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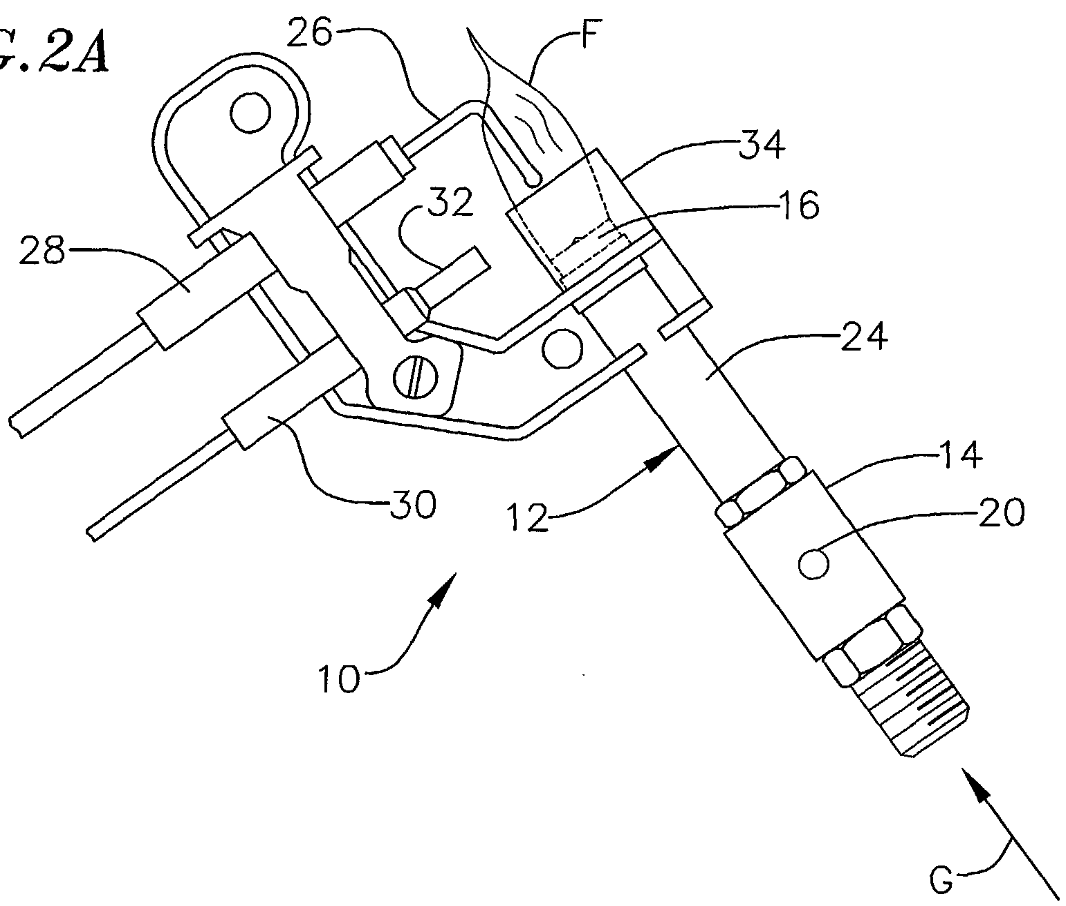
(54) Gas pilot system and method having improved oxygen level detection capability and gas fueled device including the same

(57) A pilot system including a pilot including a nozzle (16) and a sensor (30, 54 or 64) adjacent to the nozzle that determines whether or not the pilot flame is in a predetermined position relative to the nozzle.

FIG.2A



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Description

BACKGROUND OF THE INVENTIONS

1. **Field of Inventions**

[0001] The present inventions relate generally to gas pilots and, more particularly, to the oxygen level detection systems associated with gas pilots.

2. **Description of the Related Art**

[0002] Gas pilot systems are associated with a wide variety of gas fueled devices. Such devices include, but are not limited to, vented gas heaters, which include pipes or conduits that are used to vent exhaust to the atmosphere, vent-free gas heaters, vented and vent-free gas log heater, vented and vent-free fireplace systems, water heaters, vented and vent-free stoves, and ovens. The most common types of gas fuel are natural gas and propane. A gas pilot system typically includes an ignition device, such as an electrode, and a pilot having a small nozzle. A pilot flame is formed when gas from the nozzle is ignited by the ignition device. The pilot flame is then used to ignite the gas that is supplied to the burner(s) of the gas fueled device during use.

[0003] The level of oxygen in the air is typically about 20.9%. It is important that the oxygen level in a room in which a gas fueled device is used remain at or near 20.9%, both for proper combustion and safety purposes. An adequate supply of fresh air will maintain the oxygen level at or near the desired level. In buildings with loose structures, such as houses made of wood, an adequate supply of fresh air will enter via wall spaces as well as door and window frames. Other buildings are more tightly sealed. Here, steps should be taken to insure that fresh air is supplied.

[0004] Unfortunately, some rooms do not receive an adequate supply of fresh air. Thus, for safety purposes, many gas fueled devices include an oxygen depletion sensor system ("ODS system") which will automatically shut off the flow of gas to the pilot and burner when the oxygen level in the air drops below a predetermined "unsafe" level (typically below about 18.2%). The ODS systems monitor the pilot flame because the position of the pilot flame relative to the pilot nozzle is indicative of the oxygen level in the room.

[0005] Referring to FIGURES 1A to 1C, conventional ODS systems employ a thermocouple TC to detect the presence of a pilot flame F when it is in the "normal" oxygen level position (oxygen level greater than or equal to 21%) illustrated in FIGURE 1A or the "relatively low" oxygen level position (oxygen level between 18.2% and 19.2%) illustrated in FIGURE 1B. In either case, gas will continue to flow to the pilot and burner because the voltage generated by the thermocouple TC, and received by the ODS system controller, will be within an allowable range. When the oxygen level drops to an "unsafe" level (oxygen level below 18.2%), the pilot flame F will move to the location illustrated in FIGURE 1C. Here, the pilot flame will not be in contact with the thermocouple TC or substantially close to thermocouple TC. As a result, the temperature of the thermocouple TC will drop, as will the voltage produced thereby. The voltage drop will cause the ODS system to cut off the supply of gas to the pilot and burner. As illustrated in U.S. Patent No. 5,807,098 to Deng, some ODS systems also include a second thermocouple that is used to generate a warning when the pilot flame moves to the "relatively low" oxygen level position.

[0006] Although conventional ODS systems are generally quite useful, the inventor herein has determined that there are also certain disadvantages associated therewith. Most notably, when the level of oxygen in a room is dropping, the pilot flame F will often first bounce back and forth between the "normal" position illustrated in FIGURE 1A and the "relatively low" position illustrated in FIGURE 1B, and then bounce back and forth between the "relatively low" position illustrated in FIGURE 1B and the "unsafe" position illustrated in FIGURE 1C. This can go on for a significant period of time. The pilot flame F will, for example, often bounce back and forth between the "relatively low" position and the "unsafe" position for 15 seconds and, during this time, the temperature at the thermocouple TC will not drop to a level low enough to cause the ODS system to cut off the supply of gas to the pilot and burner. As a result, the inventor herein has determined that the conventional methods of monitoring the pilot flame introduce unnecessary delays into the operation of conventional ODS systems.

SUMMARY OF THE INVENTIONS

[0007] A pilot system in accordance with one embodiment of a present invention includes a pilot having a nozzle and a sensor adjacent to the nozzle that senses or measures a property other than temperature in the pilot area. A gas fueled device in accordance with a present invention includes a burner, a nozzle and a sensor adjacent to the nozzle that senses or measures a property other than temperature in the pilot area. Exemplary sensors include light sensors and electrical resistance measurement devices. The sensor determines whether or not the pilot flame is in a predetermined position relative to the nozzle. In a preferred implementations, the sensor determines when the pilot flame is not in either of the "normal" oxygen level and "relatively low" oxygen level positions, i.e. when the pilot flame is in the "unsafe" oxygen level position.

[0008] There are a number of advantages associated with such inventions. Most notably, non-temperature based sensors are capable of detecting movement of the pilot flame the instant that the pilot flame first moves to the "unsafe" oxygen level position, even if it quickly bounces back to the "relatively low" oxygen level position. ODS systems employing the present pilot system will, therefore, be able to make an "unsafe" oxygen level determination much more quickly than ODS systems that employ a conventional thermocouple-based pilot flame monitoring arrangement. As a result, ODS systems employing the present pilot system will also be able to, for example, cut off the supply of gas to a pilot and burner much faster than ODS systems that employ a conventional thermocouple-based pilot flame monitoring arrangement.

[0009] The above described and many other features and attendant advantages of the present inventions will become apparent as the inventions become better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Detailed description of preferred embodiments of the inventions will be made with reference to the accompanying drawings.

FIGURE 1A is a side view of a conventional pilot system and oxygen depletion sensor with the pilot flame in the "normal" oxygen level position.

FIGURE 1B is a side view of the conventional pilot system and oxygen depletion sensor illustrated in FIGURE 1A with the pilot flame in the "relatively low" oxygen level position.

FIGURE 1C is a side view of the conventional pilot system and oxygen depletion sensor illustrated in FIGURE 1A with the pilot flame in the "unsafe" oxygen level position.

FIGURE 2A is a side view of a pilot system and oxygen depletion sensor in accordance with a preferred embodiment of a present invention with the pilot flame in the "normal" oxygen level position.

FIGURE 2B is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 2A with the pilot flame in the "relatively low" oxygen level position.

FIGURE 2C is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 2A with the pilot flame in the "unsafe" oxygen level position.

FIGURE 3 is a section view of a mixing chamber in accordance with a preferred embodiment of a present invention.

FIGURE 4 is a top view of a portion of the pilot system and oxygen depletion sensor illustrated in FIGURE 2A.

FIGURE 5A is a side view of a pilot system and oxygen depletion sensor in accordance with a preferred embodiment of a present invention with the pilot flame in the "normal" oxygen level position.

FIGURE 5B is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 5A with the pilot flame in the "relatively low" oxygen level position.

FIGURE 5C is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 5A with the pilot flame in the "unsafe" oxygen level position.

FIGURE 6 is a top view of a portion of the pilot system and oxygen depletion sensor illustrated in FIGURE 5A.

FIGURE 7A is a side view of a pilot system and oxygen depletion sensor in accordance with a preferred embodiment of a present invention with the pilot flame in the "normal" oxygen level position.

FIGURE 7B is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 7A with the pilot flame in the "relatively low" oxygen level position.

FIGURE 8 is a perspective view of a portion of the pilot system and oxygen depletion sensor illustrated in FIGURE 7A.

FIGURE 9 is a plan view of a portion of the pilot system and oxygen depletion sensor illustrated in FIGURE 7A.

FIGURE 10A is a side view of a pilot system and oxygen depletion sensor in accordance with a preferred embodiment of a present invention with the pilot flame in the "normal" oxygen level position.

