der Kammer (1301) über das Auslassventil (1307) in eine Richtung, um einen Brand zu bekämpfen.

14. Verfahren nach Anspruch 13, ferner umfassend die Schritte:

Aufheizen von Flüssigkeit, um dadurch eine Temperatur der in der Auswurfkammer aufgenommenen Flüssigkeit zu erhöhen, mithilfe eines Heizelements, das in oder in der Nähe der Auswurfkammer angeordnet ist.

15. Verfahren nach Anspruch 14, ferner umfassend die Schritte:

Aufheizen der Flüssigkeit in der Auswurfkammer vor dem Schritt des Öffnens des Auslassventils.

16. Verfahren nach einem der Ansprüche 13 bis 15, ferner umfassend die Schritte:

Erhöhen des Drucks in der Auswurfkammer über ein Pumpelement, das in oder in der Nähe der Auswurfkammer angeordnet ist.

17. Verfahren nach einem der Ansprüche 13 bis 16, ferner umfassend die Schritte:

Vorheizen der Flüssigkeit, die dem Einlassventil zugeführt wird, vor dem Eintreten der Flüssigkeit in die Auswurfkammer.

18. Verfahren nach einem der Ansprüche 13 bis 17, ferner umfassend die Schritte:

Bereitstellen eines tragbaren Feuerlöschers, umfassend ein Reservoir und einen Griff, an einem Ort, an dem ein Brand bekämpft werden soll.

19. Verfahren nach einem der Ansprüche 13 bis 17, ferner umfassend die Schritte:

Bereitstellen eines Leitungssystems einschließlich einer Vielzahl von Auswurfkam-

mern, die an mindestens einer Versorgungsleitung befestigt sind, und
automatisches Auswerfen von Flüssigkeit und/oder Flüssigkeitsdampf aus Auslassventilen, die zu entsprechenden Auswurfkammern gehören, wenn das Vorhandensein eines Brandes festgestellt worden ist.

Revendications

1. Dispositif pour éteindre un incendie, comprenant :

une chambre d'éjection (1301) pour tenir une partie d'un liquide d'extinction choisi ;
une soupape d'admission (1306) disposée afin de s'ouvrir de manière sélective pour transférer un liquide d'extinction dans ladite chambre d'éjection (1301) ;
une soupape de sortie (1307) disposée afin de s'ouvrir de manière sélective pour éjecter un liquide d'extinction de la chambre d'éjection (1301) ;
un moyen pour augmenter la pression du liquide d'extinction dans ladite chambre d'éjection (1301) ;
caractérisé en ce que

un régulateur (1305) contrôle électroniquement les soupapes d'admission et de sortie (1306, 1307) selon la pression dans ladite chambre d'éjection (1301), ladite pression étant surveillée par un ou plusieurs capteurs de pression ou de température, dans lequel le régulateur (1305) est disposé pour ouvrir la soupape de sortie (1307) lorsqu'une première pression prédéterminée dans la chambre d'éjection (1301) est atteinte et pour fermer la soupape de sortie (1307) lorsque la pression dans la chambre d'éjection (1301) chute sous une seconde pression prédéterminée, au moyen de laquelle, dans l'utilisation, un liquide d'extinction et/ou une vapeur liquide d'extinction sont éjectés de la chambre d'éjection (1301) par la soupape de sortie (1307).

2. Dispositif selon la revendication 1, comprenant en outre : un élément chauffant disposé dans ladite chambre d'éjection ou à proximité de ladite chambre d'éjection pour augmenter la température d'un liquide dans ladite chambre.

3. Dispositif selon la revendication 1 ou 2, comprenant en outre :

un élément de pompe disposé dans ladite chambre d'éjection ou à proximité de ladite chambre d'éjection pour augmenter la pression d'un liquide dans ladite chambre d'éjection.

4. Dispositif selon l'une quelconque des revendications 1 à 3, dans lequel ledit capteur comprend un capteur de température.

5. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le liquide et/ou la vapeur liquide sont éjectés par un procédé d'explosion de vapeur.

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le liquide et/ou la vapeur liquide sont éjectés sous forme de pulvérisation dont le jet est supérieur à 20.

7. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le liquide et/ou la vapeur liquide sont éjectés sous forme de pulvérisation dont le jet est supérieur à 100.

8. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ledit liquide comprend de l'eau.

9. Dispositif selon l'une quelconque des revendications précédentes, comprenant en outre :

un réservoir de liquide pour l'entreposage du liquide d'extinction avant de le transférer vers ladite chambre d'éjection par ladite soupape d'admission.

10. Dispositif selon la revendication 9, dans lequel ledit réservoir est portatif et ledit dispositif comprend en outre une poignée pour tenir ledit réservoir de liquide.

11. Dispositif selon la revendication 9, dans lequel ledit réservoir de liquide est connecté à ladite chambre d'éjection au moyen d'un dispositif de conduits, ledit dispositif de conduits étant connecté à d'autres chambres, chacune disposée pour éjecter un liquide d'extinction et/ou une vapeur liquide au moyen d'une soupape de sortie respective.

12. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ladite chambre a une capacité d'au moins 100 ml.

13. Procédé de lutte contre les incendies, qui comprend les étapes consistant à :

fournir une chambre d'éjection (1301) disposée pour maintenir une partie d'un liquide d'extinction choisi ;
ouvrir de manière sélective une soupape d'ad-

mission (1306) pour transférer une partie du liquide dans la chambre (1301) ;
ouvrir de manière sélective une soupape de sortie (1307) pour éjecter un liquide d'extinction de la chambre d'éjection (1301) ;
augmenter la pression du liquide d'extinction dans ladite chambre d'éjection (1301) ;
caractérisé par
la surveillance de la pression dans la chambre d'éjection (1301) à l'aide d'au moins un capteur de pression ou de température ;
le contrôle des soupapes d'admission et de sortie (1306, 1307) basé sur la pression dans ladite chambre d'éjection (1301) ;
l'ouverture sélective d'une soupape de sortie (1307) de ladite chambre d'éjection (1301) lorsqu'une première pression prédéterminée dans la chambre d'éjection (1301) est atteinte et la fermeture sélective de la soupape de sortie (1307) lorsque la pression dans la chambre d'éjection (1301) chute sous une seconde pression prédéterminée ; et
l'éjection du liquide d'extinction et/ou de la vapeur liquide d'extinction de la chambre (1301) au moyen de la soupape de sortie (1307) dans une direction pour combattre un incendie.

14. Procédé selon la revendication 13, qui comprend en outre les étapes consistant à :

chauffer le liquide pour ainsi augmenter la température d'un liquide maintenu dans la chambre d'éjection au moyen d'un élément chauffant disposé dans ou à proximité de la chambre d'éjection.

15. Procédé selon la revendication 14, qui comprend en outre les étapes consistant à :

chauffer le liquide dans la chambre d'éjection avant l'étape de l'ouverture de la soupape de sortie.

16. Procédé selon l'une quelconque des revendications 13 à 15, qui comprend en outre les étapes consistant à :

augmenter la pression dans la chambre d'éjection au moyen d'un élément de pompe disposé dans ou à proximité de ladite chambre d'éjection.

17. Procédé selon l'une quelconque des revendications 13 à 16, qui comprend en outre les étapes consistant à :

préchauffer le liquide alimenté vers la soupape d'admission avant l'entrée du liquide dans la chambre d'éjection.

18. Procédé selon l'une quelconque des revendications 13 à 17, qui comprend en outre les étapes consistant à :

fournir un extincteur portatif, comprenant un réservoir et une poignée à un endroit où un feu doit être combattu.

19. Procédé selon l'une quelconque des revendications 13 à 17, qui comprend en outre les étapes consistant à :

fournir un système de conduites qui comporte une pluralité de chambres d'éjection fixées à au moins un tuyau d'alimentation ; et
éjecter automatiquement un liquide et/ou une vapeur liquide de soupapes de sorties associées qui correspondent aux chambres d'éjection respectives lorsque l'existence d'un incendie est établie.

