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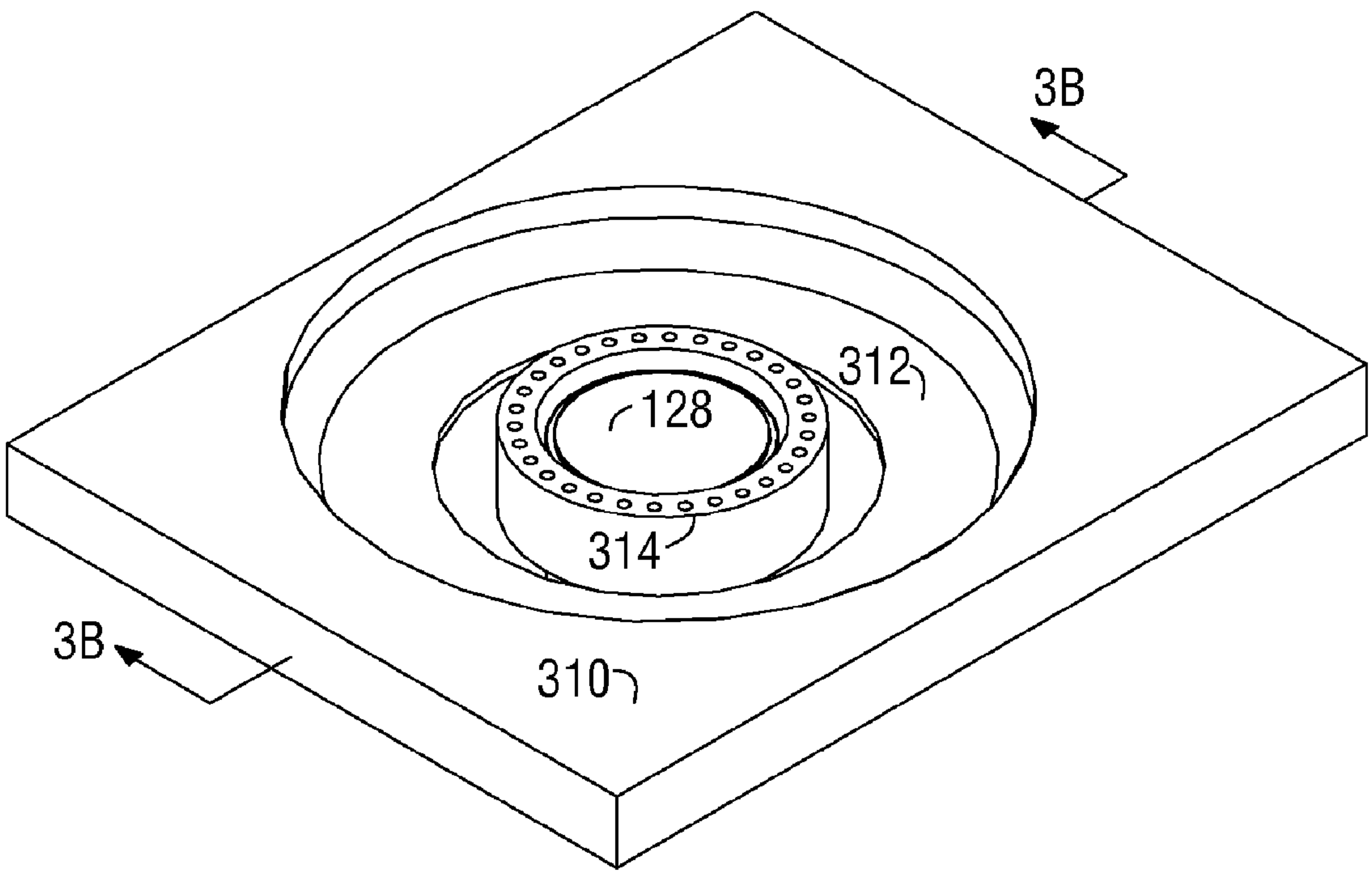

FIG. 3A

(57) Abrégé/Abstract:
In accordance with one embodiment, energy savings is achieved in a cooktop by reducing the energy supplied to a burner (314) when no cooking vessel is present. A sensor (120) communicates the presence or absence of the cooking vessel to a controller (110). When the cooking vessel is present, the controller (110) signals a valve (130) by means of a digital-to-analog converter (112) to allow energy to flow to burner (314) unrestricted. When the cooking vessel is not present, the controller (110) signals valve (130) to restrict the flow of energy to burner (314).

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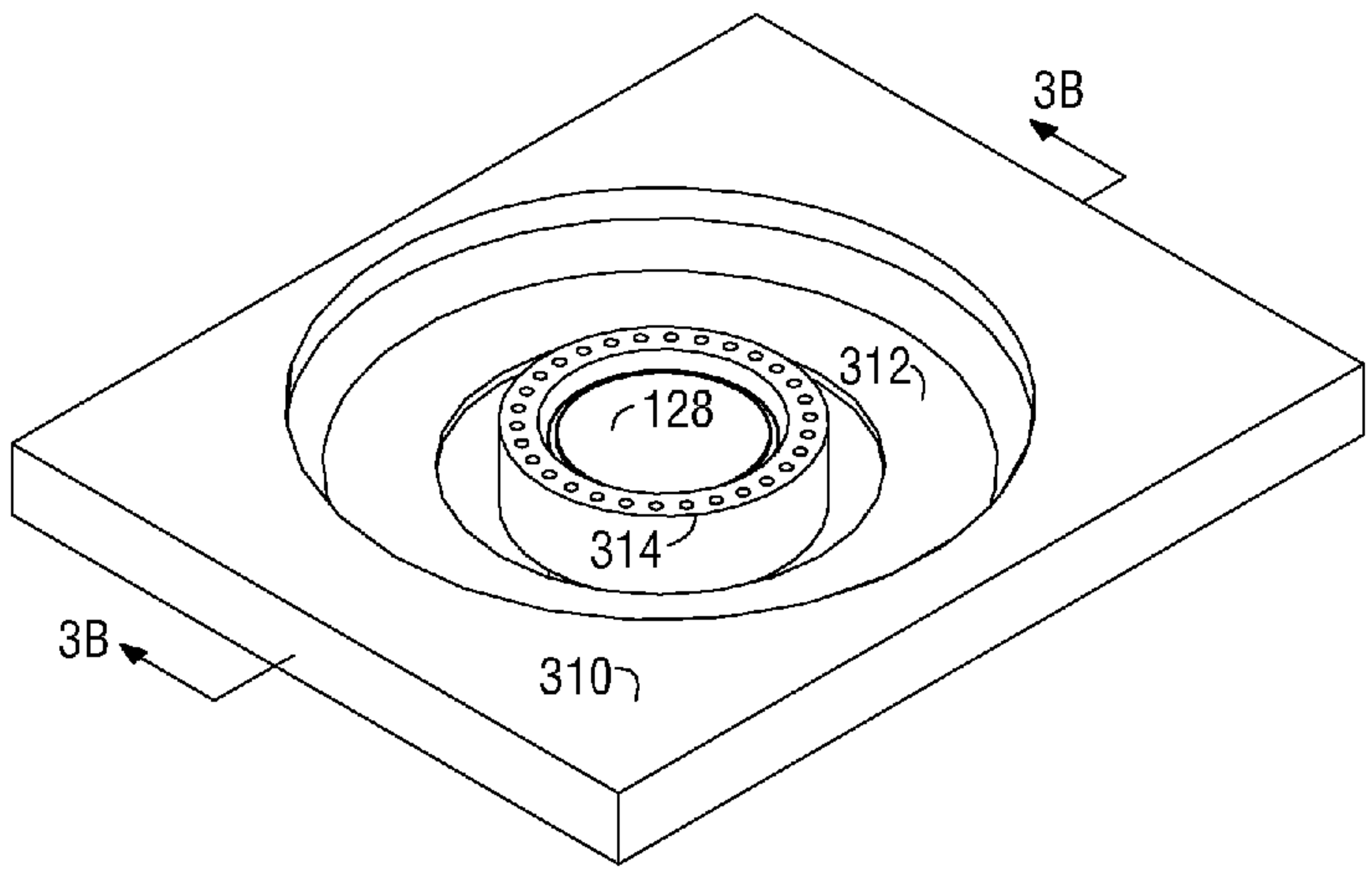

FIG. 3A

(57) Abstract: In accordance with one embodiment, energy savings is achieved in a cooktop by reducing the energy supplied to a burner (314) when no cooking vessel is present. A sensor (120) communicates the presence or absence of the cooking vessel to a controller (110). When the cooking vessel is present, the controller (110) signals a valve (130) by means of a digital-to-analog converter (112) to allow energy to flow to burner (314) unrestricted. When the cooking vessel is not present, the controller (110) signals valve (130) to restrict the flow of energy to burner (314).

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ENERGY SAVING COOKTOP

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefits of the earlier filed US Provisional Application Serial No. 60/959,559, filed 16 July 2007 (16.07.2007) and the earlier filed US Provisional Application Serial No. 60/961,108, filed 19 July 2007 (19.07.2007), which are incorporated by reference for all purposes into this specification.

BACKGROUND OF THE INVENTION - FIELD OF THE INVENTION

The present invention generally relates to the field of cooktops and ranges (defined as an integrated cooktop and oven), and in particular a cooktop or range that includes an energy saving feature that reduces or removes the heat applied to a burner when the pan or other cooking vessel is removed from the burner.

Cooking in an institutional or commercial setting is a very challenging and hectic enterprise. Chefs are typically racing to complete a variety of dishes simultaneously, which can lead them to take whatever shortcuts are practical. In this environment, it is common for a burner to be consuming energy while a pan is not in place.

Commercial kitchens are near the top of the list of greatest energy usage per square foot in a commercial setting, and therefore offer some of the best opportunities for reducing the amount of energy consumed. The automation of the control of the gas, electricity, or other fuel as a function of the presence of a cooking vessel on a cooktop could yield significant energy savings.

Most business owners are becoming increasingly aware of the need to conserve energy and other natural resources. Consumer sentiment and the regulatory climate demand that owners take every reasonable opportunity to preserve the environment. Additionally, many such owners have a strong personal interest in conservation. Therefore, products such as a cooktop that uses less energy have a strong and rapidly increasing market demand.

The energy savings is multiplied in the case of a cooktop that uses less energy. Most commercial kitchens require substantial air conditioning capacity in order to maintain a reasonably comfortable environment for the kitchen staff. Reducing energy usage by the primary cooking equipment, such as the cooktops, provides a secondary benefit by reducing the required air conditioner tonnage.

In addition, labor shortages are among the biggest issues encountered by operators of commercial kitchens. Innovations that improve the working conditions in a commercial kitchen would serve to increase the attractiveness of kitchen jobs. By using a cooktop that consumes less energy, owners will be able to provide a more comfortable environment for their employees without increasing their operating costs.

BACKGROUND OF THE INVENTION – PRIOR ART

Previously, inventors have endeavored to sense the positioning of a cooking vessel on the burner of a cooktop. For instance, Smolenski, et al, in US Patent 6,350,971, issued in February 2002, sense lateral or rotational movement of a pan on a ceramic or glass cooktop in order to reduce the possibility of erroneously signaling a “boil-dry” condition. They also endeavor to reduce the power applied to a burner when a true “boil-dry” condition exists. However, they do not detect the presence or absence of a pan, nor do they decrease the power to the burner when the pan is absent in order to save energy.

In a similar vein, Smith in US Patent 4,334,135, issued in June 1982, describes a method to detect the condition of a cooking vessel being placed off-center on a burner, but does not describe the advantages of the present invention.