FIGURE 10B is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 10A with the pilot flame in the "relatively low" oxygen level position.

FIGURE 10C is a side view of the pilot system and oxygen depletion sensor illustrated in FIGURE 10A with the pilot flame in the "unsafe" oxygen level position.

FIGURE 11 is a perspective view of a heater in accordance with a preferred embodiment of a present invention.

FIGURE 12 is a partially exploded view of a propane gas heating assembly that may be used in conjunction with the heater illustrated in FIGURE 11.

FIGURE 13 is a diagram of a portion of a gas fueled system in accordance with a preferred embodiment of a present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] The following is a detailed description of the best presently known modes of carrying out the inventions. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the inventions.

[0012] As illustrated for example in FIGURES 2A, 3 and 4, a pilot system 10 in accordance with a preferred embodiment of a present invention includes a pilot 12 having a gas/air mixing chamber 14 and a nozzle 16. Gas G enters the mixing chamber 14 through a small gas orifice 18, while air A enters the mixing chamber through a pair of small air orifices 20. The gas/air mixture G/A exits the mixing chamber 14 through an outlet orifice 22. Mixing continues as the gas/air mixture G/A travels through a tube 24 to the nozzle 16. The gas G in the gas/air mixture G/A is ignited by the L-shaped electrode 26 of an ignitor 28 to create the pilot flame F. The inlet and outlet orifices 18 and 22 are preferably formed from a relatively hard material. In a preferred implementation, the orifices are formed in a ruby or other hard precious stone that is mounted in a copper frame.

[0013] The size of the orifices 18 and 20 depends on the fuel being used. For example, when the fuel is natural gas supplied at a pressure of 6 inches of mercury, the orifice 18 is approximately 0.38 mm in diameter and the orifice 18 is approximately 0.46 mm in diameter when the natural gas is supplied at a pressure of 3 inches of mercury. In both cases, the orifices 20 are each approximately 3 mm in diameter. The orifice 18 is approximately 0.22 mm in diameter and the orifices 20 are each approximately 3.2 mm in diameter when the fuel is liquid propane gas supplied at about 8 to 11 inches of mercury. The outlet orifice 22 is approximately 4 mm. The outlet pressure should be about 8 to 11 inches of mercury when the fuel is liquid propane gas and about 3 to 6 inches of mercury when the fuel is natural gas.

[0014] Mixing the gas and air in the manner described above is advantageous because it insures that the level of oxygen in the ambient air will be accurately represented by the position of the pilot flame F, thereby increasing the accuracy of the ODS system described below. Accuracy of the ODS system may also be augmented by controlling movement of the pilot flame F through use of the relationship between the diameter of the pilot nozzle 16, the fuel pressure, the distance of the electrode 26 from the nozzle as well as the location of the electrode relative 26 to the nozzle centerline, and the level of oxygen in the air. In a pilot system for use in conjunction with a propane gas heater such as that illustrated in FIGURES 11-13, the diameter of the pilot nozzle 16 is approximately 0.23 mm ($\pm$0.005 mm) and the gas pressure is between 8 and 11 inches of mercury. The downwardly extending portion of the L-shaped electrode 26 is offset with respect to the centerline of the pilot nozzle 16 by 3.00 mm and is spaced approximately 3.50 mm from the nozzle. Such an arrangement reduces the speed of gas flow, thereby increasing the duration and effectiveness of gas/air mixing, and also reduces the tendency of the pilot flame F to bounce around, as compared to conventional S-shaped electrodes.

[0015] The exemplary pilot systems disclosed herein also includes an oxygen depletion sensor that may be used in a ODS systems in the manner described below with reference to FIGURES 11-13. The oxygen depletion sensor is preferably a sensor that measures or senses a property other than temperature and a variety of such oxygen depletion sensors are described below.

[0016] The oxygen depletion sensor in the exemplary pilot system 10 illustrated in FIGURES 2A, 3 and 4 is a light sensor that senses light from the pilot flame F. Any suitable light sensor may be employed so long as it is capable of detecting the presence and absence of light emitted by the pilot flame F. In one preferred embodiment, the pilot system 10 is provided with an infrared sensing device 30 having a sensing element 32 that is positioned adjacent to the pilot nozzle 16 and pilot flame F. A suitable infrared sensing device is manufactured by Shanghai Infrared Appliances Co., located in Shanghai, China. The pilot flame F generates infrared electromagnetic radiation (i.e. electromagnetic radiation with wavelengths between 750 nanometers and 1 millimeter) which is sensed by the sensing element 32 when the pilot flame is in the "normal" oxygen level position illustrated in FIGURE 2A (oxygen level greater than or equal to 21%) and, in the illustrated embodiment, in the "relatively low" oxygen level position illustrated in FIGURE 2B (oxygen level between 18.2% and 19.2%). The infrared radiation causes the sensing element 32 to generate a flame signal which indicates that the flame is in an allowable (or "safe") position. Another example of a suitable light sensor is one that senses visible light (not shown), such as those produced by China Wuxi Light Appliances Co, located in Wuxi, China.

[0017] In the preferred embodiment, the instant that the pilot flame F moves beyond the "relatively low" oxygen level position illustrated in FIGURE 2B to the "unsafe" level position (oxygen level below 18.2%) illustrated in FIGURE 2C, the sensing device 30 will stop generating a flame signal which indicates that the pilot flame is in an allowable position. The signal from the sensing device may drop to zero, or simply to a level lower than the expected level, when the pilot flame F moves from the "normal" or "relatively low" oxygen level position to the "unsafe" oxygen level position. Thus, even in those instances where the pilot flame F jumps back and forth between the "relatively low" and "unsafe" oxygen level positions, the present sensing device 30 will immediately indicate that the oxygen level has dropped to an "unsafe" level because it will fail to produce the expected flame signal the first time that the pilot flame moves out beyond of the "relatively low" position to the "unsafe" position.

[0018] As illustrated in FIGURES 2A and 4, the exemplary pilot system 10 may also be provided with a light shield 34 that is positioned above the nozzle 16 around the area that will be occupied by the pilot flame F when the oxygen level is "normal." The light shield 34, which is preferably opaque, non-reflective and formed from metal, includes a slot 36 that faces the sensing element 32. The light shield 34 prevents the sensing element 32 from being effected by stray light that could result in the expected flame signal when the flame is actually in the "unsafe" oxygen level position. As such, the sensing element 32 will only be effected by the infrared or visible electromagnetic radiation from the pilot flame F which passes through the slot 36 when the pilot flame is in the "normal" and "relatively low" oxygen level positions. In the illustrated embodiment, the light shield 34 is about 7.2 mm in diameter and about 10 mm in length, while the slot 36 is about 3.6 mm wide.

[0019] In an alternative embodiment (not shown), the components may be reconfigured such that the sensing device 30 will stop generating a signal which indicates that the pilot flame F is in an allowable position the instant that the pilot flame F moves out of the "normal" oxygen level position to either the "relatively low" oxygen level position or the "unsafe" oxygen level position. For example, the light shield 34 could be provided with a small hole that faces the sensing element 32 in place of the slot 36 in order to substantially reduce the amount of light from the pilot flame F that will reach the sensing element when the pilot flame moves to the "relatively low" oxygen level position.

[0020] The exemplary pilot system 10 is also provided with a bracket system 38 that fixes the positions of the various elements of the pilot system relative to one another. Referring more specifically to FIGURES 2B and 2C, the exemplary bracket system 38 includes a L-shaped main bracket 40 having a first portion 42 that is mounted on the pilot 12 adjacent to the nozzle 16. The light shield 34 is supported by the first portion 42. The ignitor 28 and sensing device 30 are mounted on a second portion 44 of the main bracket 40 and are fixed in place by a clamp 46. The clamp 46 may be secured to the main bracket 40 with a screw 48 or other suitable fastening device. A pair of mounting apertures 50 and 52 are formed in the main bracket 40 so that the pilot system 10 may be easily mounted within a gas fueled device. In the illustrated embodiment, the end of the sensing element 32 is about 20 to 22 mm from the nozzle 16 and about 26 to 36 mm above the nozzle (measured with the system 10 oriented such that the pilot 12 extends vertically).

[0021] Another exemplary pilot system, which is generally represented by reference numeral 10', is illustrated in Figures 5A-6. Pilot system 10' is substantially similar to pilot system 10 and similar elements are represented by similar reference numerals. Turning first to Figures 5A and 6, the pilot system 10' includes a sensor that measures the electrical resistance of whatever gas (e.g. pure air, pure gas or a gas/air mixture) is in the area adjacent to the nozzle 16. Any suitable resistant measurement device may be employed so long as it is capable of measuring the electrical resistance of the gas in the area adjacent to the nozzle. The exemplary pilot system 10' is provided with an electrical resistance measuring device 54 including an sensing device 56 that is positioned adjacent to the pilot nozzle 16 and pilot flame F. The sensing device 56 includes a pair of generally L-shaped electrodes 58a and 58b positioned above the nozzle 16 in the position shown in Figure 6. A space 60 of approximately 3 mm separates the free ends of the L-shaped electrodes 58a and 58b, which are located in the area that will be occupied by the outer edge of the pilot flame F when the pilot flame in the "normal" oxygen level position illustrated in Figure 5A. The pilot system 10' also includes a shield 34' with a slot 36' that accommodates the L-shaped electrodes 58a and 58b.

[0022] Preferably, a constant current (I) is applied to the sensing device 56 by the electrical resistance measuring device 54 and the voltage (V) across the electrodes 58a and 58b is measured by the measuring device. The electrical resistance (R) may then be determined using the R=V/I formula. The measuring device 54 also produces a signal indicative of the electrical resistance in the area adjacent to the nozzle 16.

[0023] The high temperature at the outer edge of the pilot flame F causes the gas in the gas/air mixture G/A to be ionized and electrical resistance is inversely related to the level of gas ionization. The electrical resistance of the gas in the region adjacent to the nozzle 16 will be approximately 8-12 MΩ (i.e. $8\text{-}12 \times 10^6\ \Omega$) when the pilot flame is in the "normal" oxygen level position (oxygen level greater than or equal to 21%) illustrated in FIGURE 5A. The resistance level will be significantly lower when the pilot flame F is in the region adjacent to the nozzle 16 (FIGURE 5A) than it will be when the pilot flame F is in the "relatively low" oxygen level position (oxygen level between 18.2% and 19.2%) illustrated in FIGURE 5B. More specifically, the electrical resistance will rise to about 20 MΩ when the pilot flame F is in the "relatively low" oxygen level position illustrated in FIGURE 5B because the hot outer edge of the pilot flame F will no longer be present in the region where resistance is being measured. This results in a reduction in temperature in the region adjacent to the nozzle 16 and a correspondingly lower level of gas ionization. The resistance will be about 80-100 MΩ when the pilot flame F is in the "unsafe" level position (oxygen level below 18.2%) illustrated in FIGURE 5C because the temperature and gas ionization levels in the region adjacent to the nozzle 16 will fall even further.