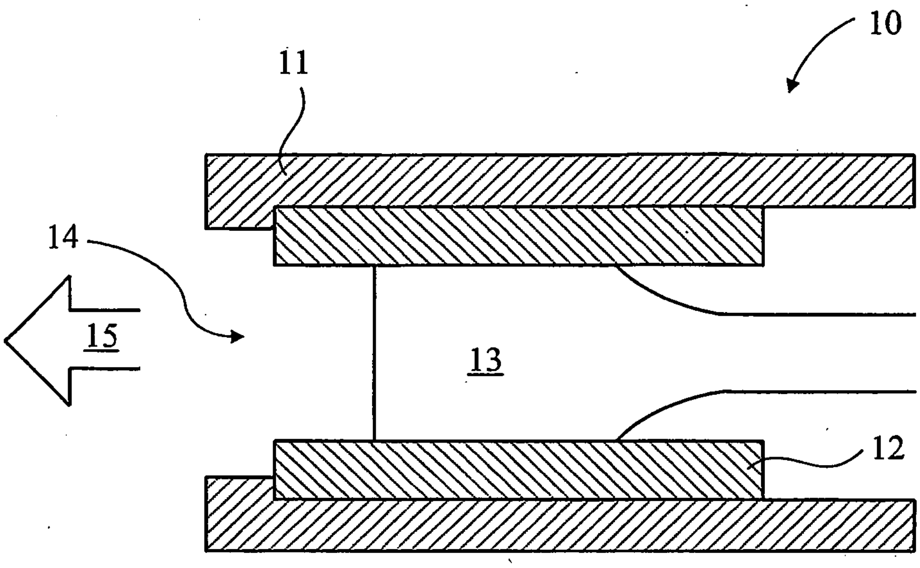


Fig. 1
(PRIOR ART)

