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Description

This invention relates to apparatus for heating water for domestic or commercial purposes and being provided with a supply of water, for example, cold water under pressure from a water main.

Hot water supplies are usually provided from a tank or other storage container, in which there is heating means such as an electrical immersion heater or a coil through which hot water heated by a boiler is circulated. Heat exchange by such methods is relatively slow and inefficient, due to gassification, i.e. water bubbles adhering to the heater element, and also the storage of the hot water is wasteful.

There have therefore been proposed various electrical heating devices which have efficiency sufficient to heat water as it flows through the apparatus. This arrangement eliminates the need for storage of hot water. The electrical heating is by means of electrical resistance heaters which are usually coiled wires disposed in the water passage. This type of apparatus is however only capable of producing a small flow of hot water, for example being sufficient to supply only one tap at a time.

DE—B—2327941 discloses a water heating apparatus having an inlet duct, an outlet duct and a conventional water heating unit between said ducts. DE—A—2240186 discloses a heater element for a hot water heater in which the element can be in the form of a printed circuit on a flat plate.

It is the object of the invention to provide water heating apparatus having no necessity for storage of the water which has been heated and which has a high efficiency for the conversion of electrical energy into heat.

According to the invention there is provided water heating apparatus comprising a body having an inlet thereto and an outlet therefrom, a heating unit within the body, the heating unit including printed circuit heater means, characterised in that the heating unit is in the form of a spiral, and in that water entering said body, in use, through said inlet is circulated around the spiral from its centre to its periphery and then out of the body through said outlet.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic perspective view of a water heating apparatus constructed in accordance with one embodiment of the invention,

Figure 2 is a perspective view of a body forming part of the water heating apparatus,

Figure 3 is a further, schematic, perspective view of the body of the water heating apparatus, showing the inside thereof, with an inlet pipe and heater unit therein,

Figure 4 is a perspective view of the inlet pipe and heater unit of Figure 3, removed from the body,

Figure 5 is an end view of the spiral heating unit,

Figure 6 is a schematic perspective view of a first embodiment of water heating means using the body of Figure 3, together with electrical control means,

Figure 7 is a schematic perspective view similar to Figure 6 of a second embodiment,

Figure 8 shows an arrangement of a three stage water heating apparatus, together with control means,

Figure 9 shows a heating unit arrangement where temperature sensors are built in with the heating elements, and

Figure 10 is a circuit diagram of the control of the apparatus.

Referring to Figure 1 this shows a water heating apparatus for use for example in a domestic situation for providing a supply of hot water and being supplied from a cold water main supply.

The apparatus as shown in Figure 1 includes an inlet section 10 and an outlet section 11 and a body section 12, containing the heating means of the appliance, situated between the inlet and outlet sections. Part of the casing has been removed for clarity and it is to be understood that the external shape of the apparatus may take any other form instead of the generally rectangular configuration shown. In addition the body section 12 can also be other than rectangular, for example it can be of pear-shaped cross-section, as shown in Figures 2 and 3.

On the inlet section 10 there can be mounted a control 13 by means of which the temperature of the water delivered can be regulated, as will be described.

Figures 2 to 5 show the construction and arrangement of various parts of a first embodiment of water heating apparatus, to fit into a casing in the form of Figure 1 or in any suitable alternative form.

Figures 2 and 3 show a metallic body 14 of generally pear shape in transverse cross-section. The body has end walls 15, 16 respectively and in the end wall 15, which is the inlet end of the body, there is provided a generally central hole 17. The hole 17 is threaded to receive an adaptor plug supporting a cold water inlet pipe 18 which, in use, is arranged to receive pressurised cold or relatively cold water from, for example, the main supply. If required the inlet could incorporate a non-return valve. The wall 15 also contains a further threaded hole 19, which is plugged, in use, and a slot 20.

The end wall 16 has a hole 21, longitudinally aligned with the hole 19, and which is threaded like the hole 17, to receive an adaptor plug 23 (Figures 6 and 7), similar to that fitted in the hole 17, and carrying an outlet pipe 24.

The inlet pipe 18 extends to the interior surface of the end wall 16 where it is closed. However the pipe 18 has an axially extending slot 25 in its surface to allow the cold water to flow therefrom into a spirally arranged heater unit 26 shown in Figure 3.

The heater unit, shown best in Figures 4 and 5,

is in the form of an electrical printed circuit heater 27 sandwiched between a pair of metal plates and rolled into a spiral. Connections 28 for supplying power to and for controlling the heater are provided on a longitudinal extension part at one corner 29 of the heater unit which protrudes through the slot 20. A glass or metal laminate, i.e. aluminium can be provided around the outside of the heater unit.

With the heater unit fitted in the water heating body 14 and being closed by the end walls 15, 16, which are, for example, secured to the remainder of the body by welding as shown in Figure 3, it can be appreciated that cold water entering the inlet pipe 18 will flow out of the slot 25 and into the innermost turn of the spiral of the heater unit. The water will then flow around the remaining spirals until it leaves the outermost part of the spiral and flows out of the outlet pipe 24 carried by the plug 23 fitted in the hole 21 in the outlet end wall 16 of the body 14.