[0024] The difference in resistance will be detected by the measuring device 54 within about 1 second from the time at which the pilot flame F moves. This is true whether pilot flame F is moving from the "normal" oxygen level position to the "relatively low" oxygen level position, or from the "relatively low" oxygen level position to the "unsafe" oxygen level position. Thus, even in those instances where the pilot flame F jumps back and forth between the "normal" and "relatively low" oxygen level positions, the present measuring device 54 will immediately indicate that the oxygen level has dropped to a "relatively low" level because the resistance measured thereby will increase beyond the 8-12 MΩ range the first time that the pilot flame F moves out of the "normal" oxygen level position to the "relatively low" oxygen level position. Similarly, in those instances where the pilot flame F jumps back and forth between the "relatively low" and "unsafe" oxygen level positions, the present measuring device 54 will immediately indicate that the oxygen level has dropped to an "unsafe" level because the resistance measured thereby will increase beyond the 20 MΩ range the first time that the pilot flame moves out of the "relatively low" oxygen level position to the "unsafe" oxygen level position.

[0025] Another exemplary pilot system, which is generally represented by reference numeral 10", is illustrated in Figures 7A-9. Pilot system 10" is substantially similar to pilot system 10' and similar elements are represented by similar reference numerals. The pilot system 10" also includes a sensor that measures the electrical resistance of whatever gas (e.g. pure air, pure gas or a gas/air mixture) is in the area adjacent to the nozzle 16. Here, an electrical resistance measuring device 62 includes a sensing device 64 that is positioned adjacent to the pilot nozzle 16 and pilot flame F. The sensing device 64 includes a first electrode that defines an enclosed open area, such as the exemplary annular electrode 66 that defines an open area 68, and a second electrode, such as the exemplary L-shaped electrode 70, which has a portion that is positioned within the open area. The L-shaped electrode 70 is also used to ignite the gas in the exemplary embodiment.

[0026] The annular electrode 66 in the exemplary embodiment is preferably formed from stainless steel wire that is about 1 mm in diameter. The annular electrode 66 also has an outer diameter of about 8 mm and is positioned about 8 mm above the nozzle 16 so that it occupies the area that will be occupied by the outer edge of the pilot flame F when the pilot flame in the "normal" oxygen level position illustrated in Figure 7A. The exemplary L-shaped electrode 70 is also formed from stainless steel wire that is about 1 mm in diameter. As such, within the open area 68, the distance D (Figure 9) between the L-shaped electrode 70 and the inner surface of the annular electrode 66 is about 2.5 mm. The electrodes 66 and 70 are preferably supported by insulative structures 72 and 74.

[0027] A constant current (I) is applied to the sensing device 64 by the measuring device 62 and the voltage (V) across the electrodes 66 and 70 is measured by the measuring device. The electrical resistance (R) may then be determined using the R=V/I formula. The measuring device 62 also produces a signal indicative of the electrical resistance in the area adjacent to the nozzle 16.

[0028] The electrical resistance of the gas in the region adjacent to the nozzle 16 will be approximately 8-12 MΩ (i.e. 8-12x10^6 Ω) when the pilot flame is in the "normal" oxygen level position (oxygen level greater than or equal to 21%) shown in FIGURE 7A. As noted above, the resistance level will increase significantly when the pilot flame F moves out of the "normal" oxygen level position adjacent to the nozzle 16 (FIGURE 7A) to the "relatively low" oxygen level position (oxygen level between 18.2% and 19.2%) illustrated in FIGURE 7B or to the "unsafe" oxygen level position (oxygen level below 18.2%). The difference in resistance will be detected by the measuring device 62 within about 1 second from the time at which the pilot flame F moves. This is true whether pilot flame F is moving from the "normal" oxygen level position to the "relatively low" oxygen level position, or to the "unsafe" oxygen level position.

[0029] Thus, even in those instances where the pilot flame F jumps back and forth, the present measuring device 62 will immediately indicate that the oxygen level has dropped to a "relatively low" level because the resistance measured thereby will increase beyond the 8-12 MΩ range the first time that the pilot flame F moves out of the "normal" oxygen level position to the "relatively low" oxygen level position. Alternatively, the present measuring device 62 may be used to immediately indicate that the oxygen level has dropped to an "unsafe" level the first time that the pilot flame F moves to the "unsafe" oxygen level position and the resistance exceeds 20 MΩ.

[0030] Another exemplary pilot system, which is generally represented by reference numeral 10"', is illustrated in Figures 10A-10C. Pilot system 10"' is substantially similar to pilot system 10 and similar elements are represented by similar reference numerals. For example, pilot system 10"' includes a pilot 12 having a gas/air mixing chamber 14 and a nozzle 16. The gas G in the gas/air mixture G/A is ignited by an electrode 26' of an ignitor 28, which is supported by a bracket system 38', to create the pilot flame F. Here, however, the oxygen depletion sensor is a light sensor that senses light associated with the ignition electrode 26' instead of light from the pilot flame F. The electrode 26' will glow when the flame F is in the "normal" oxygen level position (oxygen level greater than or equal to 21%) shown in FIGURE 10A or the "relatively low" oxygen level position (oxygen level between 18.2% and 19.2%) shown in FIGURE 10B, but will stop glowing (or will fail to create a sufficiently detectable amount of light if only glowing slightly) when the pilot flame F moves to the "unsafe" oxygen level position (oxygen level below 18.2%) shown in FIGURE 10C. The sensed light from the electrode may be either visible or infrared, depending on the type of sensor used.

[0031] In the illustrated embodiment, a sensing device 30 having a sensing element 32 is positioned adjacent to the electrode 26'. Any suitable light sensor may be employed so long as it is capable of detecting the presence or absence of light emitted by the electrode 26'. When the pilot flame F moves beyond the "relatively low" oxygen level position, the electrode 26' will stop glowing and the sensing device 30 will stop generating a flame signal which indicates that the pilot flame is in an allowable position. The signal may drop to zero, or simply to a level lower than an expected level. Alternatively, the electrode 26' may be repositioned so that it will stop glowing when the pilot flame moves beyond the "normal" oxygen level position.

[0032] Although not so limited, heaters are one example of a gas fueled device in accordance with the present inventions. An exemplary heater 100 is shown in FIGURE 11. Such a heater may be fueled by natural gas, propane gas or other appropriate fuels. The exemplary heater 100 includes a housing 102 mounted on a base 104. The housing 102 includes a heating chamber 106 which contains a plurality of heat emitting ceramic infrared burner plaques 108 and is covered by a grill 110. The housing 102 also includes a plurality of air circulation vents 112 and 114. Air enters the housing through vent 112 and exits through the heating chamber grill 110 and the vent 114. A pair of handles (not shown) may also be provided on the sides of the housing. The heater controls are located on the top portion 116 of the housing 102 in the exemplary heater 100. These controls include an on/off button 118, an ignition/pilot button 120, and a burner control knob 122 that is used to block/permit the flow of gas to the pilot 12 and to select the number of burners to which fuel will be supplied. The on/off button 118 and the ignition/pilot button 120 are part of a control device 124 which, in the exemplary control embodiment, includes an electronic controller 125 such as a control circuit, microcontroller, microprocessor or other suitable control apparatus.

[0033] As shown by way of example in FIGURE 12, a propane gas-fueled heating assembly that may be used in conjunction with the housing 102 shown in FIGURE 11 includes five burners 126, each of which consists of an infrared ceramic plaque 108 that is secured to a corresponding burner box 128. The number of burners may, however, be increased or decreased to suit particular applications. An upper burner deflector bracket 130 and lower burner deflector bracket 132 are also shown. Additionally, although the propane gas-fueled heating assembly illustrated in FIGURE 12 includes the exemplary pilot system 10''' illustrated in Figures 10A-10C, any of the other pilot systems illustrated herein (i.e. systems 10, 10' and 10'') may be employed in its place.

[0034] Gas enters the heating assembly in the exemplary embodiment through a pressure regulator 134 and travels through an inlet pipe 136 to a control valve 138. No gas will pass beyond the control valve 138 when the control knob 122 is set to the OFF position. Propane gas is supplied to the pilot system and burners in the following manner. Turning first to the pilot system, and referring to FIGURES 12 and 13, the heater is placed in the pilot mode by turning the control knob 122 from the OFF position to the PILOT position and then depressing the knob and holding it in place. This allows gas to flow to the pilot 12 through a gas line 139. The on/off button 118 is then pressed to supply power to the system. Next, when the ignition/pilot button 120 is pressed, pulses of power will be supplied to the ignition electrode 26' by way of a connection line 140. So long as the user continues to holds the ignition/pilot button 120 and a pilot flame has not been lit, the pulses will continue for 20 seconds and then cease for 10 seconds with this pattern repeating for 5 minutes. The system will shut of if there is no pilot flame at the end of the 5 minute period.

[0035] Once the pilot flame is lit, the pilot flame sensing device associated with the pilot system (the sensing device 30 in pilot system 10''', for example) will send a signal to the control 124 by way of a connection line 142 which indicates that a pilot flame is present. The controller 125 will then cause a magnetic valve unit 144, which is normally closed, to open so that the supply of gas to the pilot 12 will be maintained when the user releases the control knob 122. The opening of the magnetic valve unit 144 will also allow the user to supply gas to the burners 126. To that end, the exemplary heater 100 includes LOW, MEDIUM and HIGH heat output settings which correspond to one, three or five burners 126 receiving gas. The heat output settings are selected by rotating the control knob 122. When the control knob 122 rotated from the PILOT position (where gas will be supplied to the pilot 12 if the control knob is depressed) to the LOW position, gas will be supplied to one of the burners 126 through a gas line 146. Gas will be supplied to three of the burners 126, through gas lines 146 and 148, when the control knob 122 is in the MEDIUM position, and will be supplied to all five of the burners, through gas lines 146, 148 and 150, when the control knob is in the HIGH position.

[0036] It should be noted that if, for example, a three burner design is employed, then the corresponding progression could be one, two or three burners. It should also be noted that heaters in accordance with the present invention may also be constructed in such a manner that all of the burners will be used whenever the heater is in operation and the amount of gas supplied to the burners will be controlled by a thermostat.

[0037] Turning to oxygen level detection, the flame sensing device (the sensing device 30 in pilot system 10''', for example) and controller 125 form an ODS system that may operate in the following manner. As noted above, the instant that the pilot flame F moves to the "unsafe" oxygen level position (oxygen level below 18.2%), the sensing device 30 will stop generating a flame signal which indicates that the pilot flame is in an allowable position. The controller 125 will, as a result, immediately close the magnetic valve 144 that allows gas to pass to the pilot 12 and the burners 126. The heater 100 may, if desired, be provided with an audio and/or visual alarm that is triggered by the controller 125 when the valve 144 is closed by the controller in response to an "unsafe" oxygen level detection.