Others, including Scott in US Patent 5,977,523, issued in November 1999, and Gross, et al, in US Patent 5,491,423, issued in February 1996, describe means to detect the size of a pot placed on a glass ceramic cooktop so that the appropriate portion of a burner can be energized. This technique protects the portion of the cooktop not covered by the pot from excessive temperatures that can damage the surface of the cooktop.

Some inventors have described the use of inductive sensors to detect the presence or absence of a pan on a burner, but have been forced by the difficulties inherent in this approach to limit the applicability to very convoluted and specific implementations. Inductive sensors have the additional weakness of only being effective with metal pans.

For instance, Scott, in US Patent 5900174, issued in May 1999, describes a method using an inductive sensor placed in proximity to an electric burner that must track two separate decreases in signal in an attempt to distinguish between removal of a pot and a transition by the burner through its Curie temperature.

Similarly, Turetta, et al, in US Patent 5,424,512, issued in June 1995, describe a method of detecting the presence of a pan, requiring that an inductive sensor be placed directly between the heating element and the surface of a glass ceramic cooktop.

Unfortunately, few industrial environments are worse suited for the reliable deployment of an electronic sensor.

Finally, Essig, et al, in US Patent 5,296,684, issued in March 1994, describe an attempt to overcome the weaknesses inherent in the use of inductive sensors by sensing the rate of change of the signal rather than the strength of the signal.

SUMMARY

In accordance with one embodiment, energy savings is achieved in a cooktop or range by reducing the energy supplied to a burner when no cooking vessel is present. A sensor communicates the presence or absence of the cooking vessel to a controller. When the cooking vessel is present, the controller signals a valve to allow energy to flow to the burner unrestricted. When the cooking vessel is not present, the controller signals the valve to restrict the flow of energy to the burner.

DRAWINGS - FIGURES

FIG. 1A is a block diagram of the first embodiment.

FIG. 1B is a block diagram of an embodiment of the digital-to-analog buffer circuit required in the first embodiment.

FIG. 2 is a perspective view of an embodiment of an electric field electrode.

FIG. 3A is a perspective view of an embodiment of an electric field electrode installed in a stove.

FIG. 3B is a cross-section view of the embodiment of FIG. 3A.

FIG. 4 is a flow chart of the software that controls the first embodiment.

FIG. 5A is a perspective view of an alternative embodiment for an electric field electrode.

FIG. 5B is a detailed view of the alternative embodiment of FIG. 5A.

FIG. 6 is a perspective view of a manual rotary gas valve driven by a motor.

FIG. 7 is a perspective view of an optical detector installed in a stove.

FIG. 8 is a perspective view of an ultrasonic detector installed in a stove.

FIG. 9 is a perspective view of an alternative piping system that reduces the flow of gas when the energy saving mode is entered.

FIG. 10 is a block diagram of an alternative embodiment that includes a keypad and display.

DETAILED DESCRIPTION – FIRST EMBODIMENT – FIGS. 1-4

A block diagram of one embodiment of the energy saving cooktop system is illustrated in FIG. 1A. A microcontroller 110 is connected to a digital-to-analog converter 112 and an electric field sensor 120. The electric field sensor 120 comprises an electric field sensing integrated circuit 122, an electric field electrode 128, a signal connection 124, and a shield connection 126. Signal connection 124 is affixed to integrated circuit 122 and to electrode 128. Shield connection 126 is affixed only to integrated circuit 122. Electrode 128 is mounted in proximity to one burner of a cooktop (not shown in this figure).

The digital-to-analog converter 112 connects the microcontroller 110 and an electronically controlled valve, also called a solenoid valve, 130. Valve 130 comprises a gas inlet 132, a gas outlet 134, and a solenoid 136. One of the electrical leads of solenoid 136 is connected to a standard direct current power supply (not shown). The other electrical lead of solenoid 136 is connected to digital-to-analog converter 112.

When in operation, the embodiment illustrated in FIG. 1A senses the presence or absence of a cooking vessel on the burner of a range or cooktop. Integrated circuit 122 drives a voltage waveform on signal connection 124. The voltage waveform causes electrode 128 to generate a low level electric field. Integrated circuit 122 detects the variation in field loading caused by objects moving into and out of the electric field. The variation in field loading is due to a change in the total capacitance between the electrode and the circuit ground. As a result, the objects that are to be detected do not have to be metallic. Instead, they must be electrically conductive or must have a different dielectric constant than air. The inventor currently favors the use of Freescale Semiconductor's MC33941 e-field sensor device because it supports enough electrodes to control all the burners on most ranges. However, other integrated circuits can be easily substituted.

Integrated circuit 122 generates a secondary signal that can be used when electrode 128 is located remotely, as would be the case in this application. The printed circuit board containing integrated circuit 122 usually will be mounted at least 25 centimeters away from any burner due to limitations on the upper operating temperature of typical integrated circuits. Conversely, electrode 128 should be located in close proximity to the burner to maximize the magnitude of the signal it generates when a pan is placed on the burner and removed from the burner. The secondary signal of integrated circuit 122 is joined to shield connection 126. The secondary signal is a copy of the voltage waveform driven on signal connection 124. The current flow between the signal connection 124 and shield connection 126 is proportional to the difference in voltage between them. Therefore, if shield connection 126 is maintained in close proximity to signal connection 124, electrode 128 can be remotely located from integrated circuit 122 with minimal affect on the current flowing in signal connection 124.

Integrated circuit 122 measures the current flowing in signal connection 124 and converts the result to a DC voltage that is output on one of its pins. An analog-to-digital converter input of microcontroller 110 is connected to the DC voltage output pin of integrated circuit 122. Thus, by performing sequential analog-to-digital conversions of the voltage, microcontroller 110 can generate a digital record of the electric field loading on electrode 128 versus time.

When power is applied to the system, a calibration process is performed. Microcontroller 110 performs several analog-to-digital conversions of the DC voltage being output by integrated circuit 122, averages the readings, and stores the result as a benchmark value.

Initially, the burner controlled by the embodiment of FIG. 1A is enabled. That is, electronically controlled valve 130 is placed in its open position by de-energizing solenoid 136. This allows the free flow of gas from gas inlet 132 to gas outlet 134. The inventor currently favors the use of a normally open valve in this application, as a failure of the system would allow a burner to be used without the energy savings feature until repairs could be made. However, a normally closed valve can be used if desired. In this embodiment, the burner is disabled by energizing solenoid 136, which causes the valve to close, thus preventing the flow of gas from gas inlet 132 to gas outlet 134.

Microcontroller 110 periodically performs an analog-to-digital conversion of the DC voltage being output by integrated circuit 122. Minor variations in the resulting value can occur due to pans being moved on adjacent burners, food dropping onto electrode 128, people moving through the electric field, and sundry other reasons. These minor variations are incorporated into the benchmark value. For example, if several readings are consistently slightly higher than the stored benchmark value, the benchmark value is adjusted upward.

Conversely, if a larger change in sequential readings is detected, the state of the burner will be changed by microcontroller 110. A large decrease in the result of the analog-to-digital reading while the burner is enabled indicates that a pan has been removed from the burner. When this happens, the burner is disabled. This is accomplished by microcontroller 110 by inverting the logical value of its pin that is connected to digital-to-analog converter 112.

Similarly, a large increase in the result of the analog-to-digital reading while the burner is disabled indicates that a pan has been placed on the burner. When this happens, the burner is enabled. This is accomplished by microcontroller 110 by inverting the logical value of its pin that is connected to digital-to-analog converter 112. Note that a large increase in the reading can also happen when the burner is already enabled. This state can be reached if no pan is on the burner when the system is initially energized. The burner is initially enabled when power is applied to the system. If a pan is subsequently placed on the burner, a large increase in the analog-to-digital reading will be noted. However, this only results in an adjustment to the benchmark value. The burner remains enabled.

In this embodiment, the burner is either enabled or disabled, resulting in valve 130 being fully open or fully closed. Other embodiments are contemplated in which intermediate positions of valve 130 are possible. In those cases, the connection between microcontroller 110 and digital-to-analog converter 112 would consist of enough wires to represent each of the desired states. For instance, three wires could represent eight distinct valve positions. However, in this embodiment, a single wire suffices for the connection, and the digital-to-analog function of converter 112 is reduced to buffering the low voltage, low current output of microcontroller 110 into a high voltage, high current signal suitable for energizing solenoid 136.

Microcontroller 110 provides a means for controllably reacting to inputs from sensor 120 to modify the state of valve 130. Any microcontroller with sufficient digital outputs and analog-to-digital inputs can be used for this function..

FIG. 1B illustrates one embodiment of the digital-to-analog buffering required between microcontroller 110 and valve 130, namely an NPN Darlington transistor such as a Fairchild TIP120. Note, however, that any circuitry can be used that can translate the low voltage, low current output of microcontroller 110 into the high voltage, high current signal needed to energize solenoid 136. Resistors R1 and R2, transistors Q1 and Q2, and diode D1 are internal components of the TIP120 Darlington transistor. The external connections are base 114, collector 116, and emitter 118. Base 114 is connected to microcontroller 110, collector 116 is connected to solenoid 136, and emitter 118 is connected to electrical ground.

When microcontroller 110 outputs a logical 1, or positive voltage, to base B, transistors Q1 and Q2 turn on, connecting solenoid 136 to ground. Since the other lead of solenoid 136 is connected to a DC power supply (not shown), solenoid 136 is energized. When microcontroller 110 outputs a logical 0, or near zero voltage, to base B, transistors Q1 and Q2 turn off, disconnecting solenoid 136 from ground and de-energizing solenoid 136.

FIG. 2 illustrates one embodiment of electric field sensing electrode 128. Electrode conductor 210 is mounted to electrode body 212 using a high temperature adhesive. A mica-based ceramic adhesive is preferred, but any adhesive that bonds ceramic and metal while withstanding high temperature can be used. In this embodiment, electrode conductor 210 is a disc of stainless steel. Any electrically conductive material that is resistant to mechanical shock, high temperature, and chemicals such as acids and solvents found in foodstuffs can be used.

Electrode body 212 is a silica ceramic in this embodiment, although any material can be used that withstands high temperatures, thermal shock, and mechanical shock while being an electrical insulator. In this embodiment of electrode 128, the center conductor of coaxial cable 220 serves as signal connection 124 first described in FIG. 1, and the shield conductor of coaxial cable 220 serves as shield connection 126 first described in FIG. 1. Signal connection 124 is electrically and mechanically connected to conductor 210. In this embodiment, the connection is made by brazing. Alternatively, spot welding, or a machine screw and nut through the center of conductor 210, or similar means can be used to affix signal connection 124. Shield connection 126 is not electrically connected to electrode 128. It is only electrically connected at its other end to integrated circuit 122.

In this embodiment, the upper portion of electrode body 212 has a circular cross-section to maximize the possible area of electrode conductor 210 when electrode 128 is installed in a stove with a round burner containing an opening in its center. Note, however, that other closed shapes might be useful in other circumstances. The lower portion of electrode body 212 has a rectangular cross-section. This lower portion also has two holes 214A and 214B to facilitate assembly to a bracket that will hold electrode 128 in the desired position inside the stove. Electrode body 212 contains a wiring channel 216 that runs from the surface upon which electrode conductor 210 is attached to the opposite end of electrode body 212. Coaxial cable 220 is run through wiring channel 216, exiting the bottom of electrode body 212.

FIG. 3A illustrates a perspective view of one embodiment of electrode 128 mounted in a stove or cooktop upper surface 310. A section of the stove upper surface 310 is depressed to form burner well 312. Burner 314 is mounted within a hole in burner well 312, and electrode 128 is mounted within a hole in burner 314.