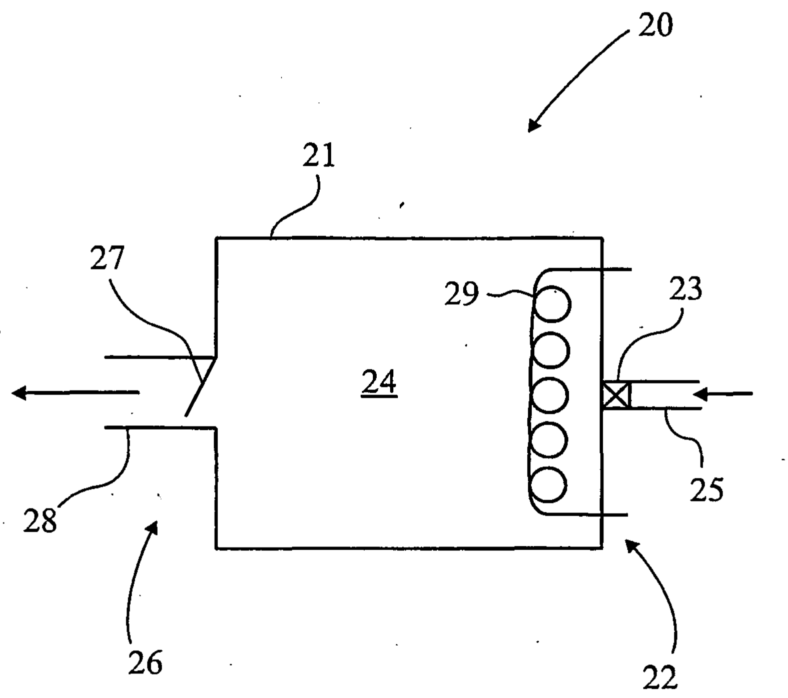


Fig. 2

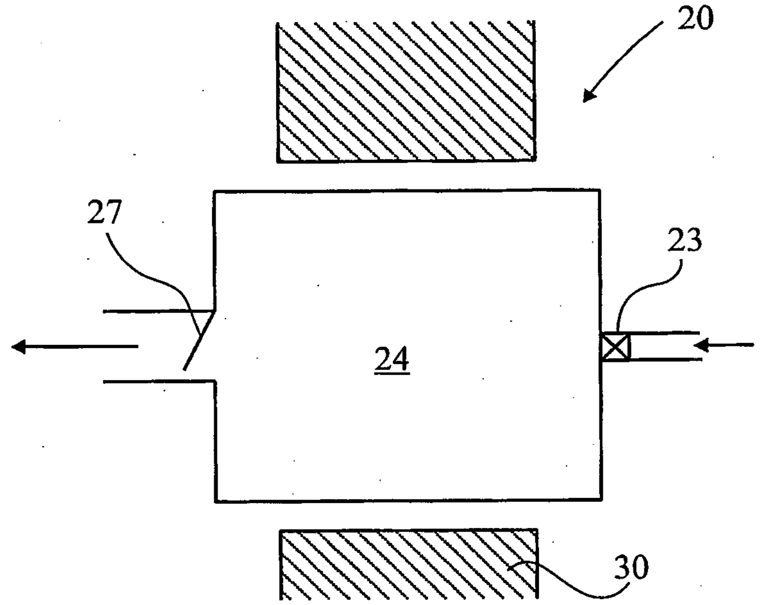


Fig. 3

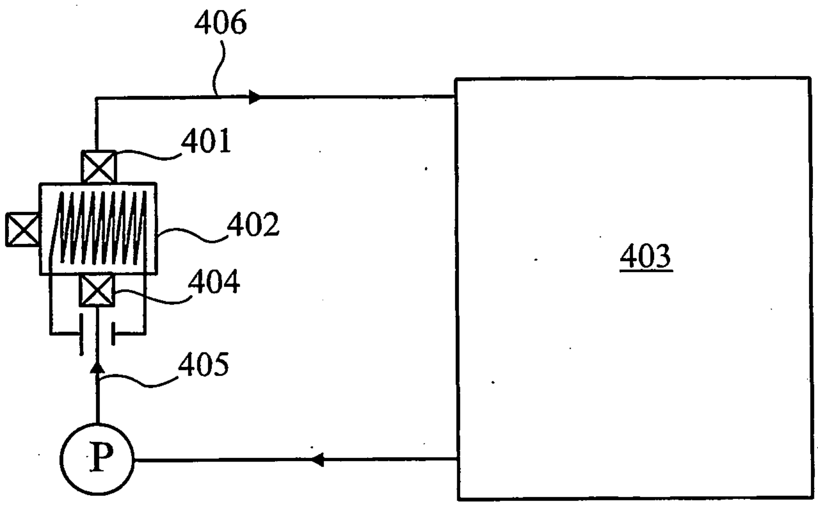


Fig. 4

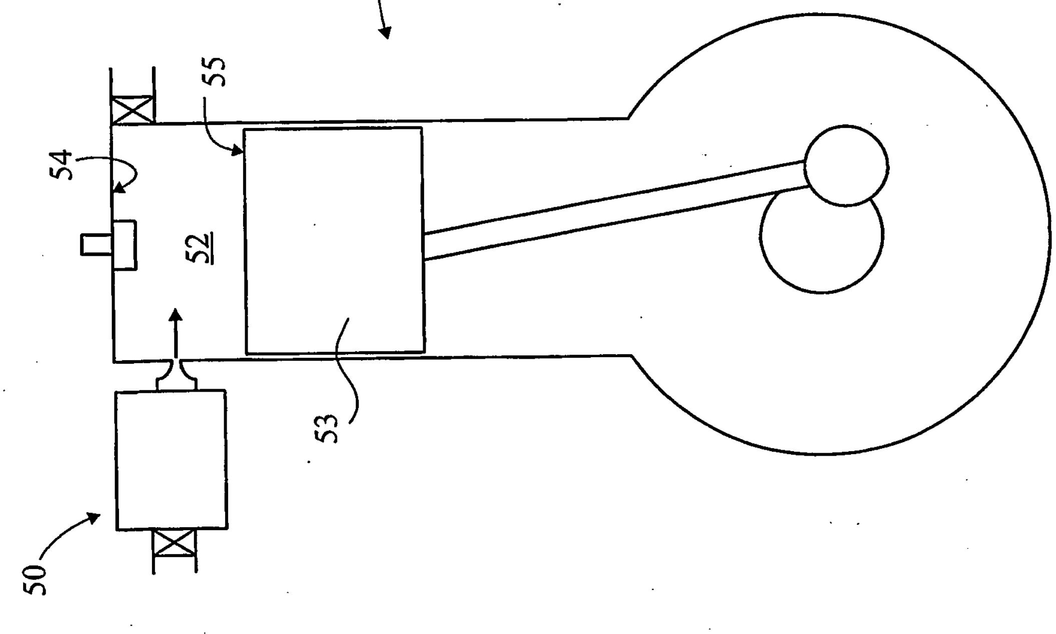


Fig. 5A

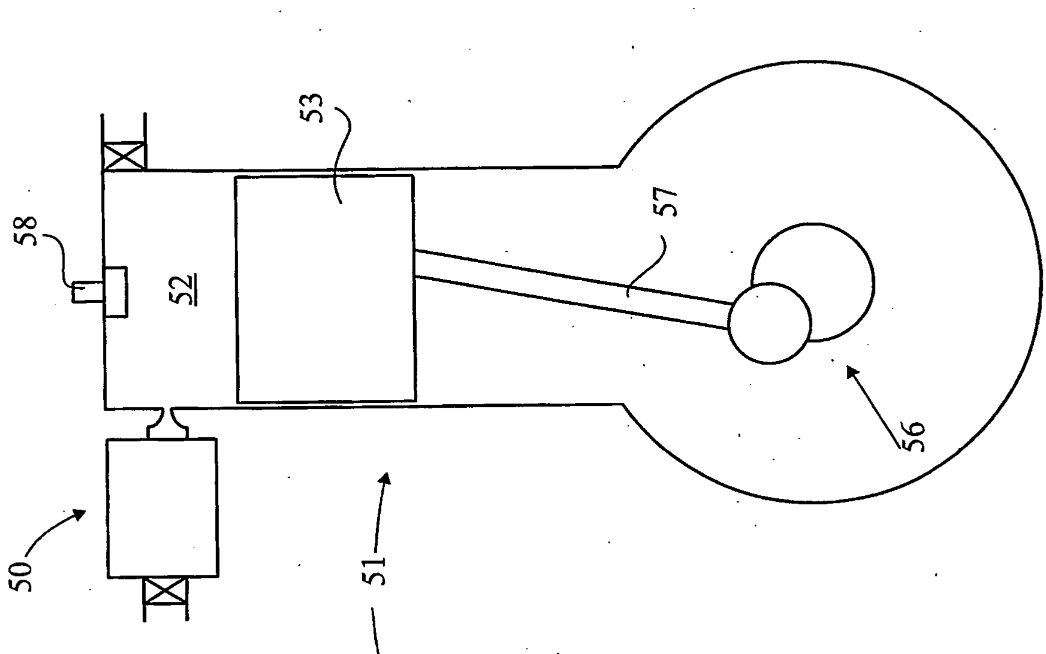


Fig. 5B