[0038] Although the present inventions have been described in terms of the preferred embodiments above, numerous modifications and/or additions to the above-described preferred embodiments would be readily apparent to one skilled in the art. By way of example, but not limitation, the present inventions may be incorporated in heaters which do not have a thermostatic control system. The "unsafe," "low" and "normal" oxygen level percentages discussed above may be varied if desired. The exemplary pilot system may also be incorporated into other gas fueled devices such as water heaters, stoves, ovens and other types of heaters. The pilot, sensing device and controller could also be reconfigured and repositioned such that the sensing device senses the flame when it is in the "unsafe" oxygen level position and this sensing results in closure of the gas valve(s). It is intended that the scope of the present inventions extends to all such modifications and/or additions.

[0039] Also, in addition to the inventions claimed below, the inventions herein also include a gas fueled device comprising a burner, a pilot including a nozzle associated with the burner, and a measurement device adjacent to the nozzle that measures a property other than temperature.

[0040] The burner in such a gas fueled device may, for example, be a ceramic plaque.

[0041] The measurement device in such a gas fueled may be an electrical resistance measurement device such as, for example, a device that includes a pair of spaced electrodes. Here, the gas fueled device may, for example, include an ignitor positioned adjacent to the nozzle such that the electrical resistance measurement device is located between the nozzle and the ignitor. The measurement device may, alternatively, be sensor that senses electromagnetic radiation, such as a light sensor or an infrared light sensor. Here, the gas fueled device may, for example, include an ignitor positioned adjacent to the nozzle that emits electromagnetic radiation when heat by the pilot flame and sensor will sense electromagnetic radiation from the ignitor.

[0042] The pilot in such a gas fueled device may, for example, be constructed such that the pilot flame will be located in a first position in response to a first oxygen level and a second position in response to a second oxygen level, the second oxygen level being less than the first oxygen level. Here, the measurement device will measure a level of the property other than temperature that is indicative of an allowable oxygen level when the pilot flame is in the first position and will not measure a level of the property other than temperature that is indicative of an allowable oxygen level when the pilot flame is in the second position.

[0043] The gas fueled device may, for example, include a gas inlet operably connected to the pilot and a control device operably connected to the measurement device that prevents gas flow from the gas inlet to the pilot when the measurement device does not measure a level of the property other than temperature indicative of an allowable oxygen level.

[0044] The gas fueled device may, for example, include a gas inlet operably connected to the burner and a control device operably connected to the measurement device that prevents gas flow from the gas inlet to the burner when the measurement device does not measure a level of the property other than temperature indicative of an allowable oxygen level.

[0045] In addition to the inventions claimed below, the inventions herein also include a method of monitoring a pilot flame produced by a pilot comprising the steps of determining whether the pilot flame is located in a predetermined region associated with the pilot by sensing a property other than temperature and preventing gas from flowing to the pilot in response to a determination that the pilot flame is not in the predetermined region.

[0046] The step of determining whether the flame is located in the predetermined region may, for example, comprise measuring electrical resistance in the predetermined region. In those instances where the gas pilot includes a nozzle and an ignitor defining a region therebetween, the step of determining whether the pilot flame is located in a predetermined region may, for example, comprise determining whether the pilot flame is located between the nozzle and the ignitor.

[0047] The step of determining whether the flame is located in the predetermined region may, for example, comprise sensing light in the predetermined region. In those instances where the gas pilot includes a nozzle and an ignitor, the step of determining whether the pilot flame is located in a predetermined region may, for example, comprise sensing light emitted from the ignitor.

Claims

1. A pilot system for generating a pilot flame including a pilot (12) having a nozzle (16), **characterized by**:

a measurement device (30, 54 or 64) adjacent to the nozzle (16) that measures a property other than temperature.

2. A pilot system as claimed in claim 1, wherein the measurement device comprises an electrical resistance measurement device (54 or 64).

3. A pilot system as claimed in claim 2, wherein the electrical resistance measurement device comprises a pair of spaced electrodes (58a/58b or 66/70).

4. A pilot system as claimed in claim 2, further comprising:

an ignitor (26) positioned adjacent to the nozzle;

wherein the electrical resistance measurement device (54) is located between the nozzle (16) and the ignitor (26).

5. A pilot system as claimed in claim 1, wherein the measurement device comprises a sensor (30) that senses electromagnetic radiation.

6. A pilot system as claimed in claim 5, further comprising:

an ignitor (26') positioned adjacent to the nozzle (16) that emits electromagnetic radiation when heat by the pilot flame;

wherein the sensor (30) senses electromagnetic radiation from the ignitor (26').

7. A pilot system as claimed in claim 1, wherein the measurement device comprises a light sensor (30).

8. A pilot system as claimed in claim 7, wherein the light sensor (30) comprises an infrared light sensor.

9. A pilot system as claimed in claim 1, wherein the pilot (12) is constructed such that the pilot flame will be located in a first position in response to a first oxygen level and a second position in response to a second oxygen level, the second oxygen level being less than the first oxygen level, and the measurement device (30, 54 or 64) will measure a level of the property other than temperature that is indicative of an allowable oxygen level when the pilot flame is in the first position and will not measure a level of the property other than temperature that is indicative of an allowable oxygen level when the pilot flame is in the second position.

10. A pilot system as claimed in claim 1, further comprising:

a mixing chamber (14) located upstream of the nozzle (16) including a gas inlet (18), an air inlet (20) and a gas/air mixture outlet (22) in communication with the nozzle.