FIG. 3B illustrates a cross section view of one embodiment of electrode 128 mounted in a stove or cooktop upper surface 310. Electrode 128 is held in place by mounting bracket 316 using standard machine screws (not shown) through holes in bracket 316 that mate with the mounting holes 214A and 214B in electrode body 212. Bracket 316, in turn, is connected to a cooktop structural member 318 by any convenient means such as machine screws, self-tapping metal screws, spot welding, or the like.

Mounting bracket 316 is sized such that the electrode conductor 210 is situated slightly below the top of burner 310. A distance of 1 to 1.5 centimeters is currently favored. The higher the placement of conductor 210, the stronger the signal that is generated by the placement of a pan on burner 310. However, higher placement also results in electrode 128 being required to withstand higher temperatures.

FIG. 4 illustrates an embodiment of a software flowchart that controls the embodiment described in FIG. 1 to accomplish the desired energy savings. The program starts at symbol 410.

Next, the hardware registers of microcontroller 110 are initialized as shown in block 412. The port connected to sensor 120 is an analog-to-digital converter and is configured to perform single readings upon software command, as opposed to continuous conversions. The port connected to digital-to-analog converter 112 is configured as an output. A timer is configured to provide the source of an interrupt that will wake microcontroller 110 from a sleep state periodically.

After the hardware is initialized, sensor 120 must be calibrated, as shown in block 414. The DC voltage that is output by integrated circuit 122 is converted to a digital value by microcontroller 110. After a suitable delay, presently defined to be on the order of 100 milliseconds, the conversion is repeated. This process of converting the DC voltage to a digital value, then waiting, should be repeated several times so that random electrical noise can be cancelled out. The average of the several readings is then used to calculate a lower threshold value for the system. The lower threshold is defined as the average of the several readings minus the system’s delta value.

The delta value is determined by characterizing the performance of the system as installed in the desired stove or cooktop. In a typical configuration, the difference in the result of the analog-to-digital conversion with and without a pan on the burner will be less than 20 units. Microcontroller 110 should first be programmed using a value of 20 for the delta value. If the placement and removal of a pan on the burner does not result in proper operation of the system, the delta value should be reduced to 19. This process should be repeated until the largest value that yields reliable operation of the system is found. This value is the system's delta value.

Block 416 shows the burner being placed into its enabled state. This requires that a value be written to the port of microcontroller 110 that is connected to digital-to-analog converter 112. The value written to the port should place valve 130 in its open position. This will allow gas to flow from gas inlet 132 to gas outlet 134. Note that this means the burner will be energized when first turned on, whether a pan is in place or not. While this method has been chosen because it seems more intuitive, it will also be acceptable to have the burner start in a disabled mode. In that case, the burner will not start until a pan is placed on it.

In block 418, a new value is read by performing another analog-to-digital conversion of the DC value output by integrated circuit 122.

Block 420 illustrates the first decision point of the flowchart. The new value from the analog-to-digital conversion is compared to the lower threshold value. If it is greater than or equal to the threshold value, it is used to calculate a new threshold value, as shown in block 422. The new threshold value is calculated by subtracting the system's delta value from the current reading. This process allows the system to adapt to changing conditions, such as pans being moved on adjacent burners.

As shown in block 424, microcontroller 110 then enters a low power sleep state for a short time, on the order of 100 milliseconds. When it is awakened from the sleep state by an internally generated timer interrupt, it jumps back to block 418.

If the new value in block 420 is less than the lower threshold value, a sequence is started that may result in the burner being disabled. In this case, the new value indicates that the pan has been lifted from the burner. However, this may be due to normal cooking techniques such as sautéing or flipping the contents of the pan. Therefore, the burner is not disabled yet.

Block 426 shows that the system waits a predefined period of time. This lag time should be a compromise between premature triggering and reduced energy savings. A value in the range of one to 1.5 seconds is currently favored.

Block 428 illustrates that the next action is to retrieve a new value from integrated circuit 122 by converting the DC voltage present on its output to a digital value.

Block 430 shows the second decision point. If the new value is greater than or equal to the lower threshold value, the burner will remain enabled and block 432 will be executed next. If the new value is less than the lower threshold, block 434 is executed next.

In block 432, a new lower threshold is calculated by subtracting the system's delta value from the reading taken in block 428. Then, the system jumps to block 424 and goes to sleep.

If control passes from block 430 to block 434, microcontroller 110 disables the burner by writing a value to digital-to-analog converter 112 that energizes solenoid 136 of valve 130. This causes valve 130 to close, preventing gas from flowing between valve inlet 132 and valve outlet 134.

After the burner is disabled, block 436 serves to calculate an upper threshold value by adding the latest value read from sensor 120 in block 428 to the system delta value.

In block 438, the system enters a sleep mode for an interval equal to that of block 424. After that time has elapsed, an internally generated timer interrupt awakens the system.

In block 440, a new value is read from sensor 120 by performing an analog-to-digital conversion of the DC voltage output by integrated circuit 122.

In block 442, the new value is compared to the upper threshold value. If the new value is less than or equal to the upper threshold, block 444 uses the new value to calculate a new upper threshold by adding the new value to the system delta value. The system then jumps to block 438.

If the new value from block 440 is greater than the upper threshold value, the system jumps to block 446. In block 446, a new lower threshold value is calculated by subtracting the system delta value from the new value from block 440. From block 446, the system jumps back to block 416, where the burner is enabled again.

DETAILED DESCRIPTIONS – OTHER EMBODIMENTS – FIGS. 5-10

FIG. 5A illustrates a perspective view of an alternative embodiment for electrode 128. For burners such as burner 510 that do not have a hole in their center, electrode 128 could not be properly placed. In this case, an electrode 520 could be fitted around the outside of burner 510. Electrode 520 can be affixed to burner well 212 using a high temperature adhesive or mechanical fasteners.

FIG. 5B illustrates the details of the alternative embodiment of the electric field sensing electrode. As was the case with electrode 128, signal connection 124 of coaxial cable 220 is affixed to electrode conductor 524. Coaxial cable 220 is passed through wiring channel 526, which is a hole in electrode body 522.

FIG. 6 illustrates an alternative embodiment for controlling the flow of gas when entering or leaving the energy saving mode. A manually controlled valve 620 comprises a valve body 622, a valve stem 624, a gas inlet 132, and a gas outlet 134. Motor 630 comprises shaft 632 and body 634. Shaft 632 of motor 630 is connected to valve stem 624 using coupler 640. When valve stem 624 is rotated clockwise to its full extent, the flow of gas between gas inlet 132 and gas outlet 134 is enabled. When valve stem 624 is rotated counterclockwise to its full extent, the flow of gas between gas inlet 132 and gas outlet 134 is disabled.

FIG. 7 illustrates an alternative embodiment of a sensor to detect the presence or absence of a pan on a cooktop. An optical detector 710 is mounted below a burner 314. Optical detector 710 comprises an emitter 712 and a detector 714. Emitter 712 radiates electromagnetic energy in the visible or infrared spectrum when energized. If a pan 716 is present on burner 314, the electromagnetic energy will be reflected back in the direction of detector 714. Therefore, activation of detector 714 by incident electromagnetic energy signals the presence of pan 716 on burner 314.

If optical detector 710 operates in the visible spectrum, measures must be taken to filter out ambient light to avoid false triggering of detector 714. For example, emitter 712 can be pulsed off and on. Then, the output of detector 714 can be processed using a high pass filter to eliminate the effects of ambient light hitting detector 714. The observation of pulses of light by detector 714 that are coincident in time with the emission of pulses of light by emitter 712 indicate that a pan 716 is present on burner 314.

If optical detector 710 operates in the infrared spectrum, ambient emissions are not a problem if optical detector 710 is properly placed in relation to burner 314. Detector 714 should be situated such that it is not triggered by infrared emissions from burner 314. Considerations include the characteristics of detector 714 with respect to the allowable angle of incident infrared energy that will trigger it, the vertical distance between detector 714 and burner 314, and the horizontal distance between detector 714 and burner 314. If desired, detector 714 can be screened from ambient energy by placing a shield 718 in front of it. Note that ambient emissions from pan 716 will not cause a malfunction of the system. Whether detector 714 is sensing reflected infrared energy from emitter 712 or infrared energy emitted from a hot pan 716, the activation of detector 714 will correctly indicate that a pan 716 is on burner 314.

FIG. 8 illustrates yet another alternative embodiment of a sensor to detect the presence or absence of a pan on a cooktop. An ultrasonic range finder 810 is mounted below a burner 314. Range finder 810 comprises an ultrasonic emitter 812 and an ultrasonic detector 814. Emitter 812 outputs pulses of ultrasonic energy. If a pan 716 is present on burner 314, the ultrasonic energy is reflected into detector 814. Therefore, activation of detector 814 by incident ultrasonic energy signals the presence of pan 716 on burner 314. Range finder 810 should be positioned so that reflections from the burner 314 do not cause false triggering of detector 814.

FIG. 9 illustrates an embodiment of a gas piping system that results in the gas flow being reduced, but not completely blocked, when the system enters the energy saving mode. Many chefs prefer to keep the grates of their cooktops hot, to facilitate a quick turnaround time when an order is received in the kitchen. In this embodiment, the reduction of the gas flow in energy savings mode represents a compromise between this quick turn requirement and the desire to save the maximum possible amount of energy.

In this embodiment, gas inlet 132 is connected to a Y connector 912. One output of Y connector 912 is coupled to electronically controlled valve 918 using metal tubing 914. The other output of Y connector 912 is coupled to flow restrictor 920 via metal tubing 916. Valve 918 and flow restrictor 920 are coupled to a second Y connector 926 using metal tubing 922 and 924. The output of Y connector 926 is affixed to gas outlet 134.

The characteristics of flow restrictor 920 are specified so as to result in the desired energy output of burner 314 when the system is in the energy saving mode. In this mode, valve 918 is closed, so the energy output of burner 314 is completely determined by the rate of gas movement through flow restrictor 920. When the system is not in energy saving mode, valve 918 is opened, and the energy output of burner 314 is determined by the sum of the flows through valve 918 and restrictor 920.

FIG. 10 illustrates the block diagram of an additional embodiment. A keypad 1010 and a display 1030 have been connected to microcontroller 110. Keypad 1010 can be used to enter configuration information into the energy saving system. Display 1030 provides visual feedback that the desired information has been entered correctly.

Keypad 1010 is a matrix keypad connected to microcontroller 110. The rows of keypad 1010 are connected to port pins 1012, 1014, 1016, and 1018 of microcontroller 110 that are configured as inputs with internal pullup resistors. The columns of keypad 1010 are connected to port pins 1020, 1022, and 1024 of microcontroller 110 that are configured as outputs.

Microcontroller 110 drives each of the port pins 1020, 1022, and 1024 low in turn, while keeping the other two in a high impedance condition. If any of the input pins 1012, 1014, 1016, and 1018 read as a low voltage, this indicates that a particular key of keypad 1010 has been depressed. The depressed key is at the intersection of the column of keypad 1010 that is currently driven low by microcontroller 110 and the row of keypad 1010 that is connected to the input pin that is providing the low voltage input to microcontroller 110.

Display 1030 is an LCD display with an integral serial communication port known in the electronics industry as an Inter-Integrated Circuit or I2C port. It is connected to the I2C port of microcontroller 110 using a three-wire bus.

Keypad 1010 can be used to enter a desired lag time in seconds between the removal of a pan from burner 314 and the reduction of gas flow to burner 314. The desired time is indicated by pressing the corresponding keys on keypad 1010, confirming that the correct number of seconds is shown on display 1030, and pressing the "#" key on keypad 1010.