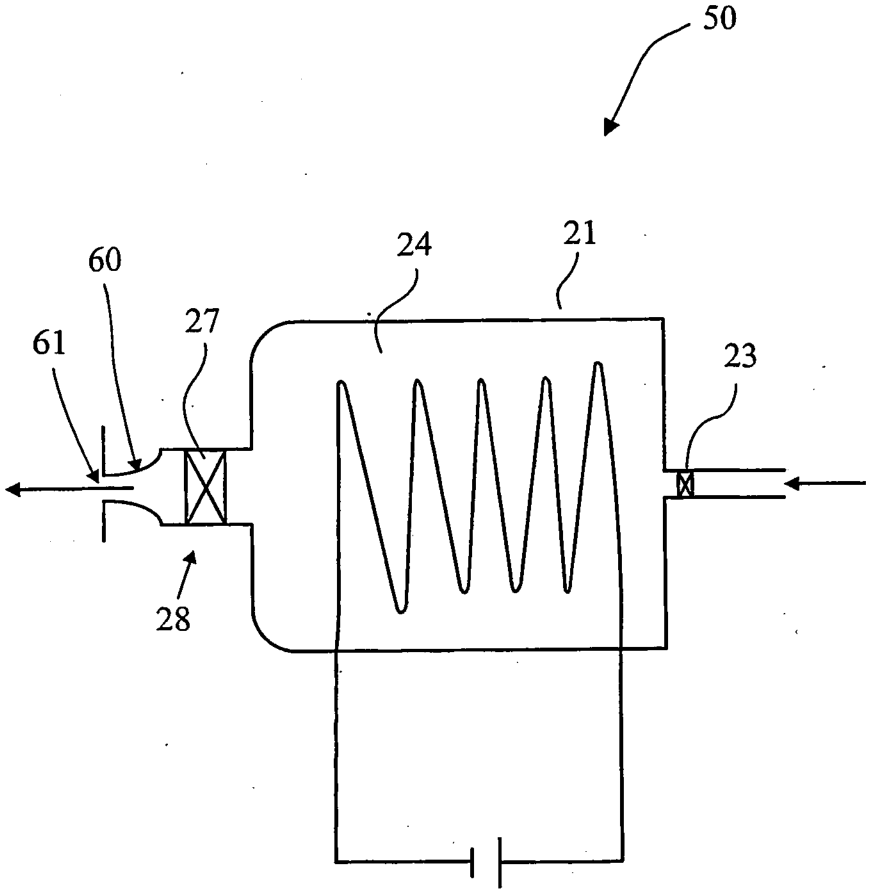


Fig. 6

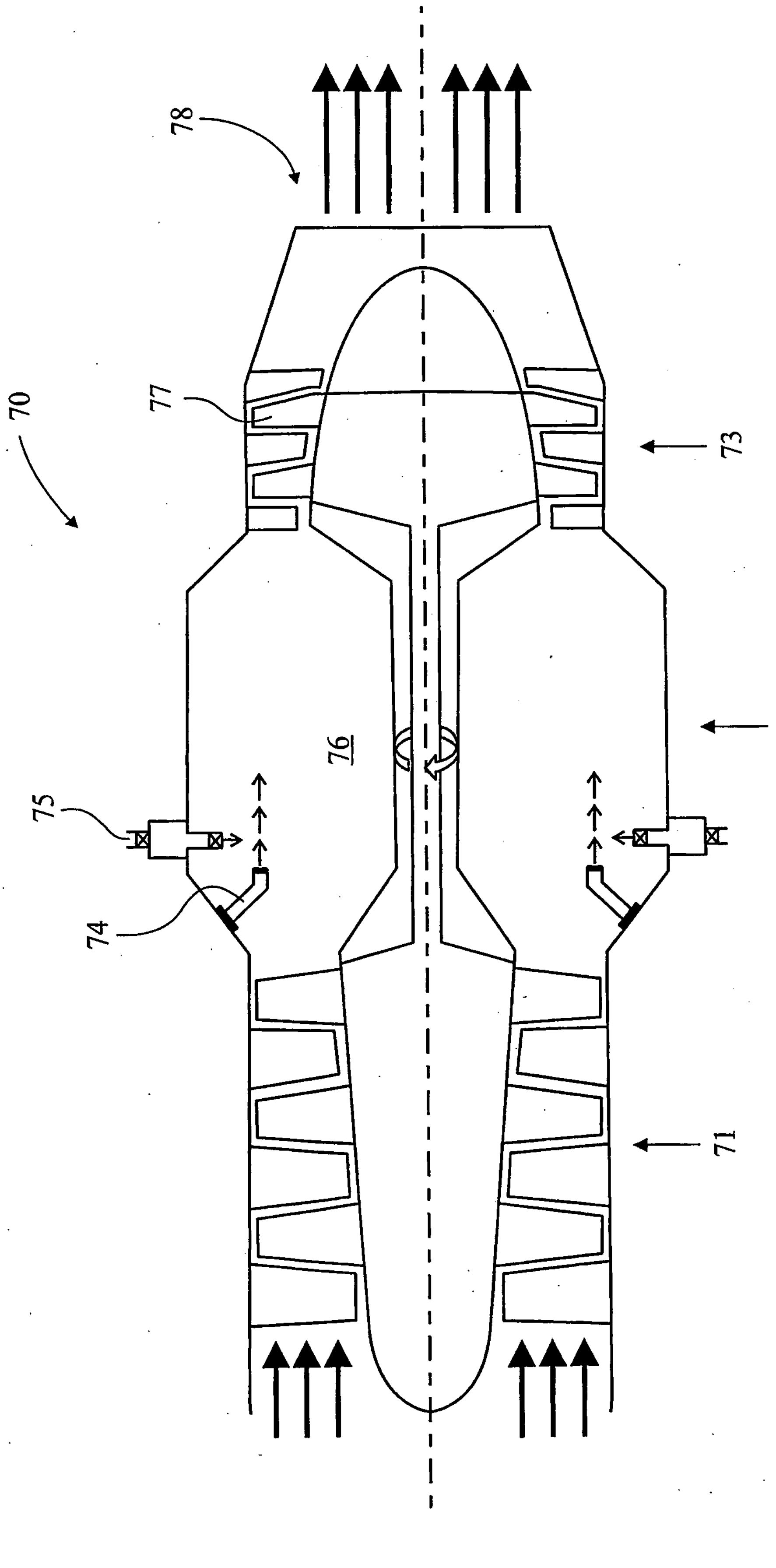


Fig. 7

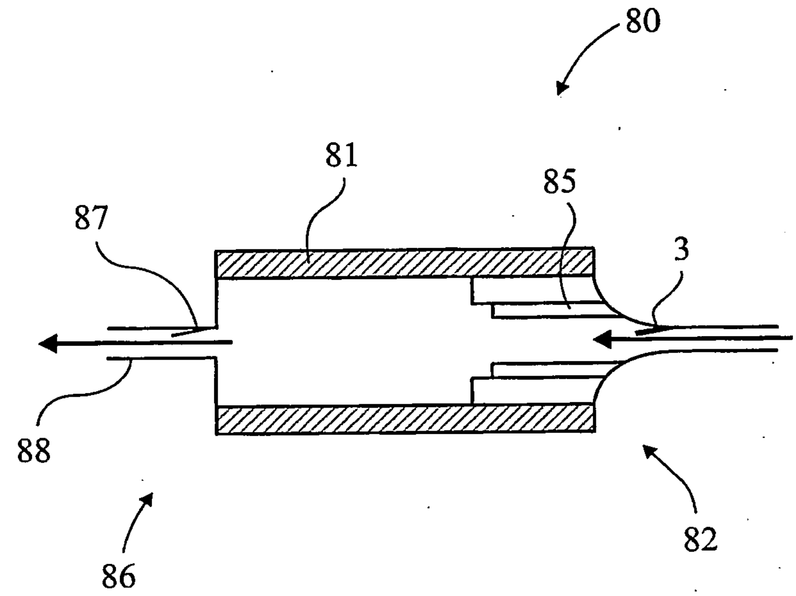


Fig. 8

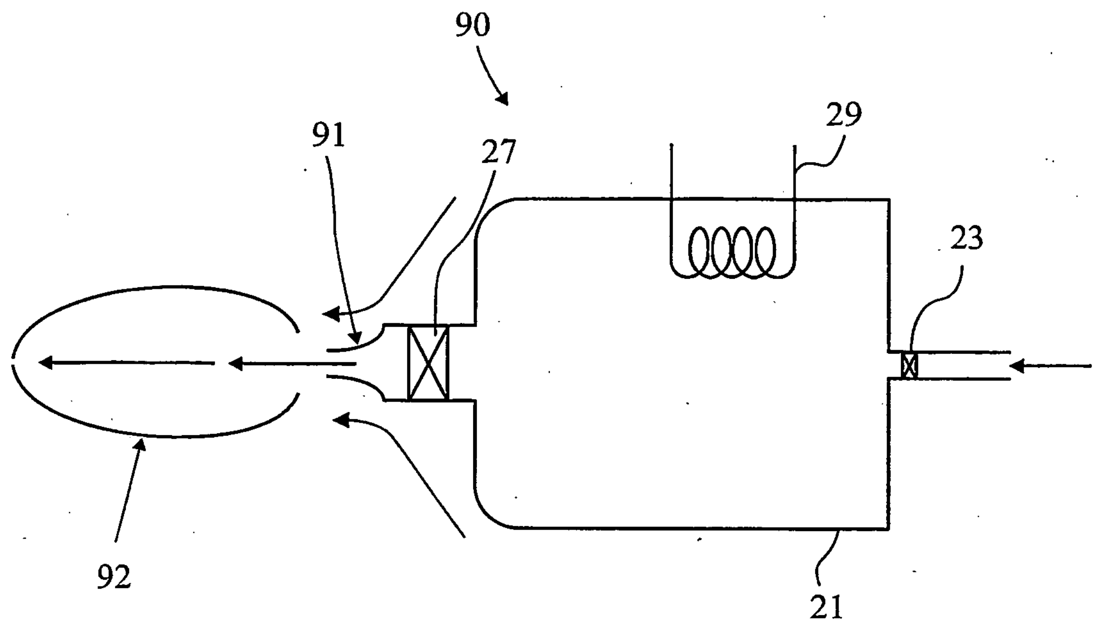


Fig. 9

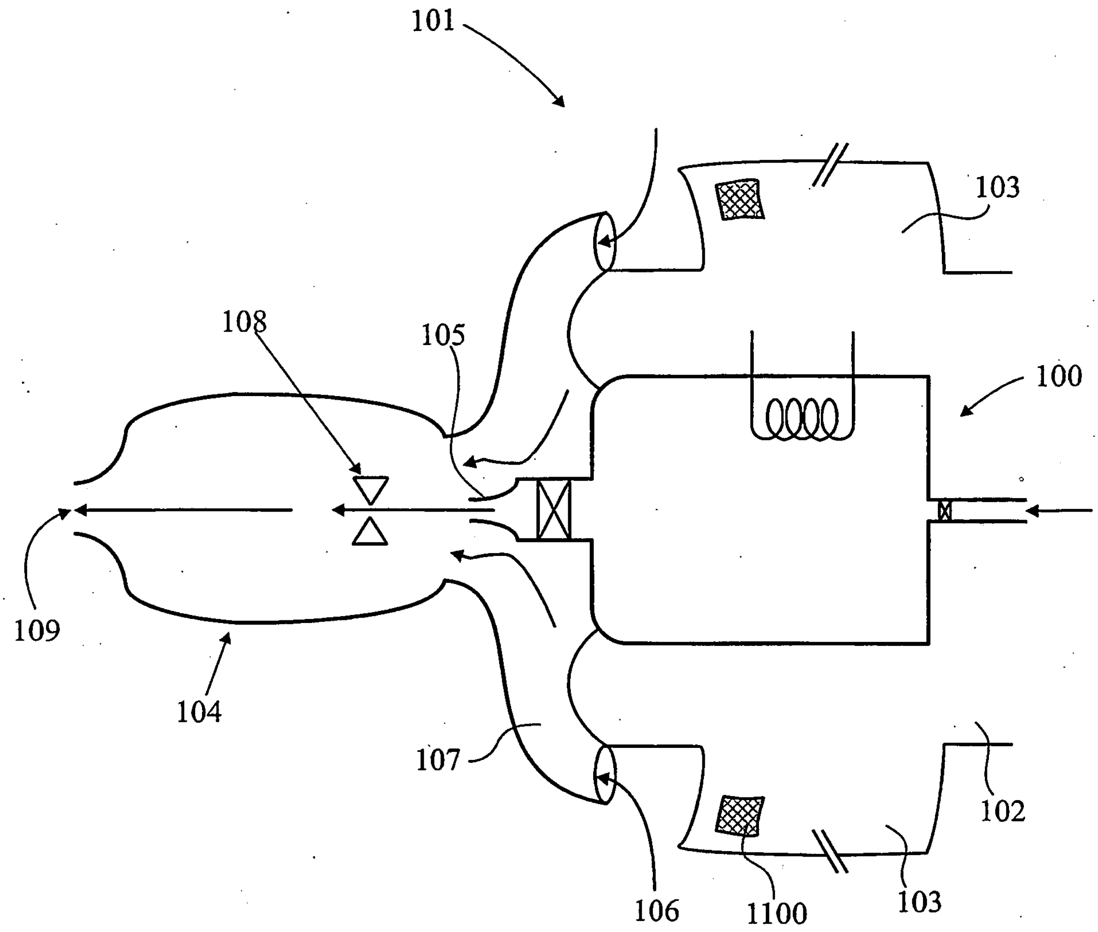
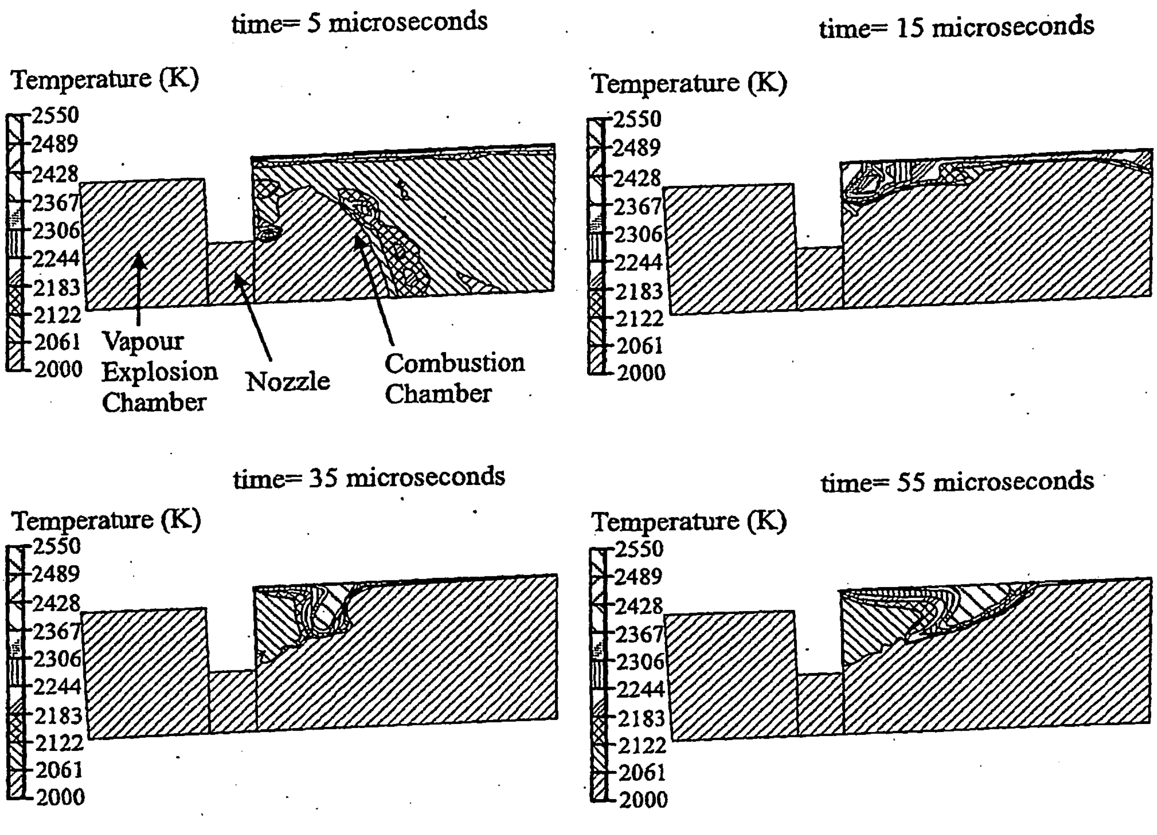