FIG. 1A
PRIOR ART

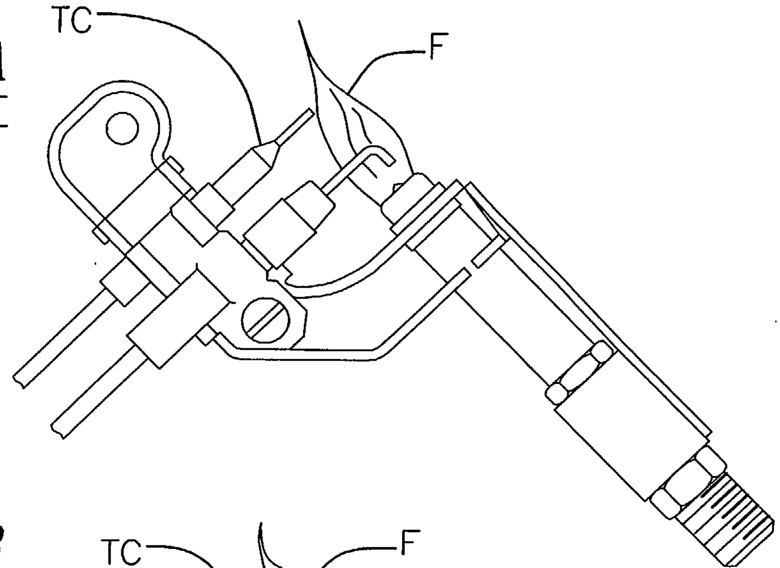

FIG. 1B
PRIOR ART

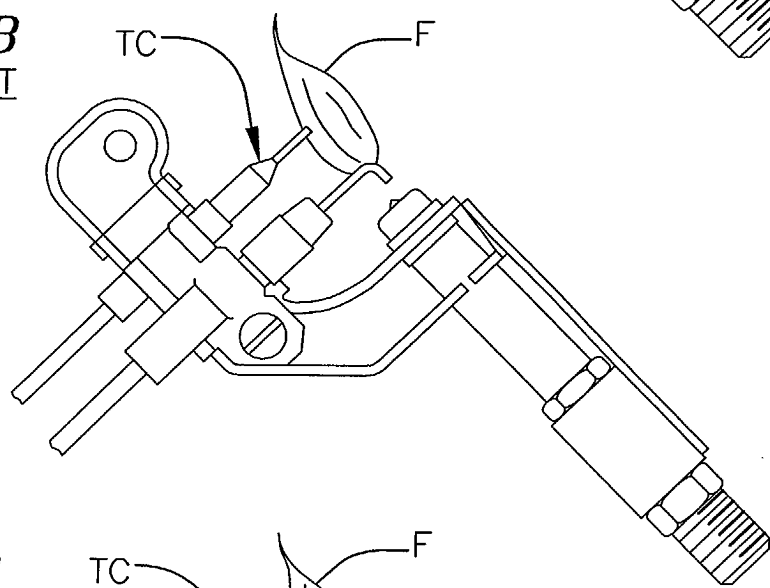

FIG. 1C
PRIOR ART

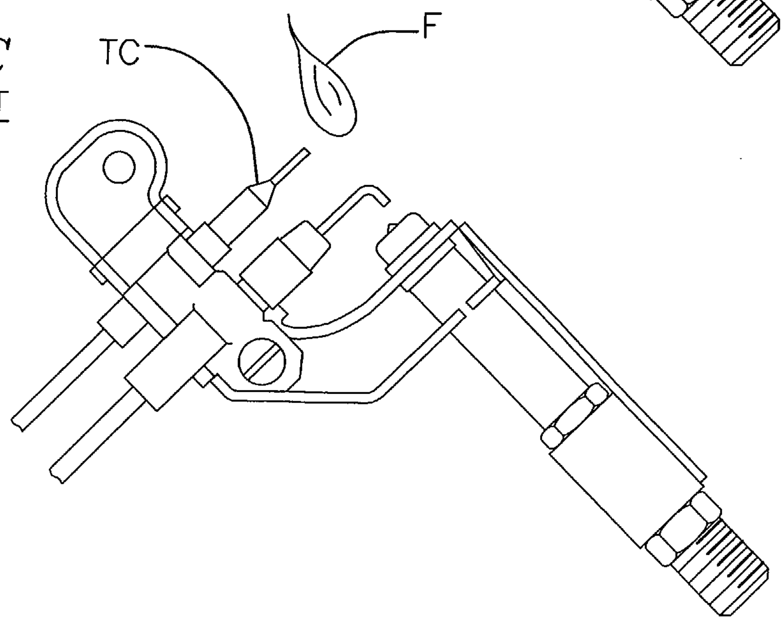

FIG. 2A

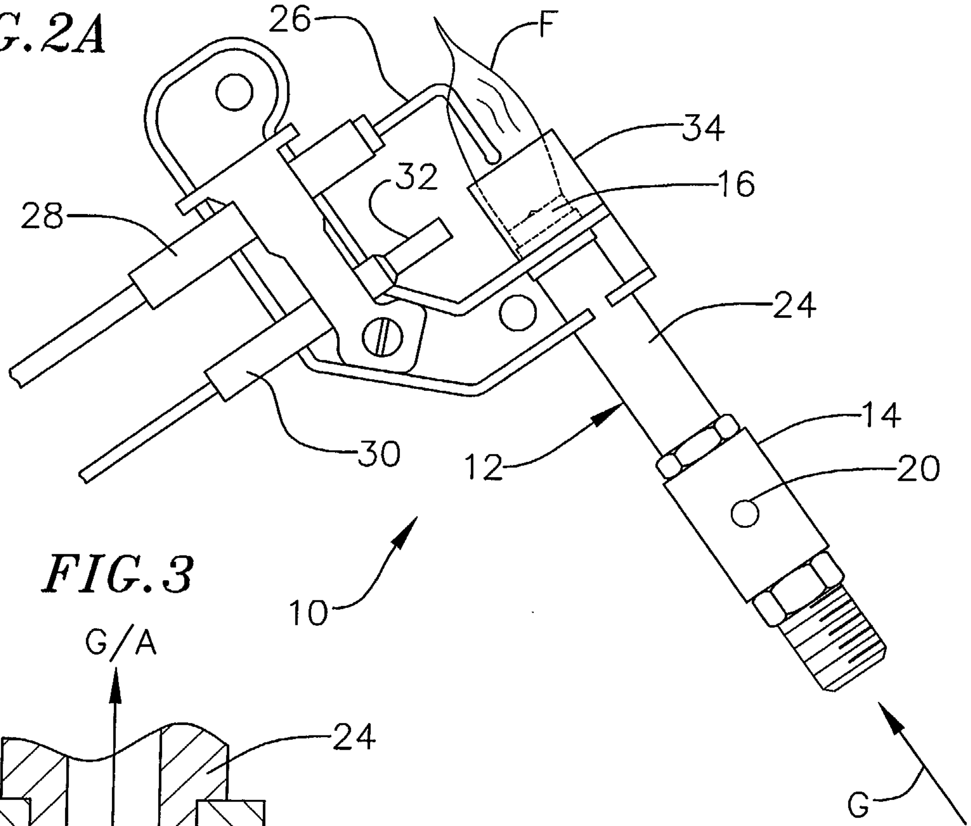

FIG. 3

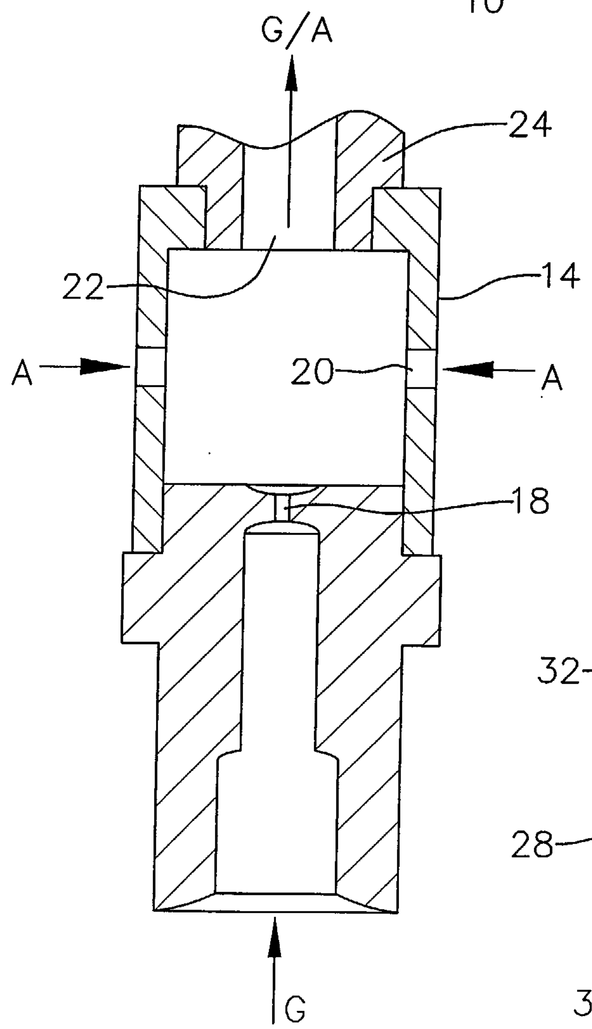

FIG. 4

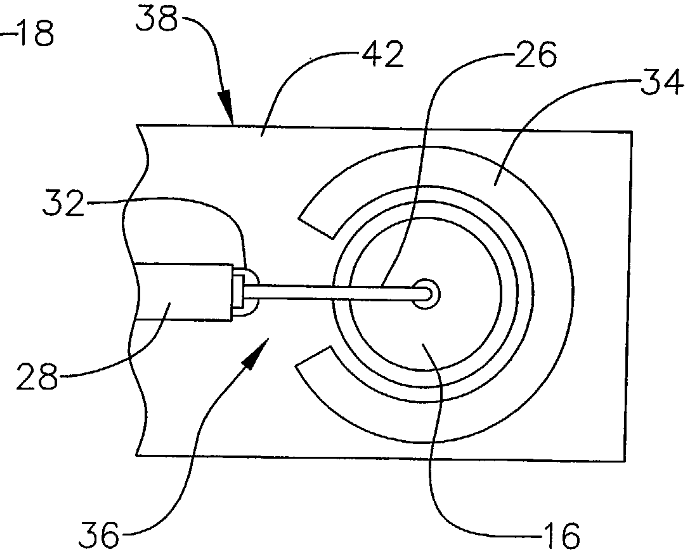

FIG.2B

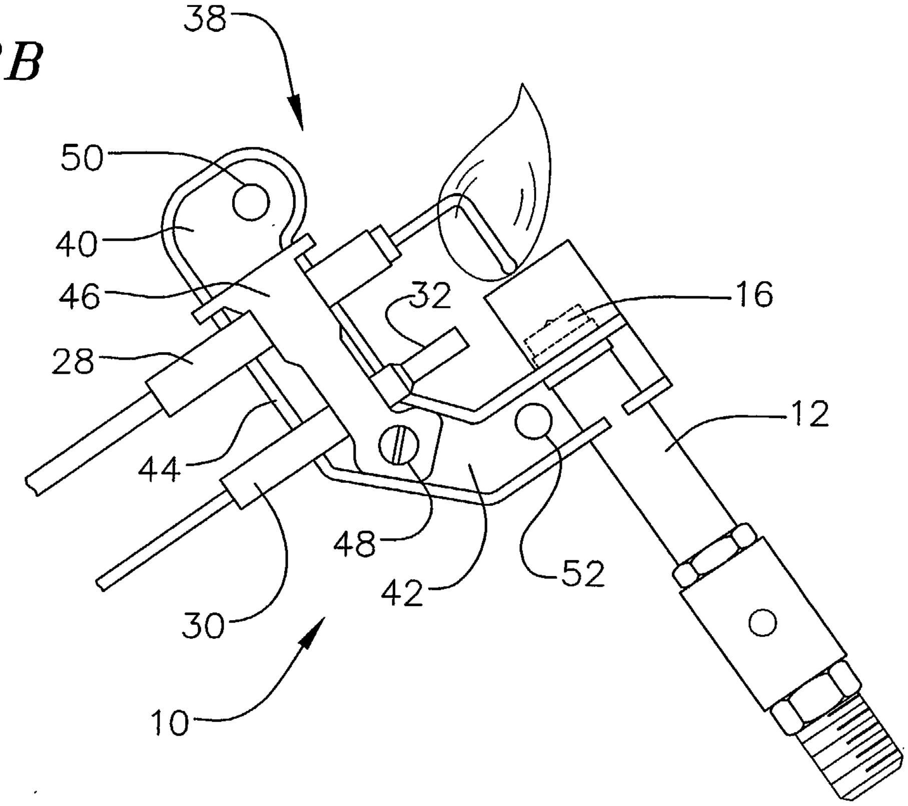
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FIG.2C

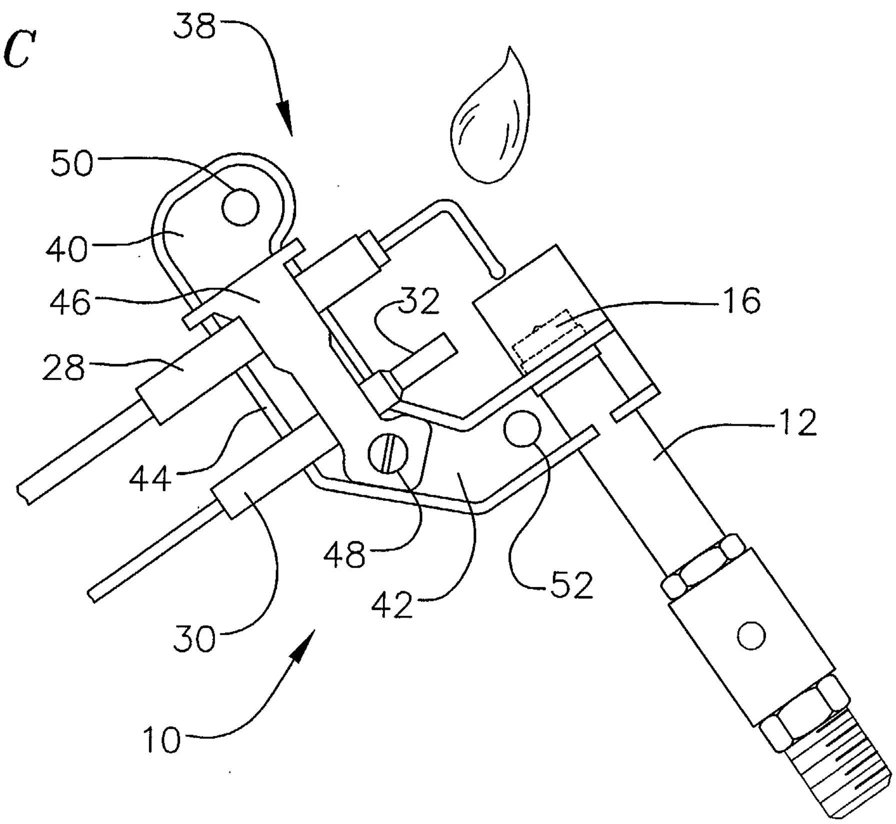
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FIG.5A