Keypad 1010 can also be used to enter the maximum time in seconds that a pan can be off burner 314 before replacing the pan will not re-enable burner 314. The desired time is entered using keypad 1010 followed by the "*" key. This mode of operation is included for added safety. If significant time had passed since the pan was removed, the chef might not notice that burner 314 automatically came on when the pan was placed on burner 314, creating a fire hazard. If this situation occurs, the burner can be re-enabled by pressing any key on keypad 1010.

CONCLUSIONS, RAMIFICATIONS, AND SCOPE OF INVENTION

The descriptions of the previous embodiments demonstrate several methods that can provide the desired effect of the present invention, namely the capability to reduce the energy usage of a cooktop.

In the context of this invention, the term valve can refer to a device that modulates the flow of a flammable gas or electricity. In the case of electricity, the valve would be an electronic valve such as a transistor, triac, thyristor, semiconductor-controlled rectifier, Darlington pair, insulated gate bipolar transistor, or similar apparatus that modulates the flow of electricity, or an electromechanical device such as a relay.

Other means of sensing the presence of a pan could be used. By way of example, a strain gauge or other method of detecting the weight of the pan on the burner could be employed. By way of further example, a camera could be mounted in proximity to the burner and pattern-matching software could determine whether a pan was present on the burner. Alternately, the burner's grate could be divided into two segments that were electrically isolated from each other, allowing a conductive pan to complete a circuit to signal its presence. Other examples include the use of a laser range finder, a radar range finder, or an ultraviolet sensor.

While a programmable microcontroller has been described in the embodiments, other means of monitoring the state of the cooktop sensors and modifying the state of the valves could be utilized. Programmable microprocessors, field programmable gate arrays, application-specific integrated circuits, digital signal processors, programmable logic devices, and complex programmable logic devices comprise alternatives that could be selected in lieu of the microcontroller.

While one embodiment describes the use of a motor to activate a manual valve, other means of generating electromotive force could be substituted within the scope of the present invention. By way of example, solenoids, piezoelectric transducers, or muscle wires could be used to modulate the flow of gas through a manual valve.

While the above descriptions contain many specificities, these should not be construed as limitations on the scope of the invention, but rather as an exemplification of several embodiments thereof. Accordingly, the scope of the invention should be determined not by the embodiments illustrated, but by the appended claims and their legal equivalents.

CLAIMS:

I claim:

1. A method of achieving energy savings in a cooktop, comprising:
   a. detecting whether a cooking vessel is present on a burner of said cooktop,
   b. reducing the flow of energy to said burner when said cooking vessel is not present on said burner, and
   c. restoring the normal flow of energy to said burner when said cooking vessel is present on said burner.

2. The method of claim 1, wherein the method of detecting whether said cooking vessel is present on said burner of said cooktop is selected from the group consisting of:
   a. detecting a change in the electric field surrounding said burner due to movement of said cooking vessel within the vicinity of said burner,
   b. detecting ultrasonic energy reflected from the lower surface of said cooking vessel,
   c. detecting electromagnetic energy reflected from said lower surface of said cooking vessel, and
   d. detecting infrared energy emanating from said lower surface of said cooking vessel.

3. The method of claim 1, wherein said burner is fueled by a flammable gas and the method of reducing the flow of energy to said burner when said cooking vessel is not present on said burner is selected from the group consisting of:
   a. activating an electronic valve to reduce the flow of said flammable gas to said burner, and
   b. activating an electromechanical device that controls a manual valve to reduce the flow of said flammable gas to said burner.

4. The method of claim 1, wherein said burner is powered by electricity and the method of reducing the flow of energy to said burner when said cooking vessel is not present on said burner comprises activating an electronic valve to reduce the flow of said electricity to said burner.

5. An energy saving cooktop, comprising:
    a. a burner over which a cooking vessel can be placed,
    b. a sensor that can detect whether said cooking vessel is present on said burner,
    c. a valve that can reduce the flow of energy to said burner, and
    d. means for controllably reacting to inputs from said sensor to modify the state of said valve,
    e. said means for controllably reacting to inputs from said sensor being connected to said sensor and said valve,
    f. said valve being connected to said burner,

    whereby said cooktop effects energy savings by causing said valve to reduce the flow of said energy to said burner when said cooking vessel is not present on said burner.

6. The energy saving cooktop of claim5, wherein said sensor is selected from the group consisting of:
    a. electric field sensors,
    b. infrared detectors,
    c. ultraviolet detectors,
    d. laser range finders,
    e. optical detectors, and
    f. ultrasonic range finders.

7. The energy saving cooktop of claim 5, wherein said means for controllably reacting to inputs from said sensor to modify the state of said valve is an electronic component selected from the group consisting of:
    a. programmable microcontrollers,
    b. programmable microprocessors,
    c. field programmable gate arrays,
    d. application-specific integrated circuits,
    e. digital signal processors,
    f. programmable logic devices, and

g. complex programmable logic devices.

8. The energy saving cooktop of claim 5, wherein said burner is fueled by a flammable gas and said valve controls the flow of said flammable gas.

9. The energy saving cooktop of claim 8, wherein said valve is electronically controlled.

10. The energy saving cooktop of claim 8, wherein said valve is a mechanically operated valve that is coupled to a means of generating mechanical force.

11. The energy saving cooktop of claim 10, wherein said means of generating mechanical force is a motor.

12. The energy saving cooktop of claim 8, further including a flow restrictor connected in parallel with said valve thereby causing said flammable gas to continue to flow at a predetermined rate to said burner when said valve is in its closed position.

13. The energy saving cooktop of claim 5, wherein said burner is powered by electricity and said valve controls the flow of said electricity.

14. The energy saving cooktop of claim 13, wherein said valve is an electronic valve selected from the group consisting of:

a. transistors,
b. relays,
c. triacs,
d. thyristors,
e. semiconductor-controlled rectifiers,
f. Darlington pairs, and
g. insulated gate bipolar transistors.

15. The energy saving cooktop of claim 5, wherein said burner is fueled by a flammable gas, said sensor is an electric field sensor, said valve is a solenoid-

controlled valve, and said means for controllably reacting to inputs from said sensor is a programmable microcontroller.

16. The energy saving cooktop of claim 5, wherein said burner is fueled by a flammable gas, said sensor is an ultrasonic range finder, said valve is a manually-controlled valve coupled to a motor, and said means for controllably reacting to inputs from said sensor is a field programmable gate array.

17. The energy saving cooktop of claim 5, wherein said burner is fueled by a flammable gas, said sensor is an optical sensor, said valve is a solenoid-controlled valve, and said means for controllably reacting to inputs from said sensor is an application-specific integrated circuit.

18. The energy saving cooktop of claim 5, further including a keypad and display whereby a desired lag time can be entered to define a delay between the removal of said cooking vessel from said burner and the operation of said valve to reduce the flow of said energy to said burner.

19. The energy saving cooktop of claim 5, further including a keypad and display whereby a desired lag time can be entered to define the maximum delay between the removal of said cooking vessel from said burner and the replacement of said cooking vessel onto said burner that will cause the operation of said valve to restore the flow of said energy to said burner.

20. A method of manufacturing an energy saving cooktop, comprising:
   a. providing a means of detecting whether a cooking vessel is present on a burner of said cooktop, and
   b. providing a means of reducing the flow of energy to said burner when said cooking vessel is not present on said burner, and
   c. providing a means of restoring the flow of energy to said burner when said cooking vessel is present on said burner.

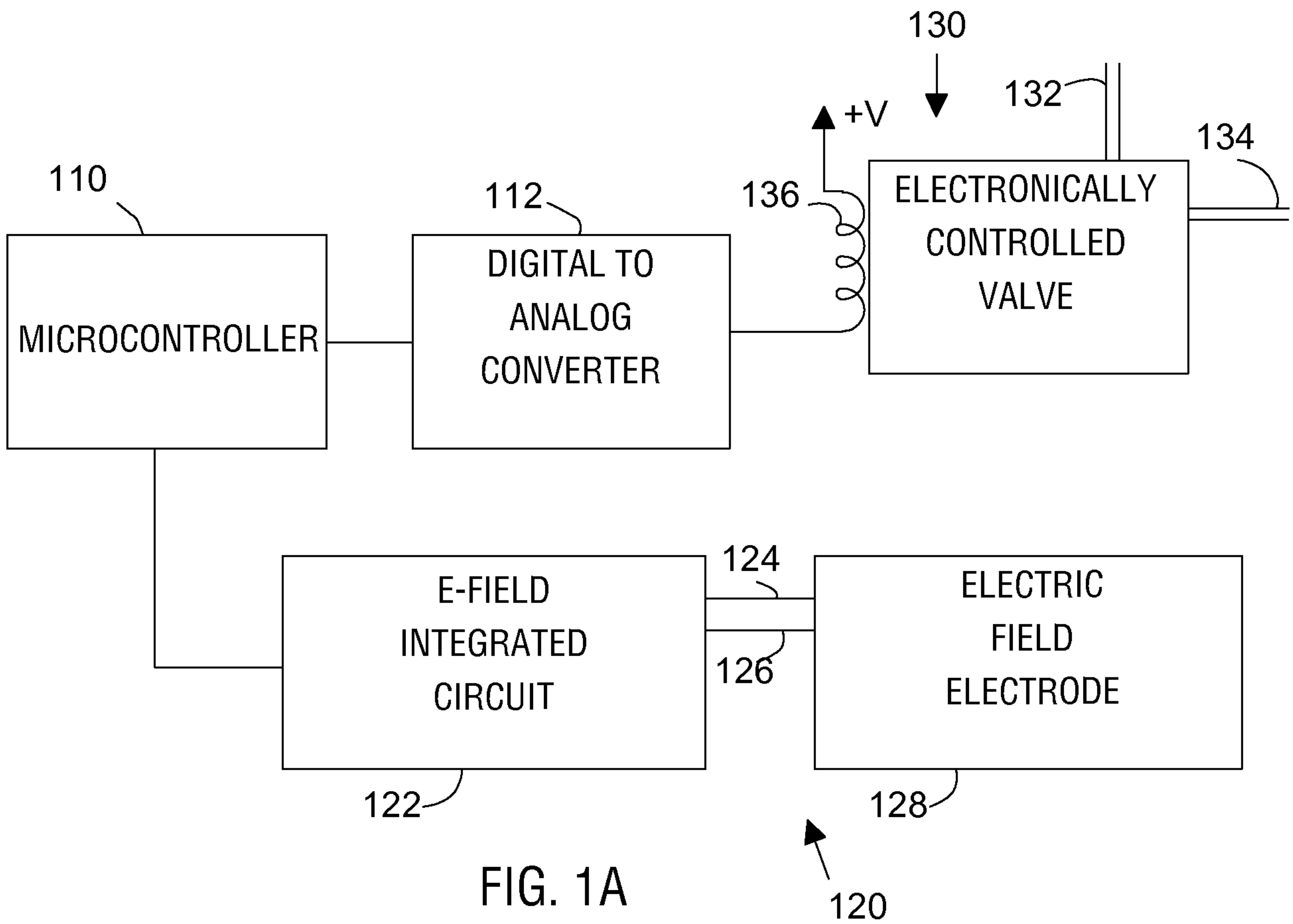
130
132
+V
134
110
112
136
ELECTRONICALLY CONTROLLED VALVE
DIGITAL TO ANALOG CONVERTER
MICROCONTROLLER
124
E-FIELD INTEGRATED CIRCUIT
ELECTRIC FIELD ELECTRODE
126
122
128
120