Fig. 10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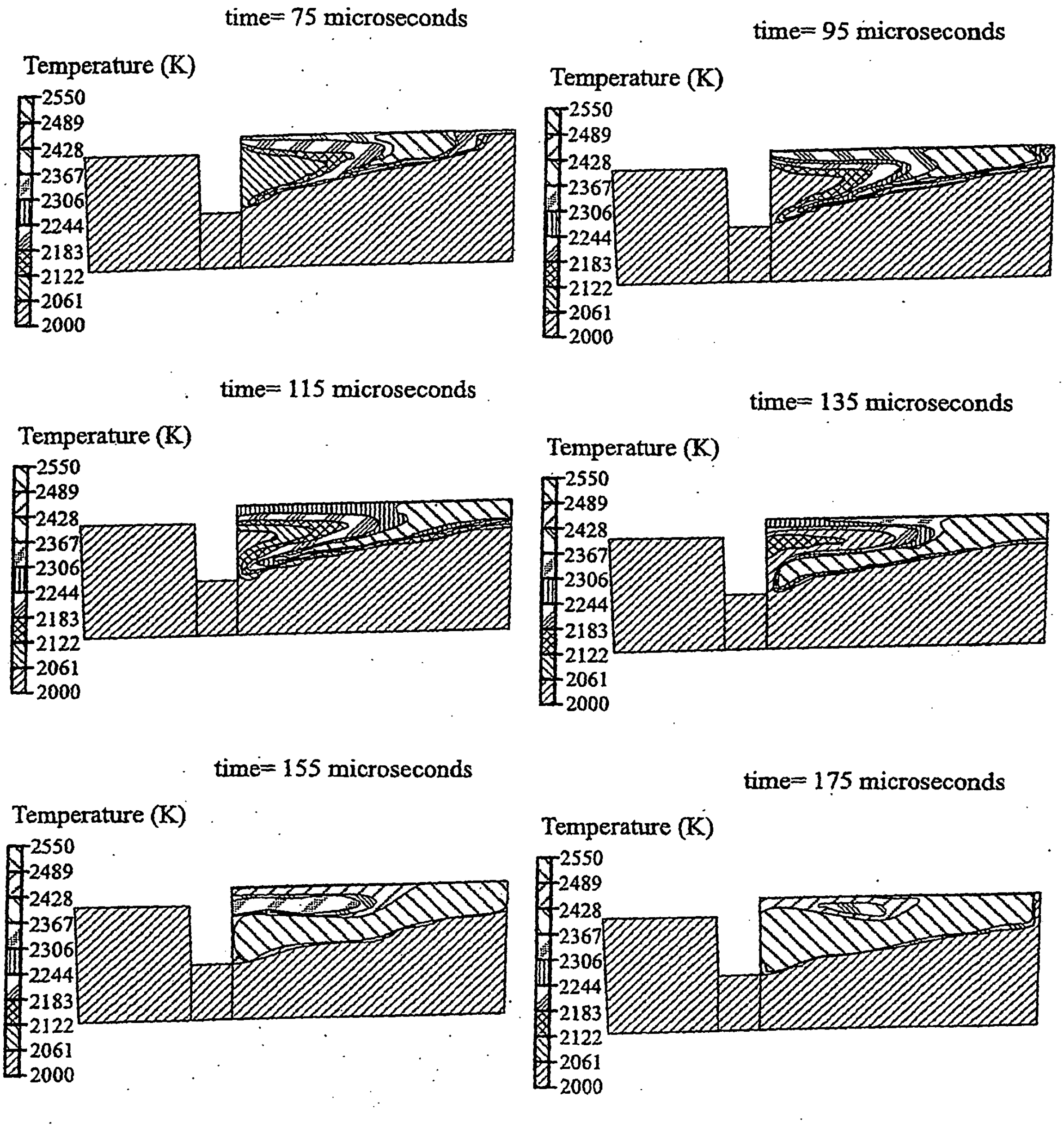
Temperature (K)
2550
2489
2428
2367
2306
2244
2183
2122
2061
2000
Vapour Explosion Chamber
Nozzle
Combustion Chamber
time= 15 microseconds
Temperature (K)
2550
2489
2428
2367
2306
2244
2183
2122
2061
2000
time= 35 microseconds
Temperature (K)
2550
2489
2428
2367
2306
2244
2183
2122
2061
2000
time= 55 microseconds
Temperature (K)
2550
2489
2428
2367
2306
2244
2183
2122
2061
2000