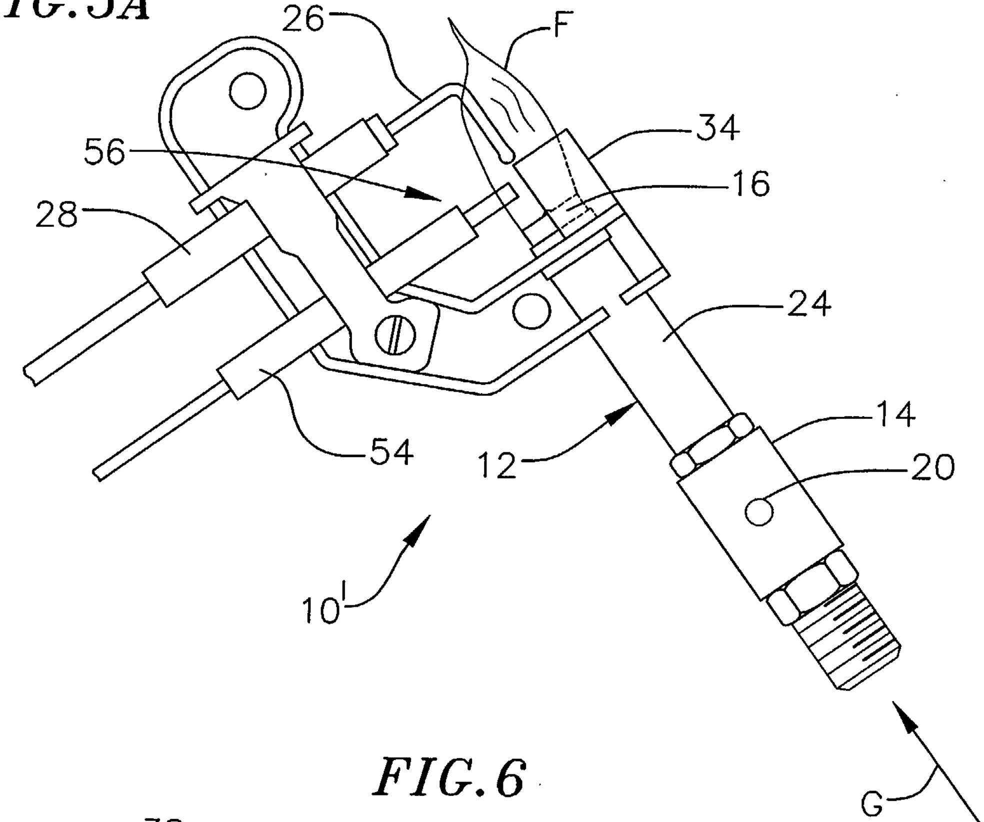
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FIG.6

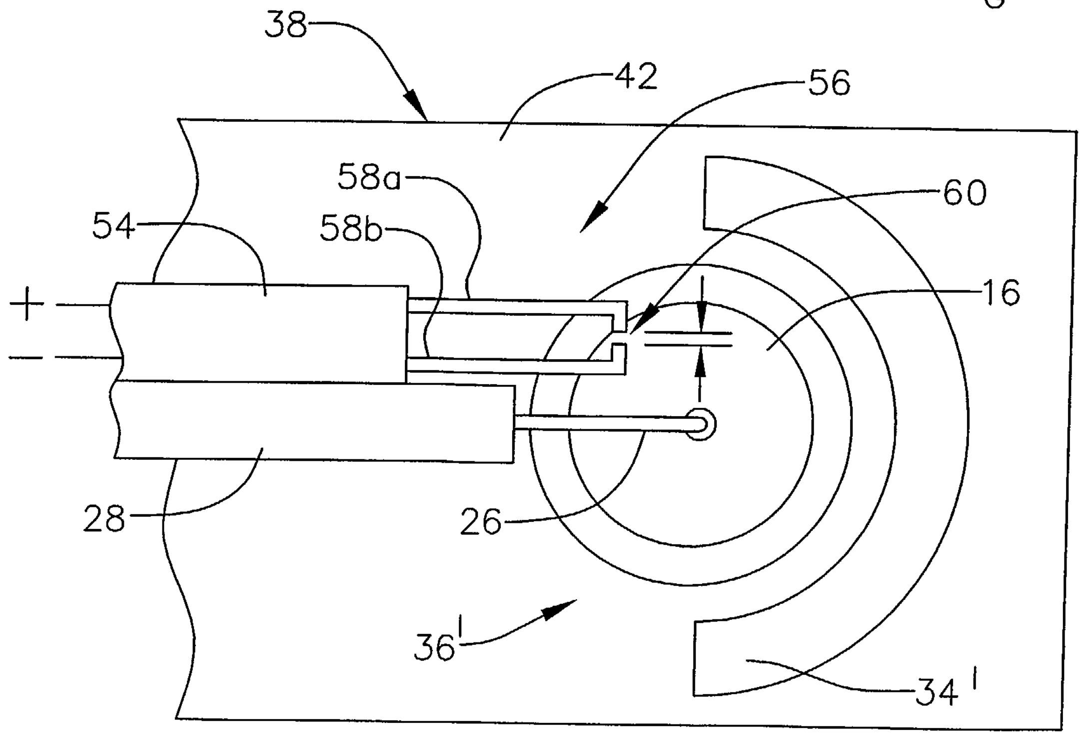
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FIG.5B

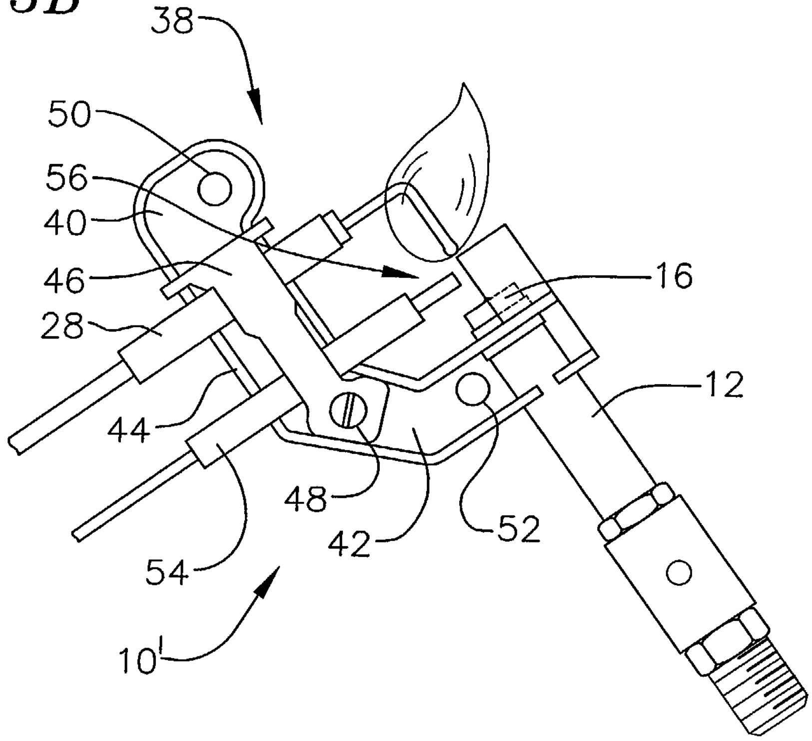
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FIG.5C

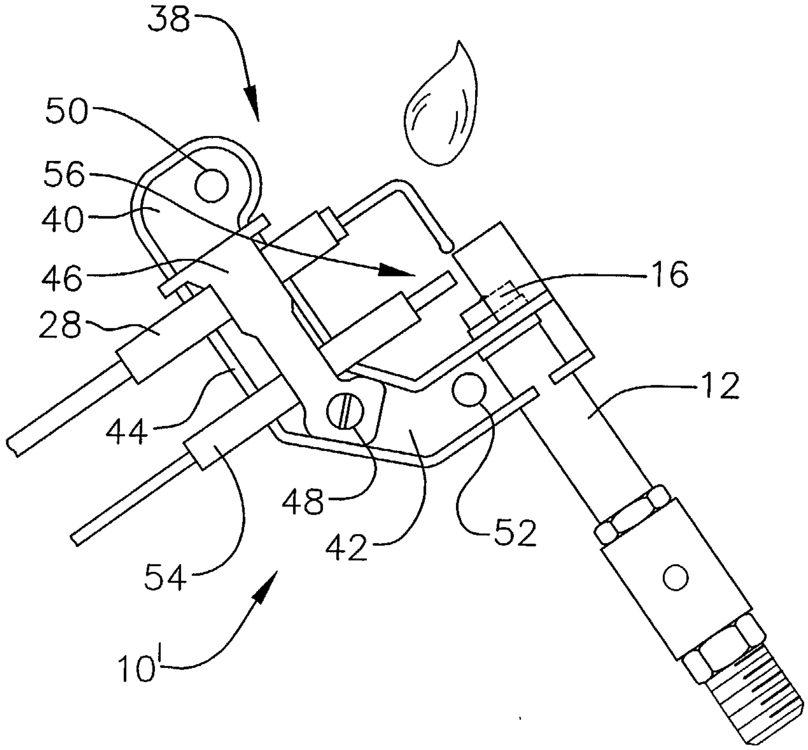
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FIG. 7A