FIG. 1A

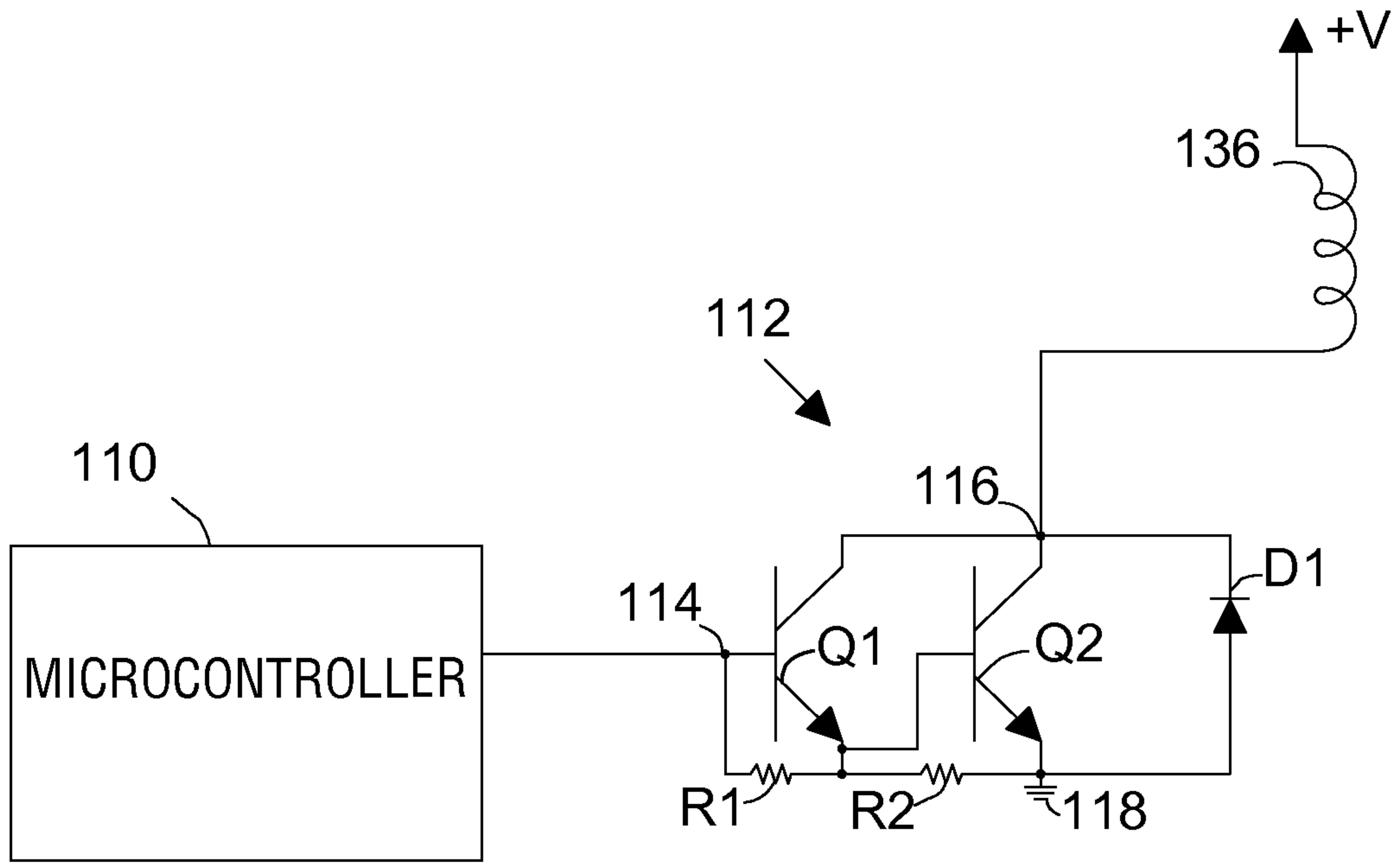
+V
136
112
110
116
D1
114
Q1
Q2
MICROCONTROLLER
R1
R2
118