Fig. 11A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Temperature (K)
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2367
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2061
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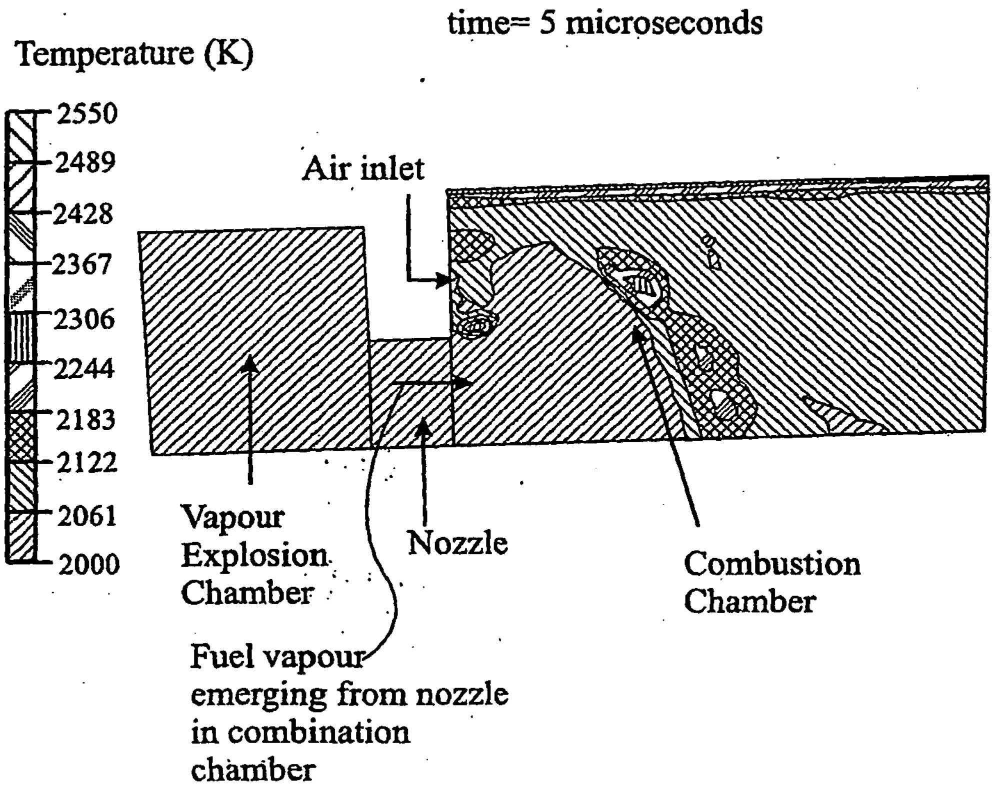
time= 95 microseconds
Temperature (K)
time= 115 microseconds
Temperature (K)
time= 135 microseconds
Temperature (K)
time= 155 microseconds
Temperature (K)
time= 175 microseconds
Temperature (K)

Fig. 11B


time= 5 microseconds
Temperature (K)
2550
2489
2428
2367
2306
2244
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2122
2061
2000
Air inlet
Vapour Explosion Chamber
Nozzle
Combustion Chamber
Fuel vapour emerging from nozzle in combination chamber