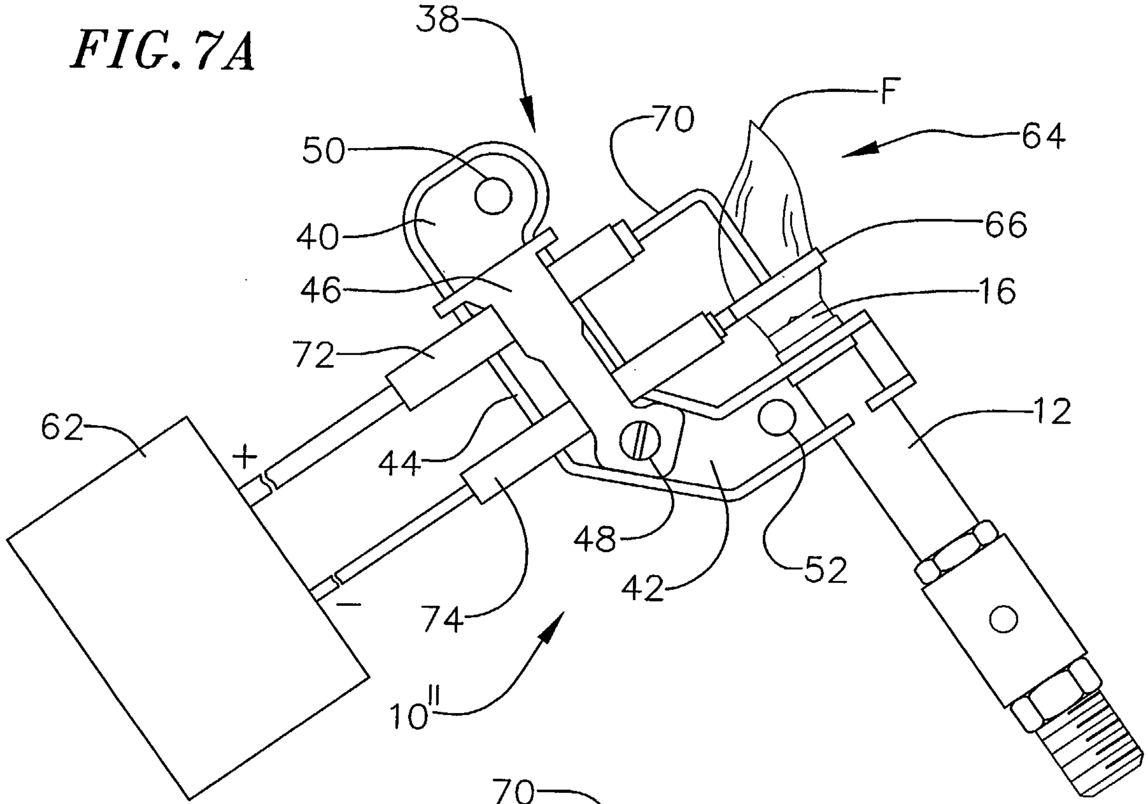


FIG. 8

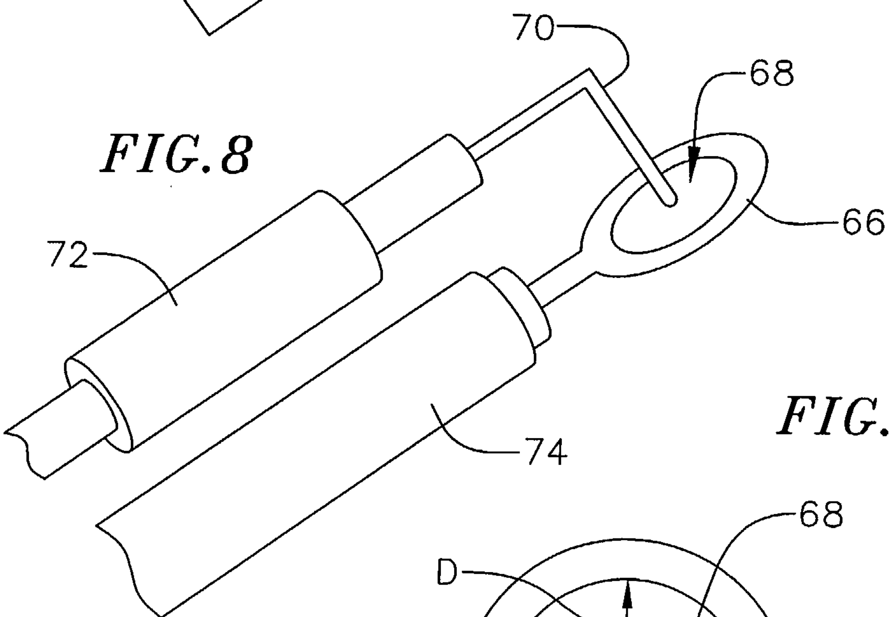


FIG. 9

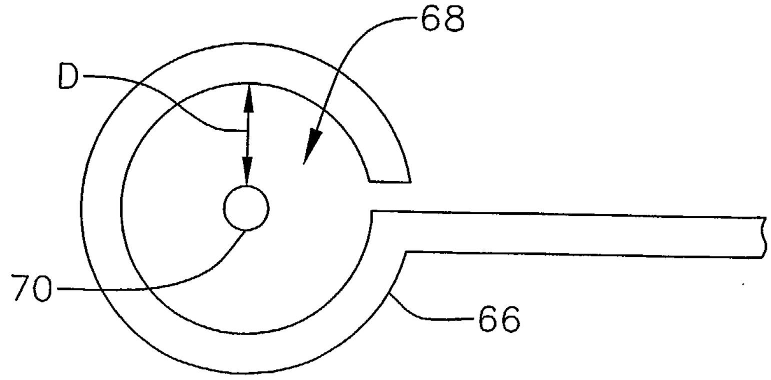


FIG. 7B

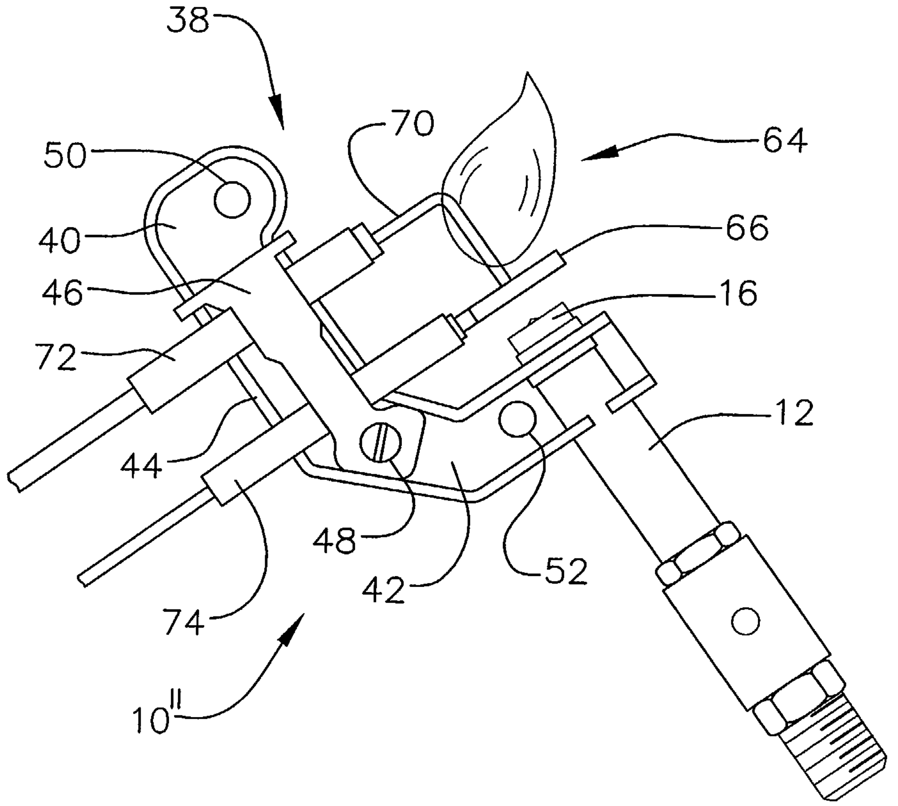


FIG. 10A

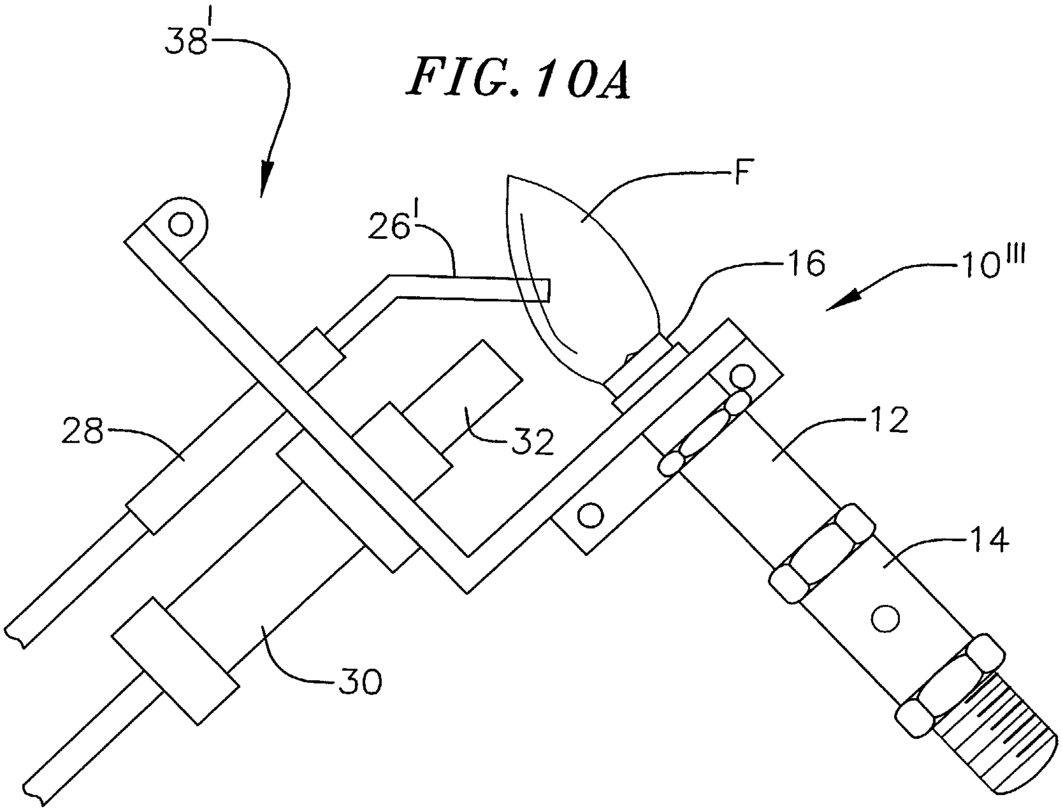


FIG. 10B