FIG. 1B

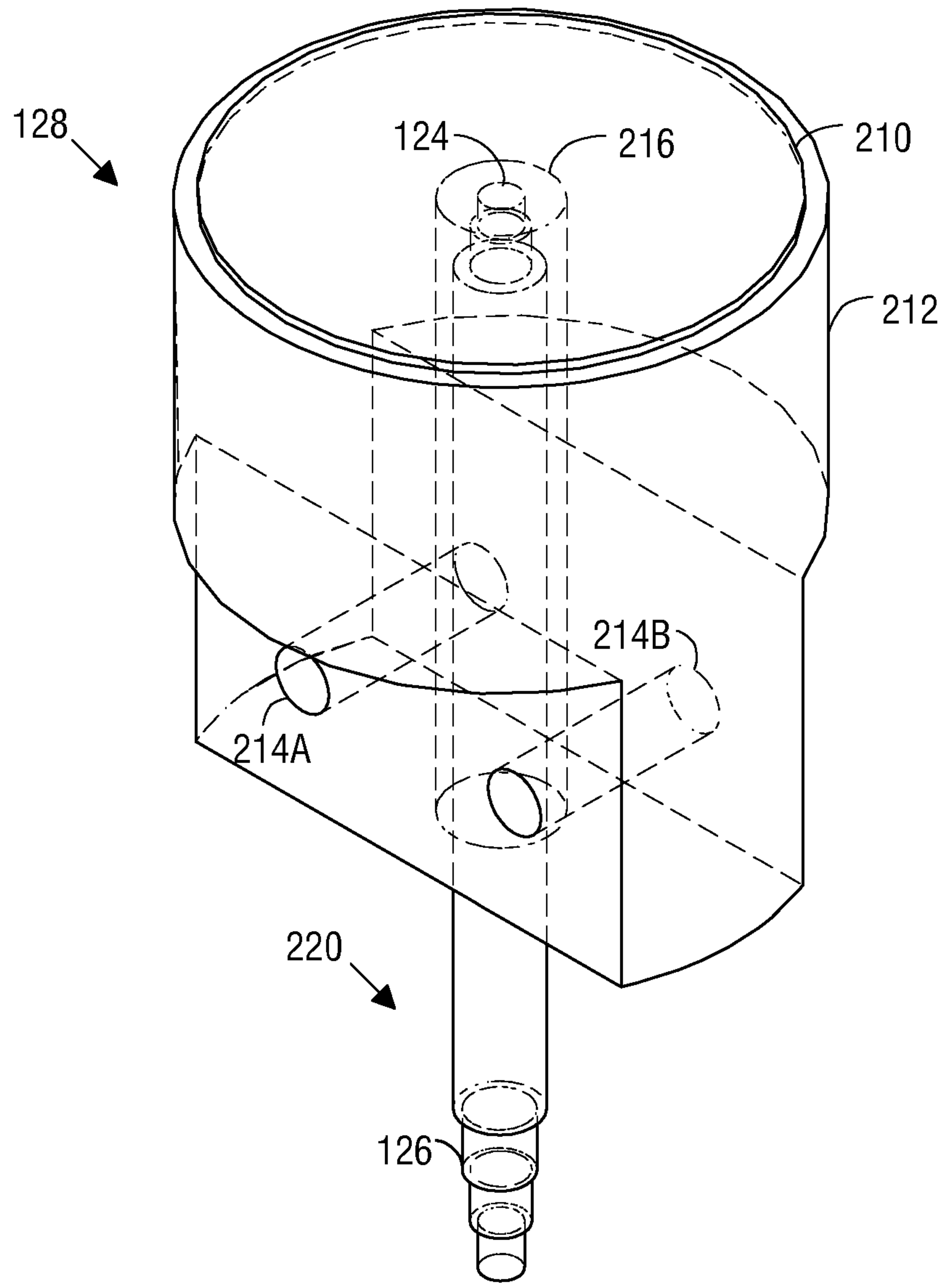

FIG. 2

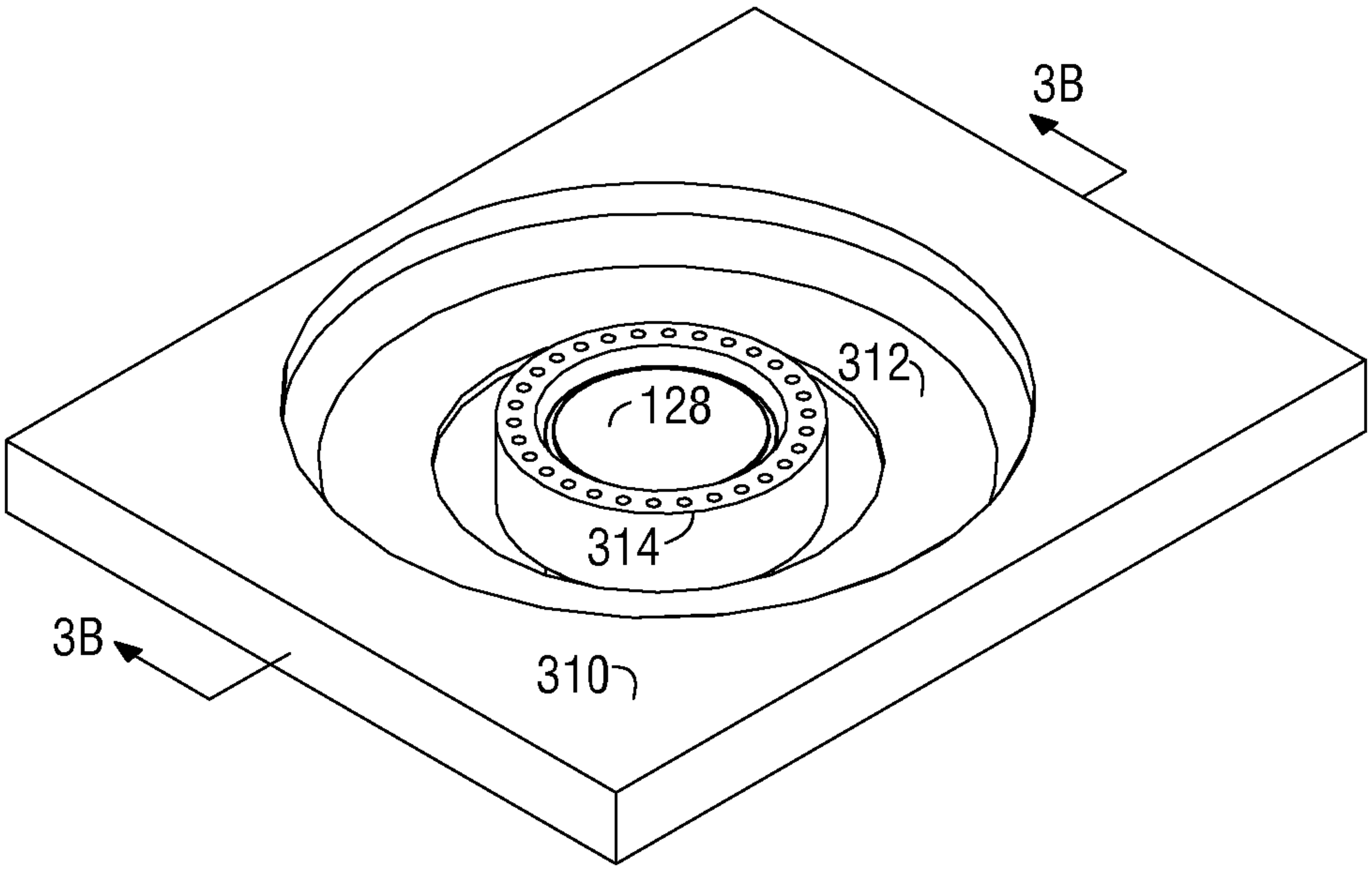

FIG. 3A

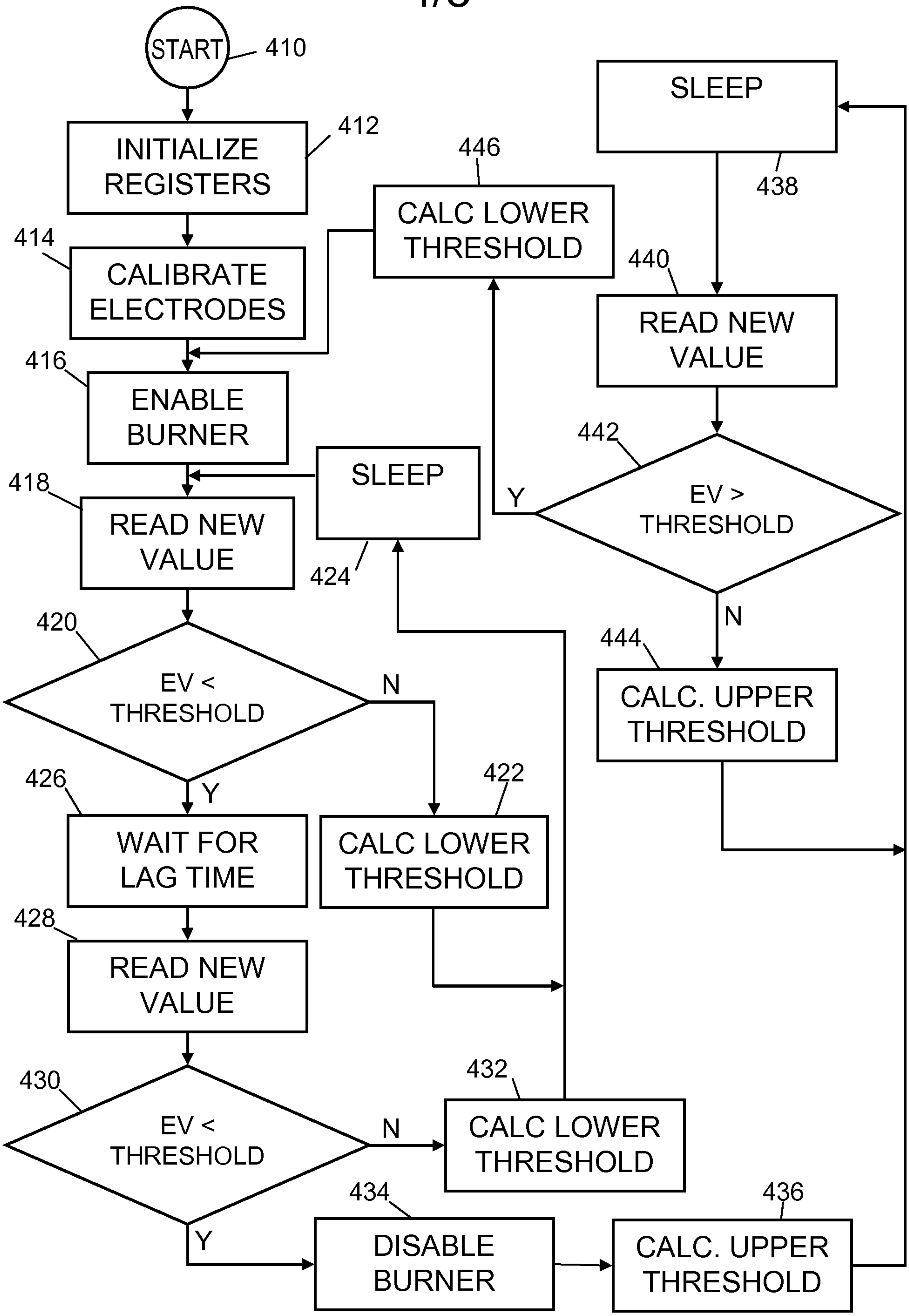
START
410
INITIALIZE REGISTERS
412
CALIBRATE ELECTRODES
414
ENABLE BURNER
416
READ NEW VALUE
418
EV < THRESHOLD
420
N
Y
SLEEP
424
CALC LOWER THRESHOLD
422
WAIT FOR LAG TIME
426
READ NEW VALUE
428
EV < THRESHOLD
430
N
Y
CALC LOWER THRESHOLD
432
DISABLE BURNER
434
CALC. UPPER THRESHOLD
436
SLEEP
438
READ NEW VALUE
440
EV > THRESHOLD
442
Y
N
CALC LOWER THRESHOLD
446
CALC. UPPER THRESHOLD
444