Fig. 12

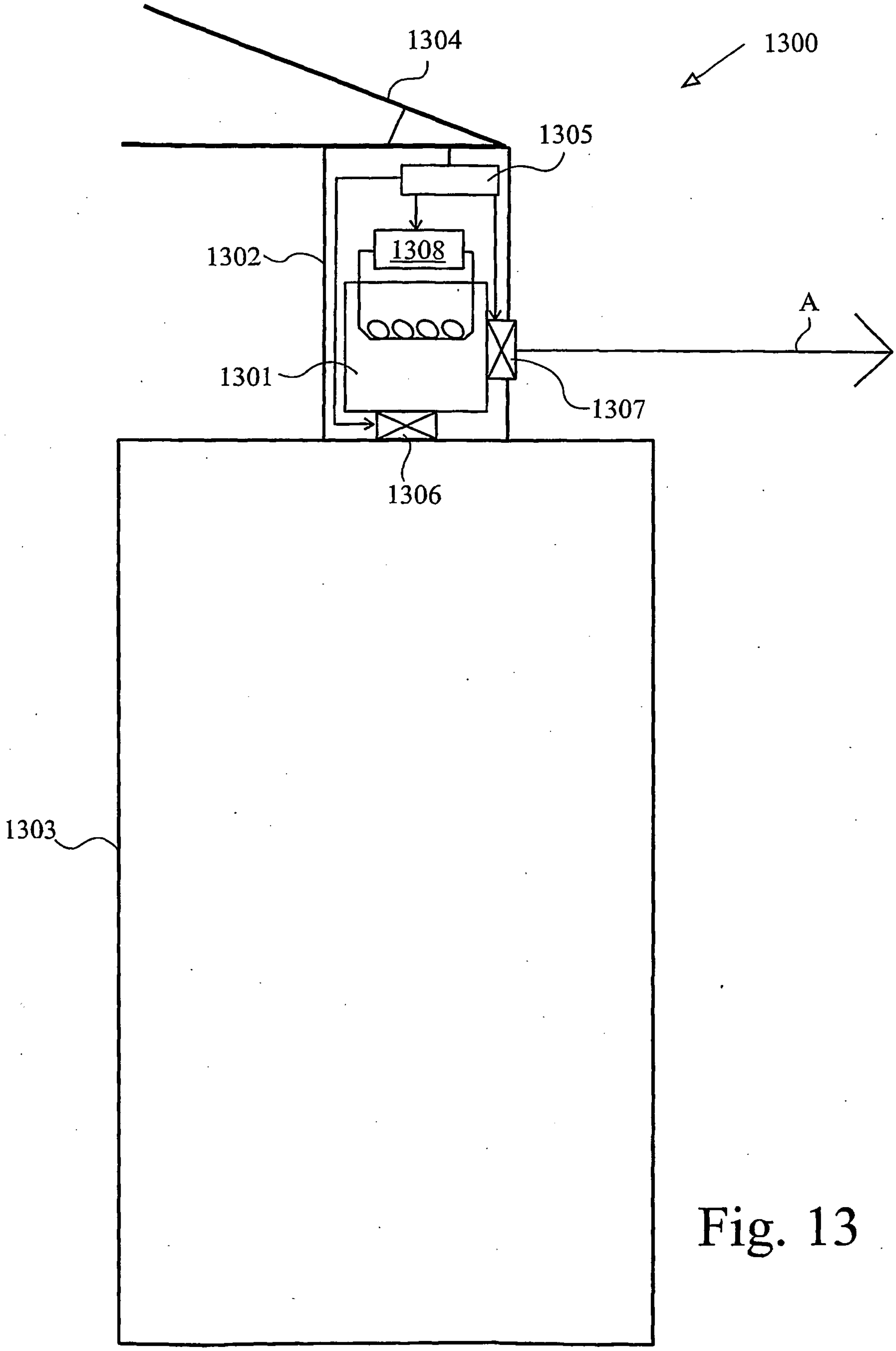

Fig. 13

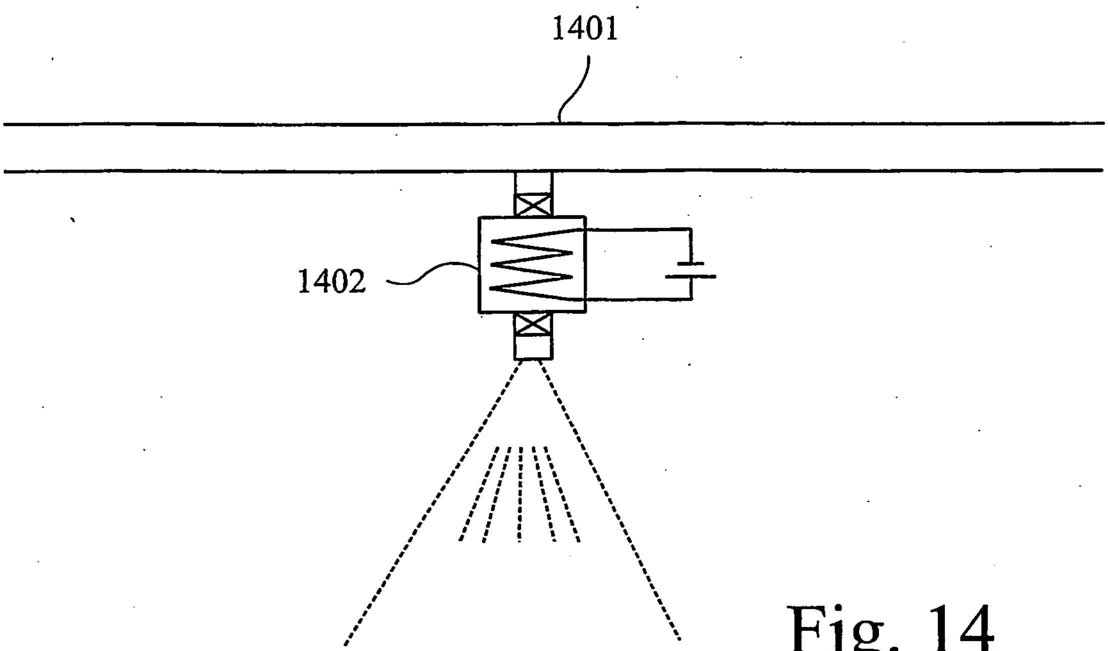

Fig. 14

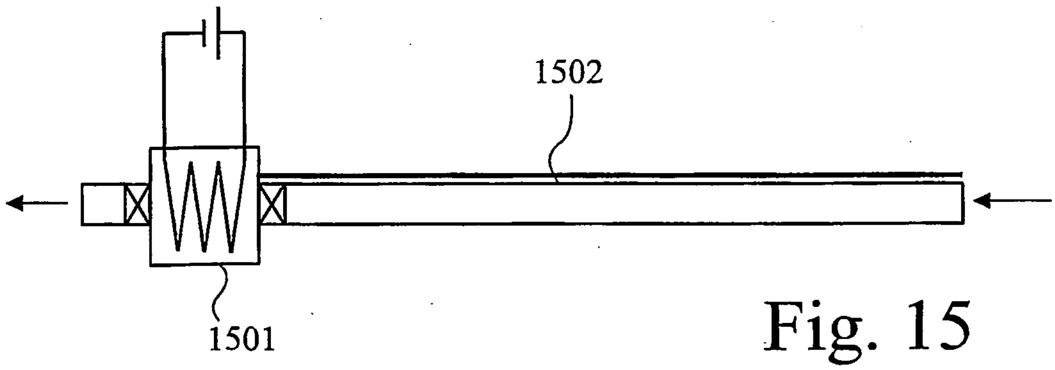

Fig. 15

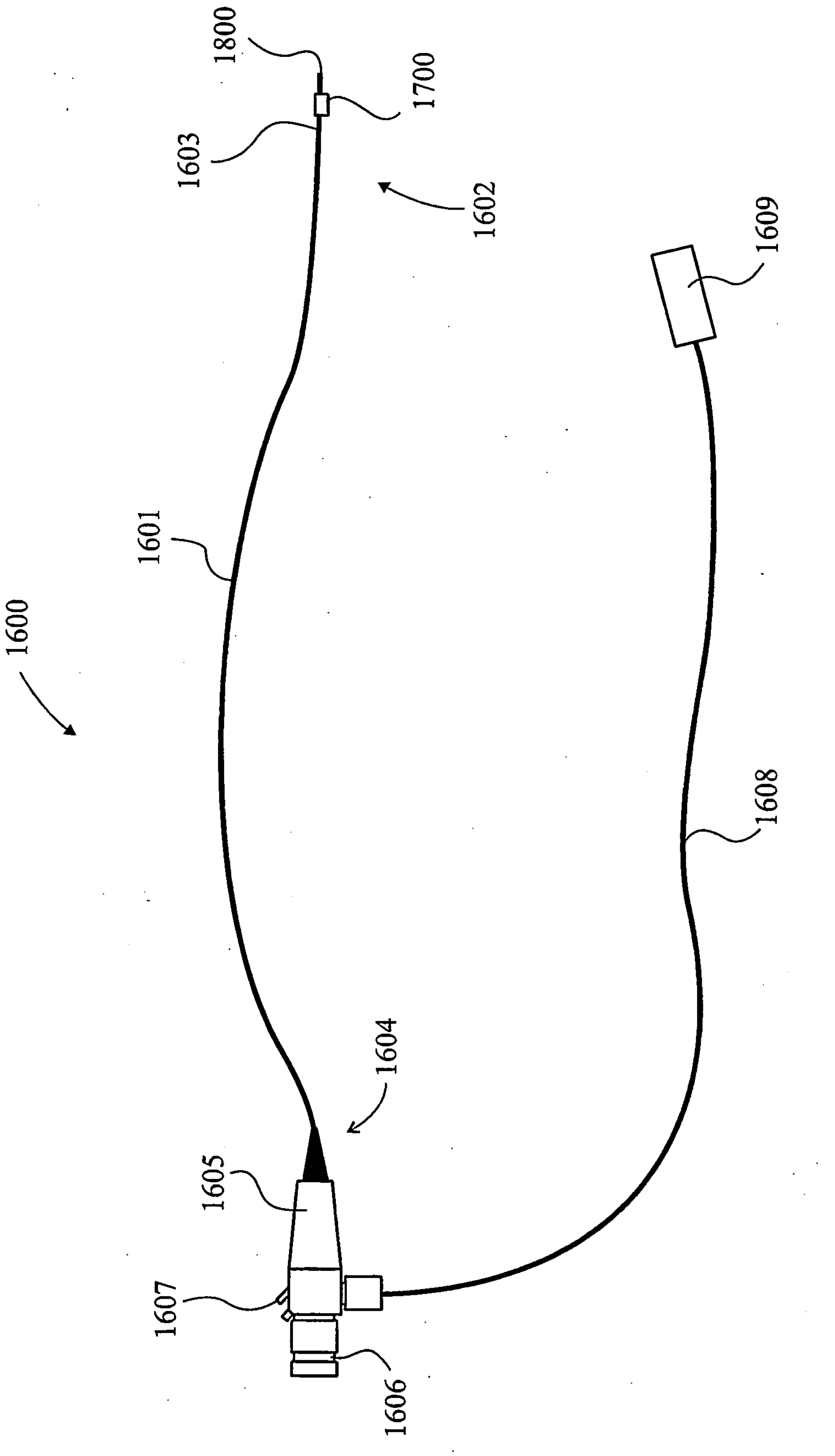

Fig. 16

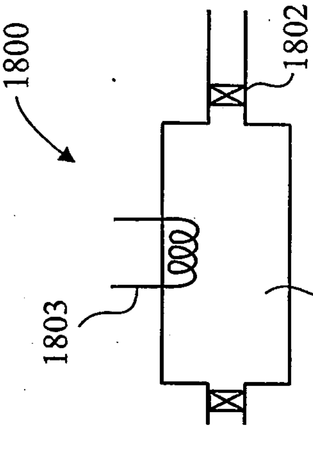

Fig. 18

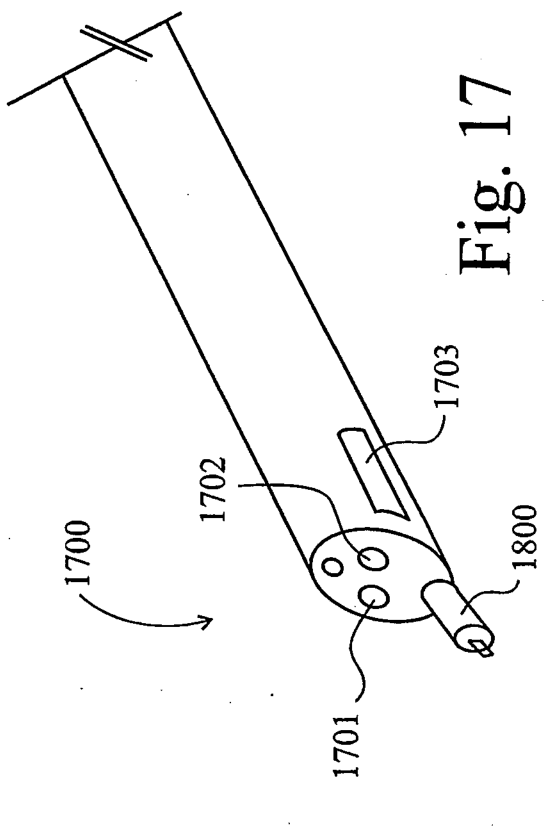

Fig. 17

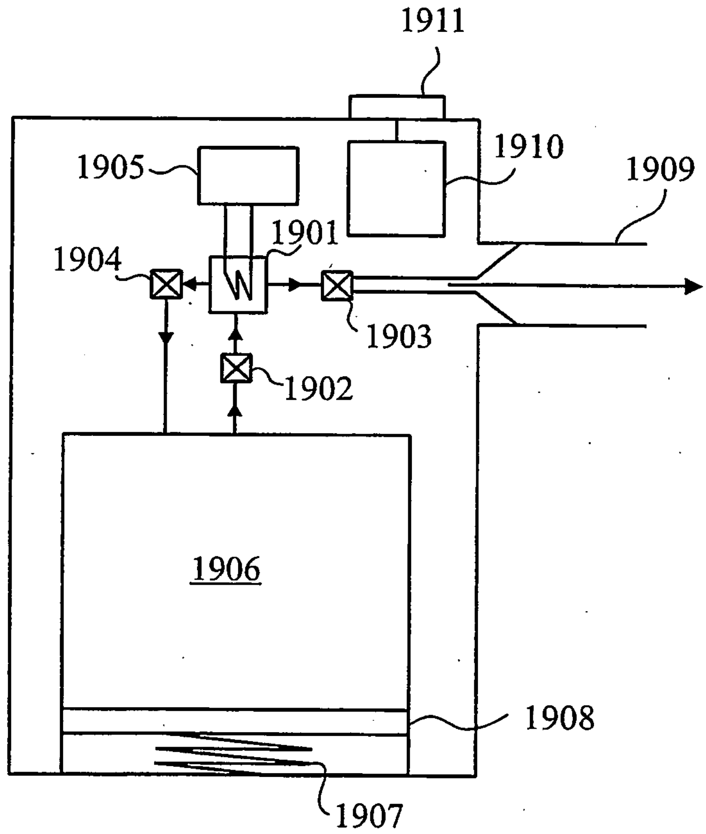