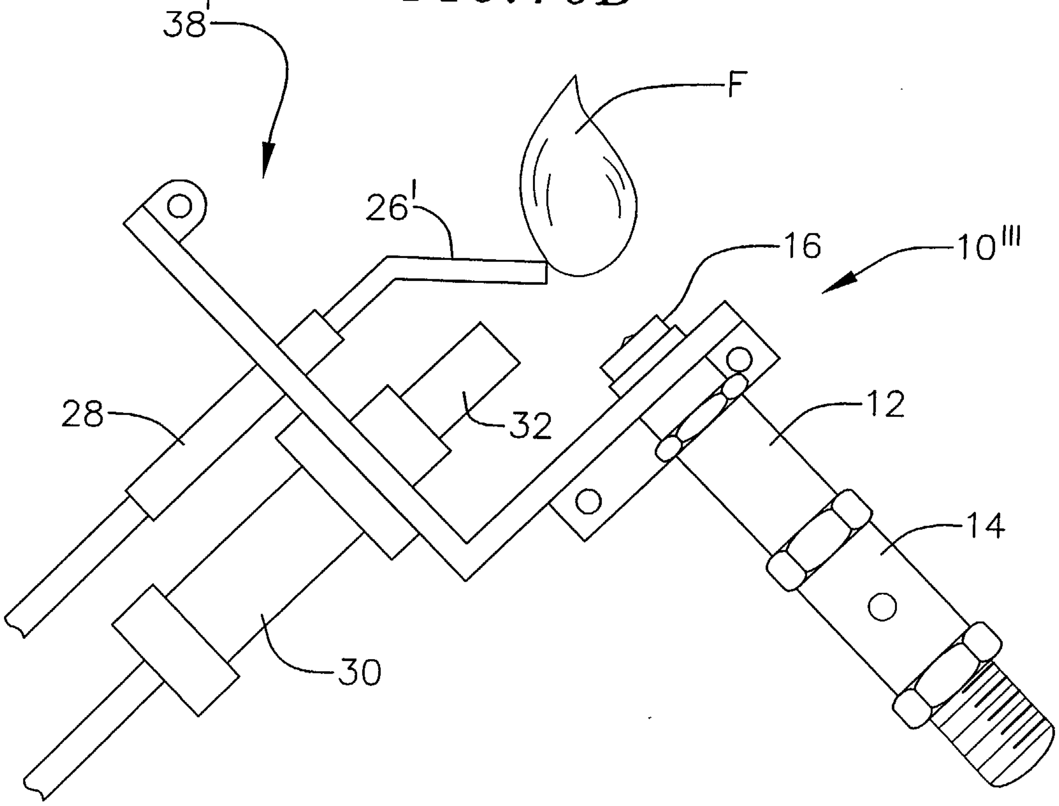


FIG. 10C

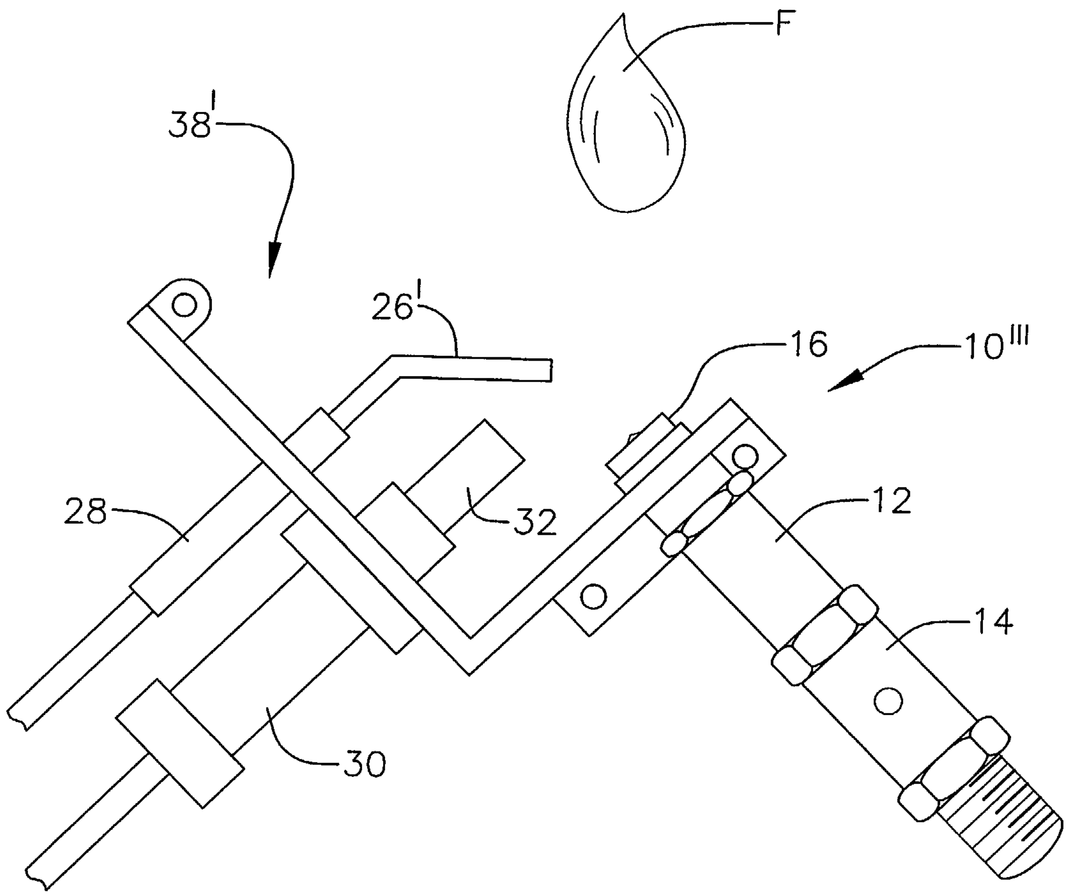
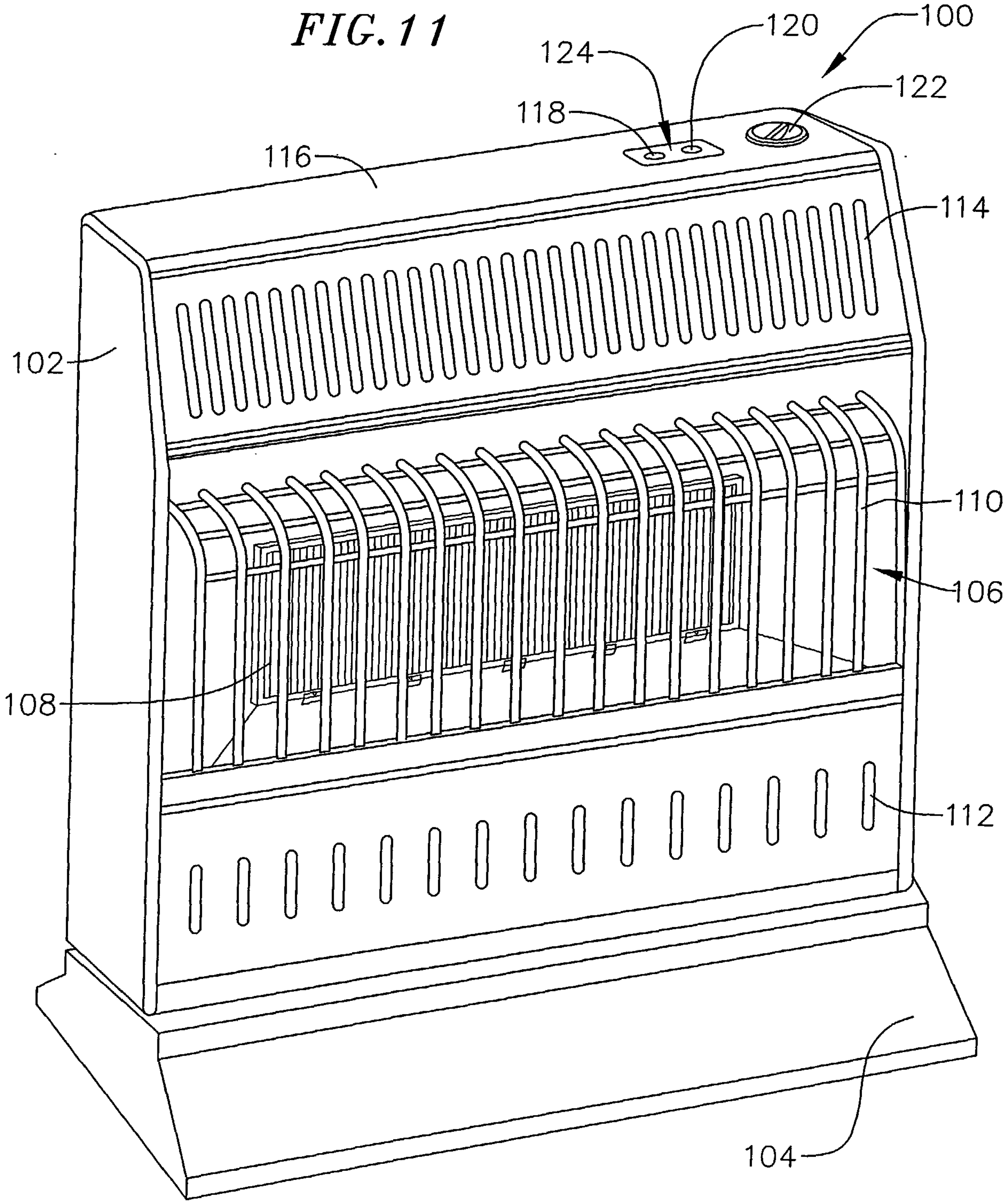


FIG. 11



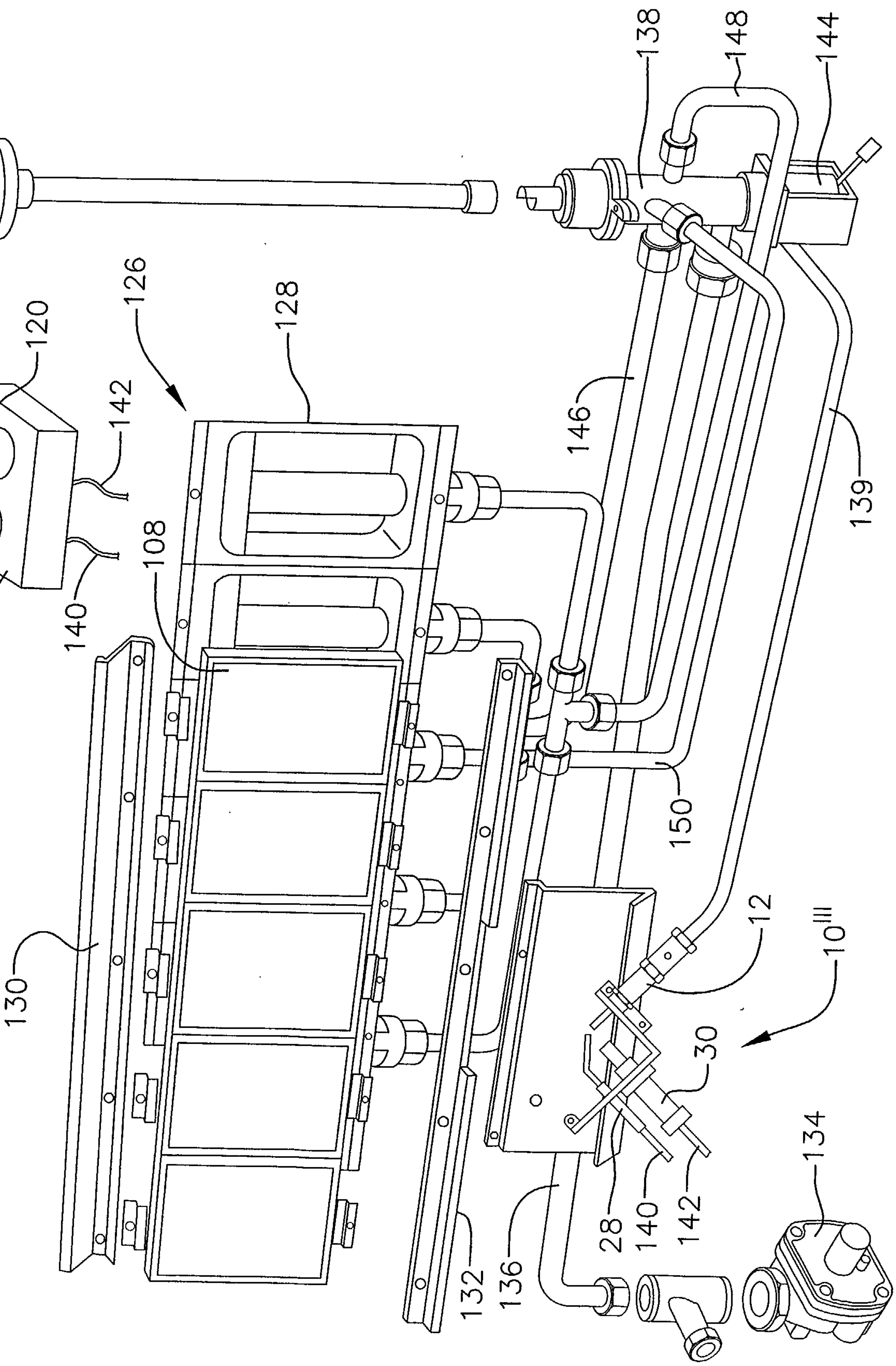

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FIG. 12

FIG. 13