FIG. 4

5/8

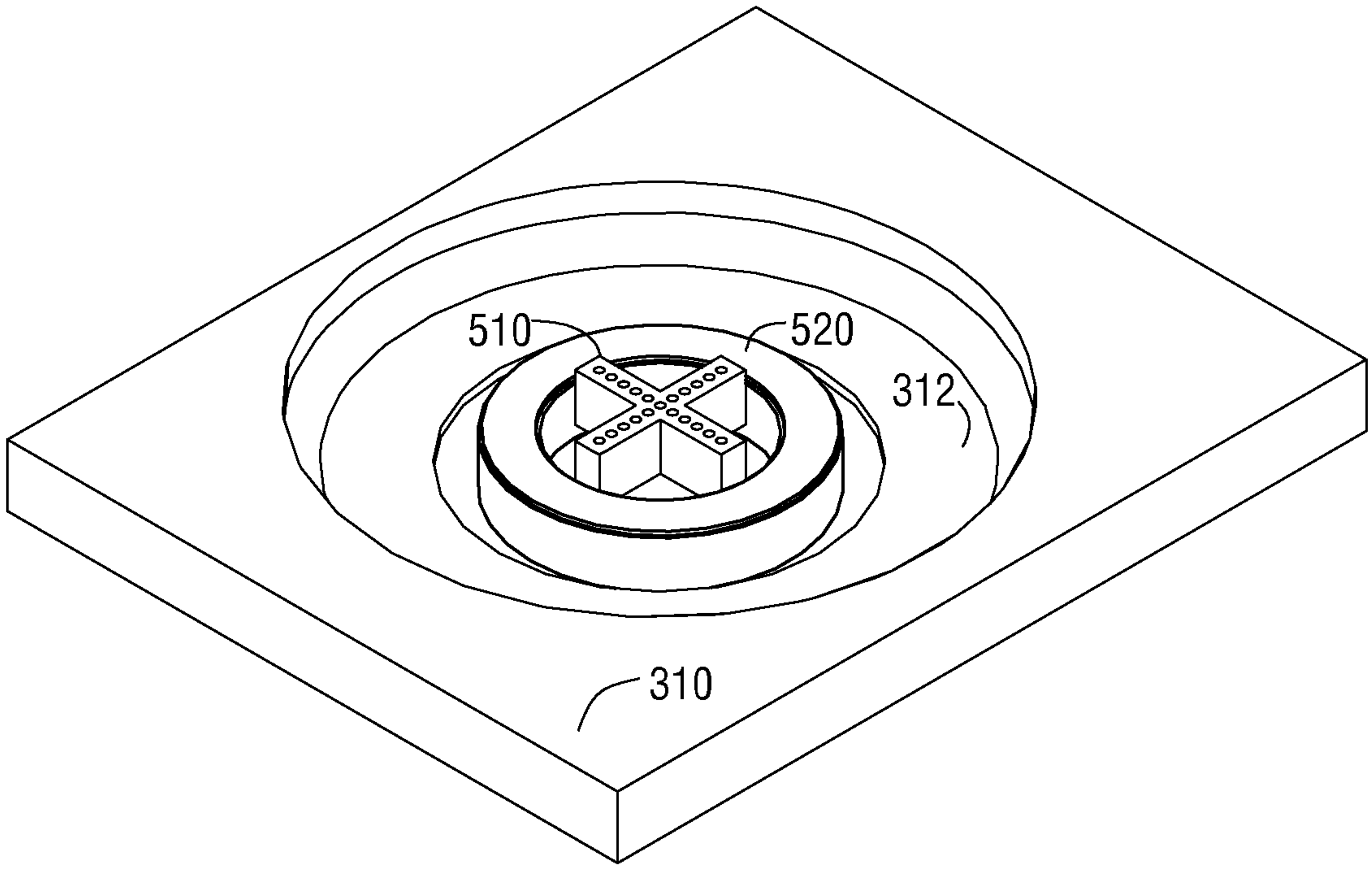

FIG. 5A

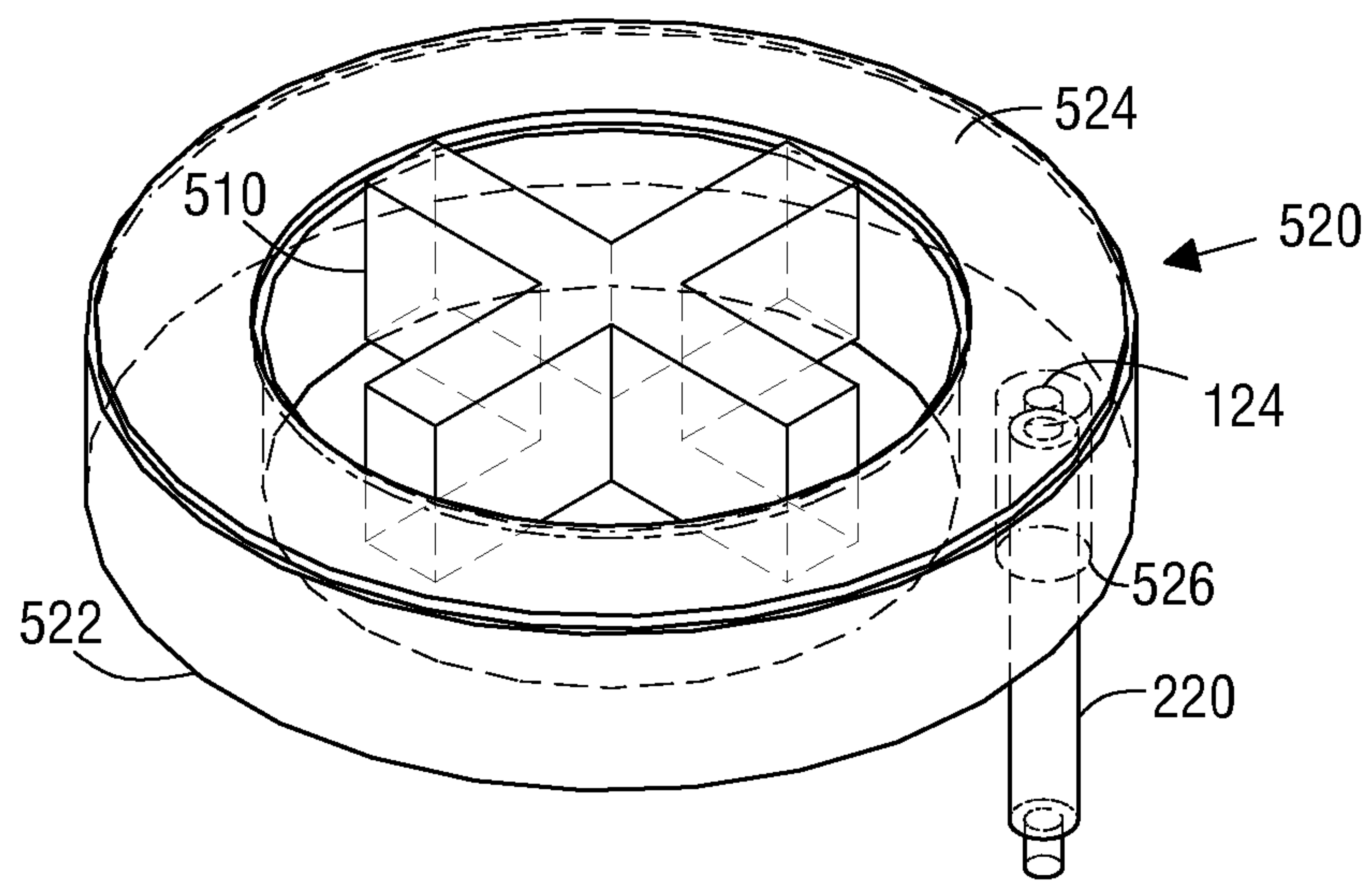

FIG. 5B

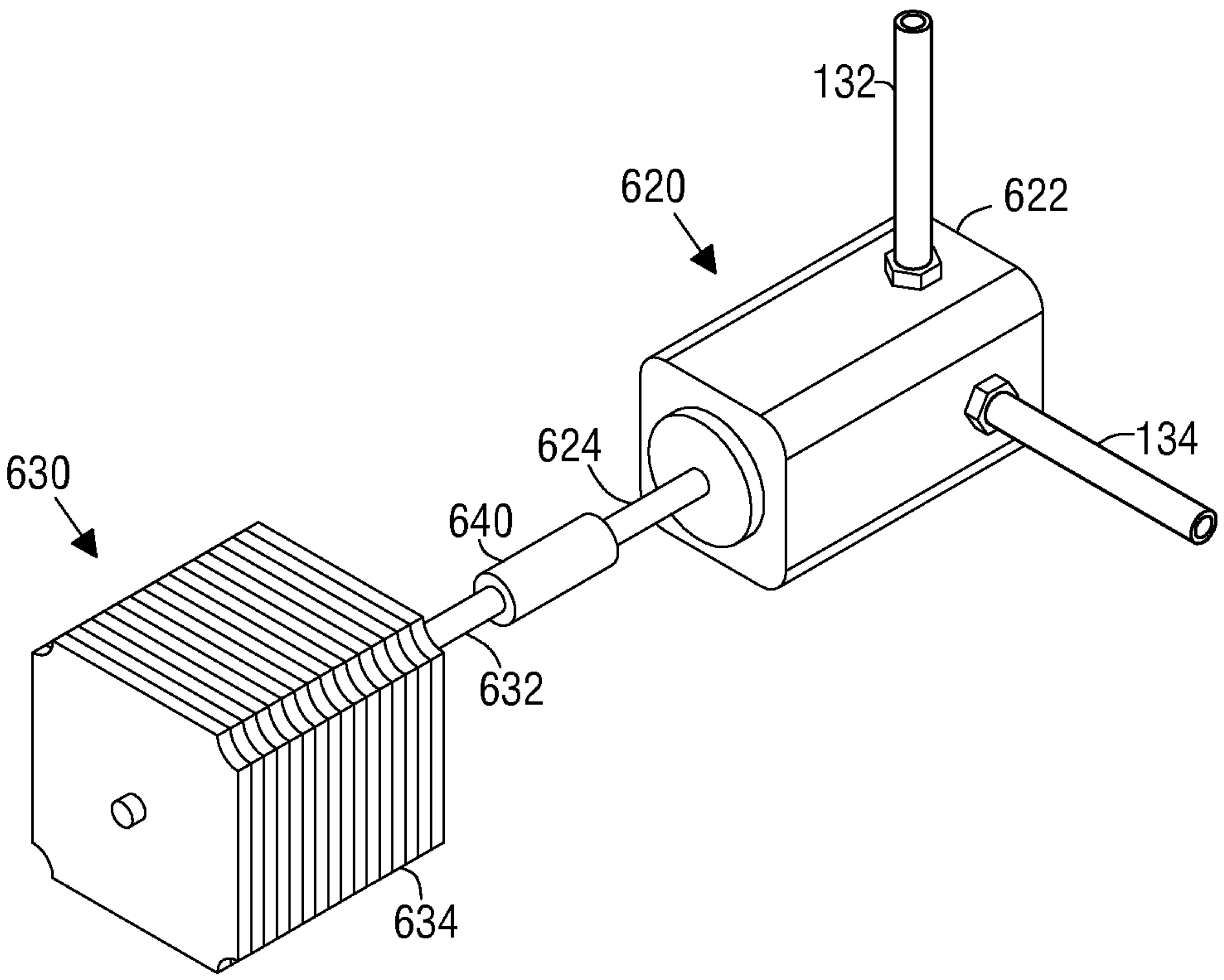

FIG. 6

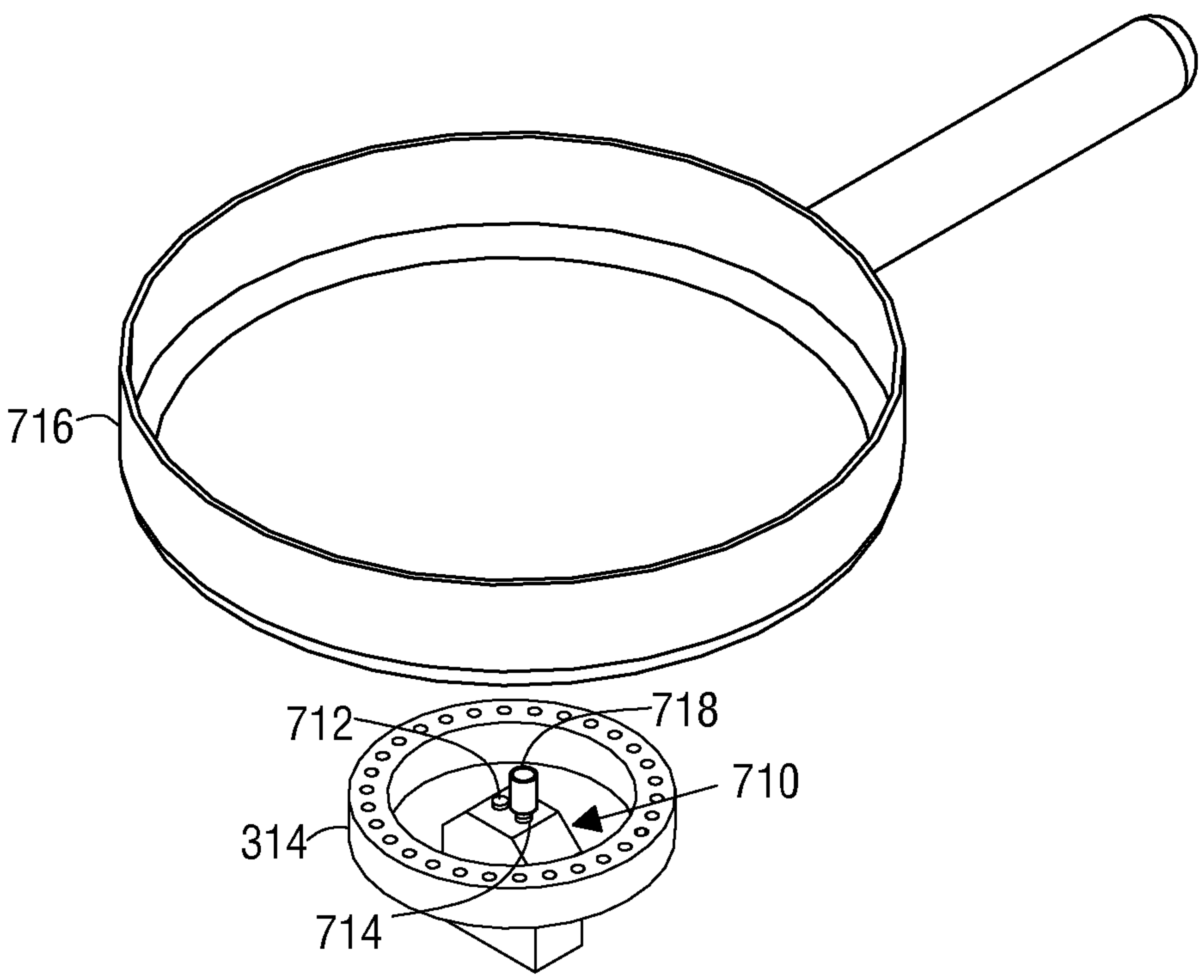

FIG. 7

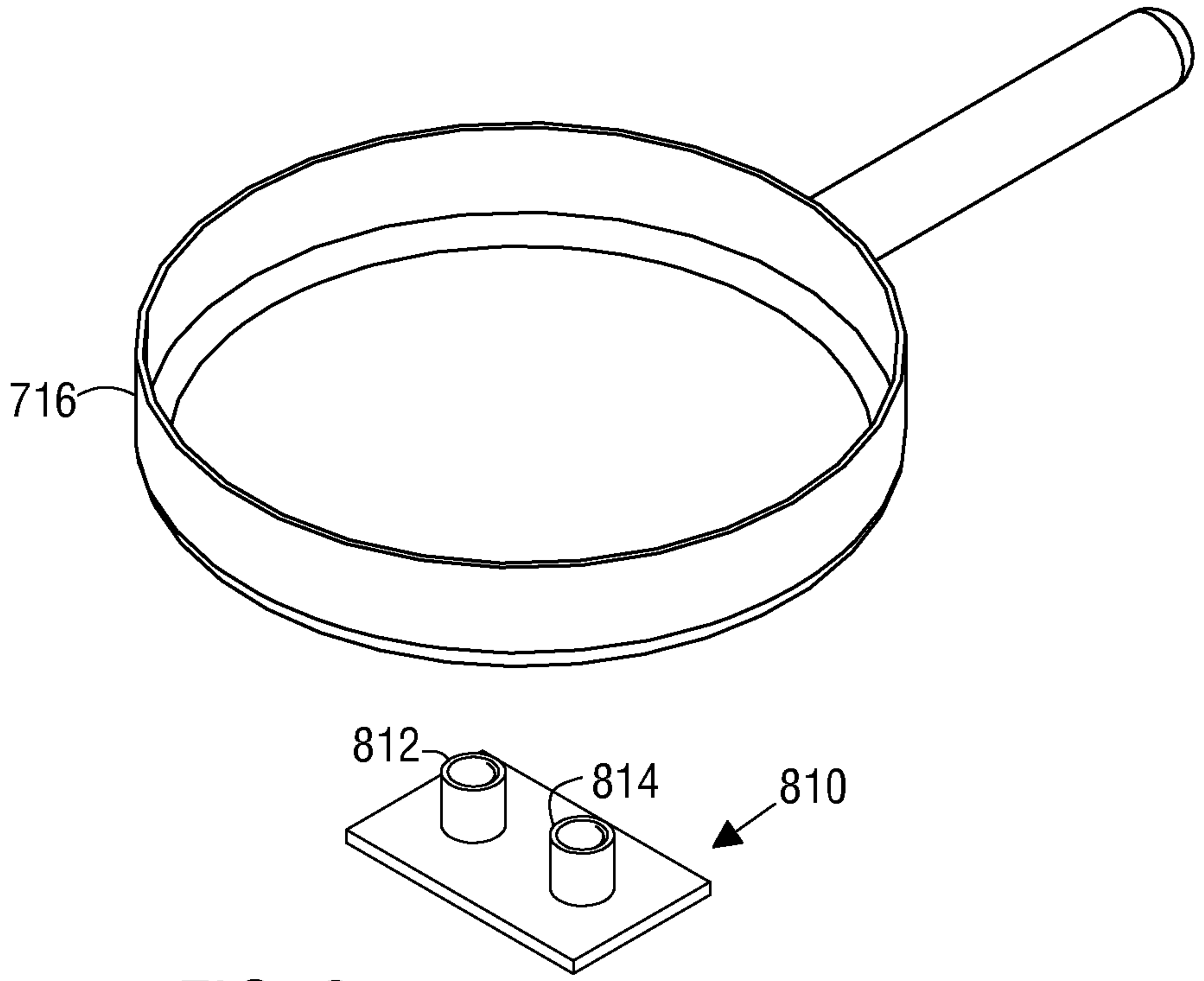