Fig. 19

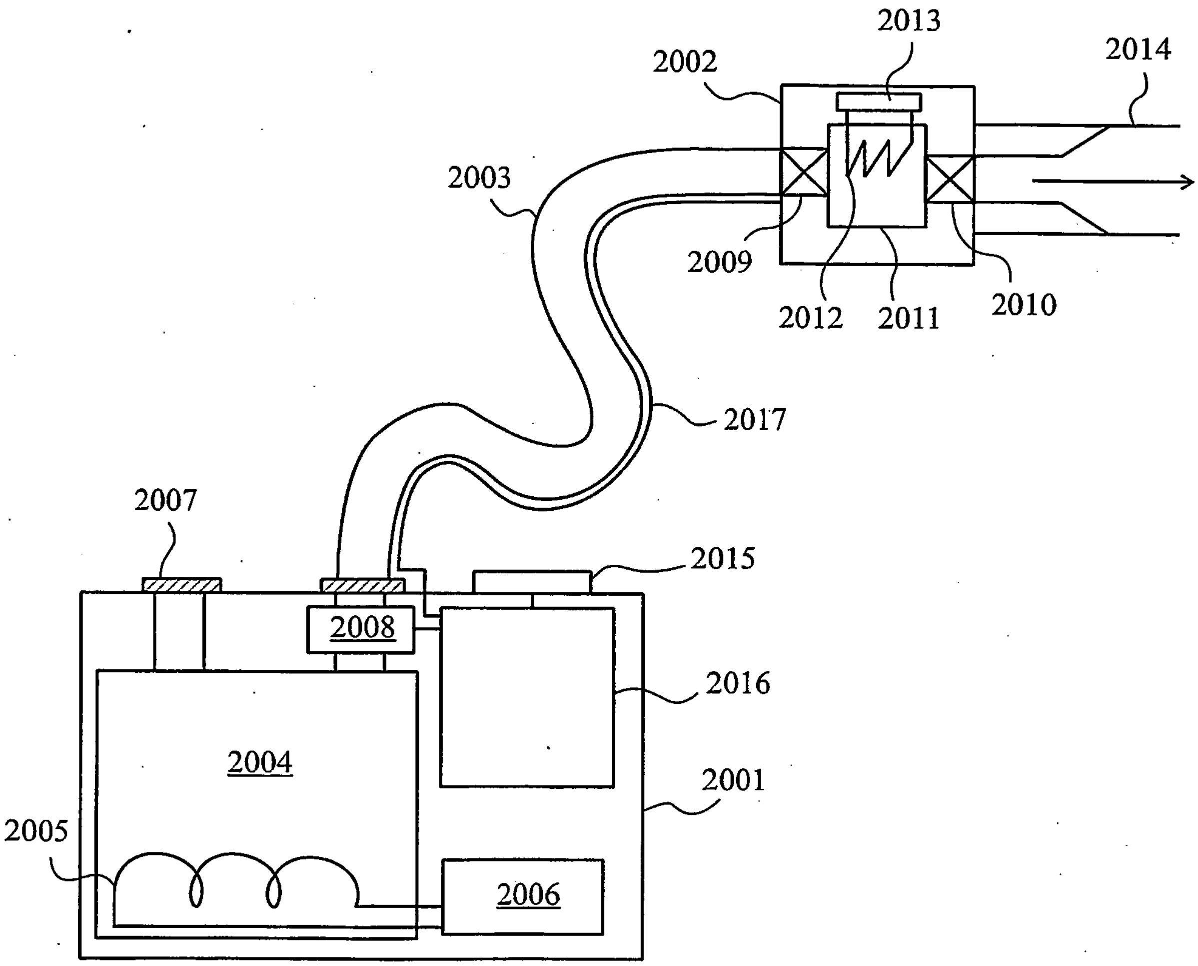
2013
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Fig. 20

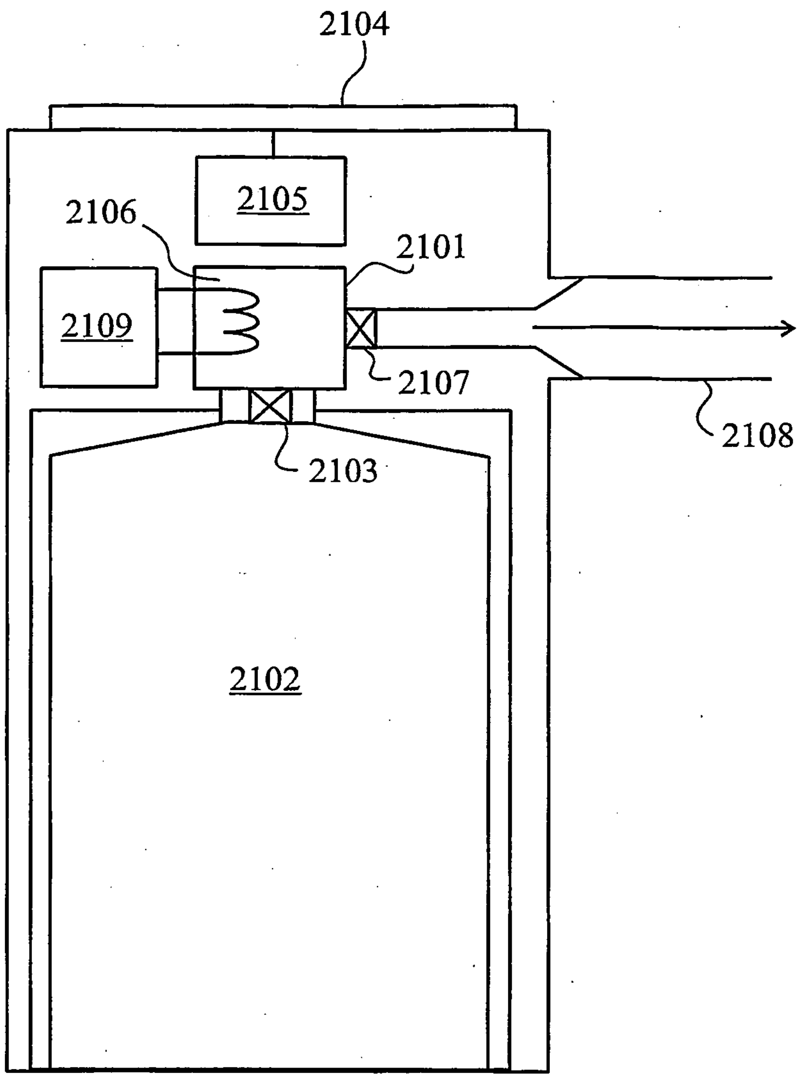

Fig. 21

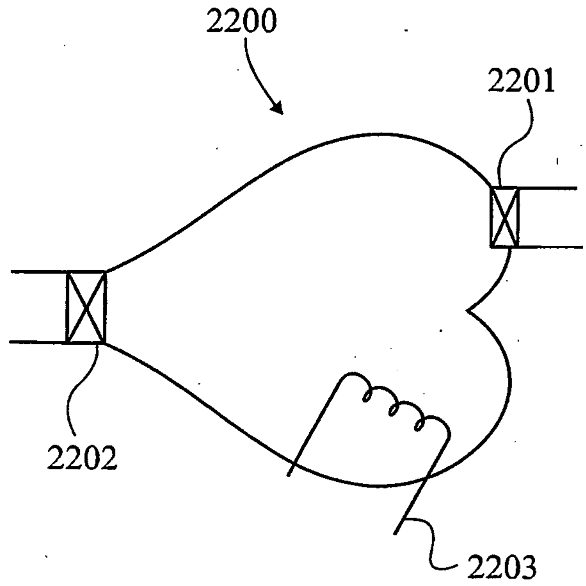

Fig. 22

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 2202440 A **[0006]**
- US 5678637 A1 **[0006]**