FIG. 8

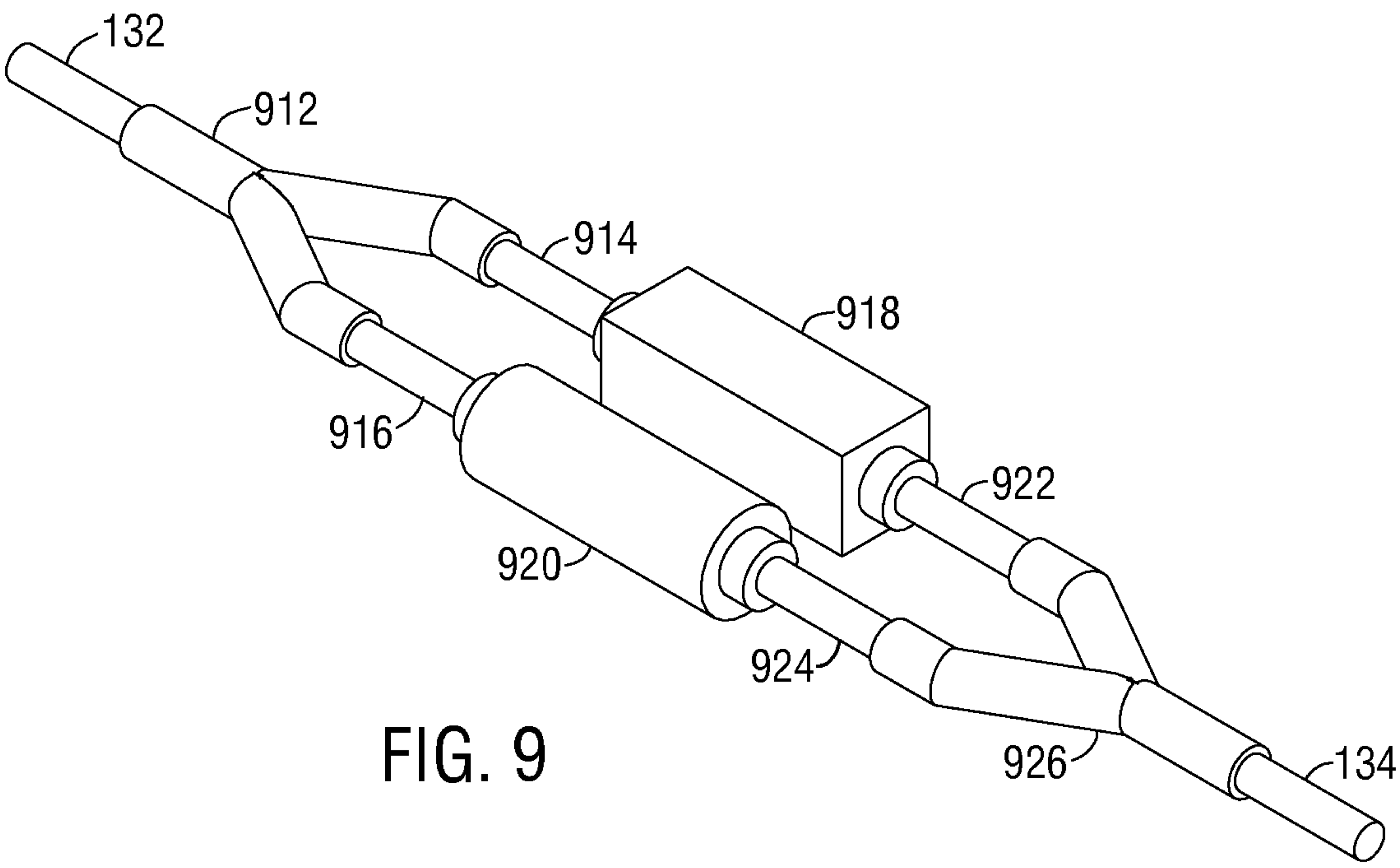

FIG. 9

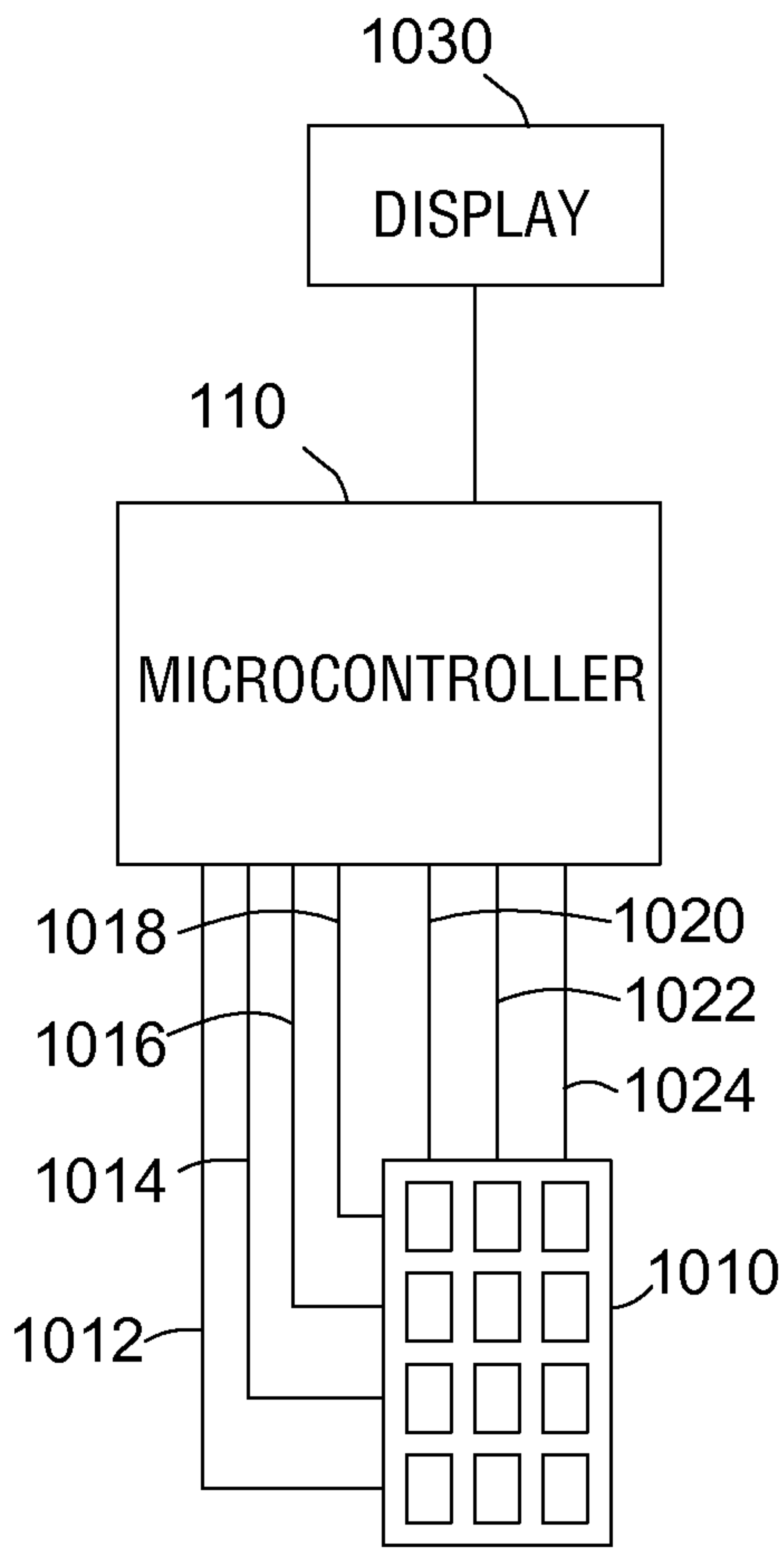
1030
DISPLAY
110
MICROCONTROLLER
1018
1016
1014
1012
1020
1022
1024
1010

FIG. 10

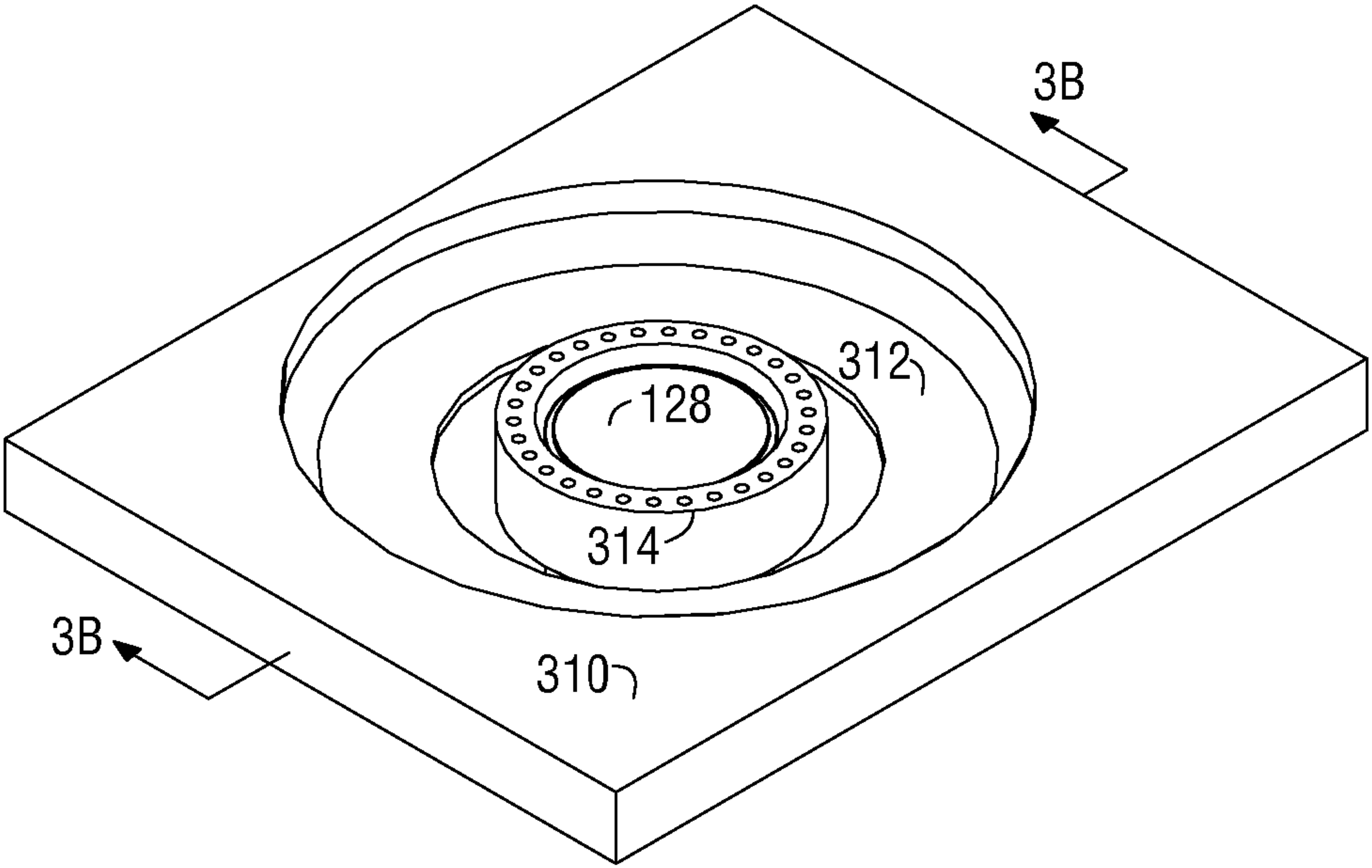

FIG. 3A