The fact that the heater unit is a spiral, in this example of four turns, means that the surface area of the heater unit contacted by the water, as well as the contact time is significantly increased as compared to conventional heater units such as heating coils. This increases the efficiency of the heater, whilst enabling it to be kept relatively short and compact, thus allowing the water heating apparatus itself to be made compactly and less expensively. It has also been found that this construction of heater substantially reduces gassification, further improving the heating efficiency.

Figure 6 shows a first example of an assembled body 14, inlet and outlet pipes 18, 24 heater unit 26 and associated controls for water heating apparatus of the invention. A casing 30 is shown schematically around the body 14, and this can contain asbestos or the like as heat insulation material. Electrical connection lines 31, 32 are taken from a power supply (to be described in Figure 10) to the connections 28 on the corner extension 29 of the heater unit. An override or cut-out sensor 33 is fitted on the body 14 to monitor the temperature of the water entering the outlet pipe 24 and to operate if a predetermined maximum value is exceeded. For example it could operate to switch off the heater unit and could be manually or automatically reset. Electrical lines 34, 35 connect the sensor to a control circuit, not shown.

Figure 7 shows a similar arrangement to figure 6, but with an increased number of printed circuit heaters, giving six contacts 36 and associated supply lines 37. As well as an override sensor 38, similar to the sensor 33 in Figure 6, there are additional sensors 39, 40 in the inlet and outlet pipes 18, 24 respectively, to provide electrical signals related to the temperature of water flowing therein. Each sensor has a pair of electrical connection lines leading therefrom to the control means of the water heating apparatus, which will be described below.

Typically a small heater unit, such as that shown in Figure 6, will be used in a 5 kw water heating apparatus and a multi-circuit arrangement such as in Figure 7 would produce 10 kw.

Figure 8 shows the use of three body assemblies of Figure 6 connected in series, so that each one can perform a stage of the water heating operation. The inlet pipe 18 of the first body assembly is fed from the cold water supply and after being heated by passing around the spiral heating unit in the body, the water passes out through the outlet pipe 24 of said first body, which also serves as the inlet pipe to the next body downstream in the series, and so on for the third and any subsequent body assemblies, as the number is not limited to the three shown. This arrangement reduces the wear on each heater unit and thus prolongs the life thereof. Each body assembly is shown as in Figure 6, but with a water temperature sensor 41, and although not shown each body assembly can also be provided with an override sensor. A heater control unit 42 and a temperature control unit 43 are also shown, along with a water outlet distribution system of five outlet branches 44 for the heated water to be taken off. The temperature sensors monitor water temperature along the whole body assembly and can detect hot or cold spots, for example, to cut out the heater in one particular section thereof. Thus with this arrangement each assembly can raise the water temperature by a given amount so that the heating load is spread over three heater units to produce water of the required temperature at the outlet of the end assembly. If required the bodies could be as in Figure 7.

Figure 9 shows an arrangement where the temperature sensor 41a is produced together with the heating elements 45 in the printed circuit board of the heater unit. This is a particularly compact arrangement allowing connections 46 to be made to the heater control unit 47 and connections 48 to the temperature control unit 49 at the board edge, thereby dispensing with an external, separate temperature sensor, like the sensor 41 in Figure 8. However like the sensor 41, the sensor 44 monitors water temperature along the whole of the heater unit and can cut out a heating section if a hot spot is detected.

Figure 10 shows an electrical control circuit suitable for all the water heating arrangements shown in Figures 1 to 9, where the heating apparatus has associated temperature sensing.

A spiral heater unit is denoted by the numeral 50 and sensors for monitoring inlet and outlet water temperature are denoted by the numerals 39 and 40, as for Figure 7, in the inlet and outlet sections 10 and 11. The heater unit is controlled through a solid state switch or relay 51. This is provided with a mains electrical supply at 52. If a relay is used, it can be of any suitable type, for example incorporating a triac value.

The sensors 39, 40 are connected in a bridge circuit 53 which is variable at 54 to regulate the heater unit output. This variation is carried out by way of the control knob 13 of Figure 1. A 24 volt power supply is connected between lines 55 and

56 with the voltage being supplied to the switch or relay 51. The line 55 is continued to the variable adjustment means 54 of the bridge circuit 53, whilst the line 56 is connected to the opposite point of the circuit 53. A line 57 extends from a further junction of the bridge circuit between the connection of the sensor 39 and a resistor to one input of an operational amplifier 58. This is a (temperature) difference amplifier. A line 59 extends from the remaining junction of the circuit 53 to another input of the amplifier 58. An output line 60 from the amplifier is connected to the line 56 of zero voltage, through resistors 61 and 62. Connected between the lines 59 and 60 is a coil 69.

A line 63 extends from the switch or relay 51 to join the line 60 between the resistors 61, 62. It has a transistor 64 connected in it between collector and base and a line 65 from the emitter of the transistor 64 extends to the base of another transistor 66, whose collector and emitter are in a line 67 between lines 56 and 63. A further resistor 68 is connected between the lines 56 and 65 to complete the circuit.

The arrangement is such that the inlet and outlet temperatures are sensed by sensors 39, 40 and according to the setting of the control knob 13 at variable adjustment 54, the heater current is regulated to maintain the chosen output temperature despite changes in input temperature.

The described spiral arrangement of the heating element is most advantageous, since in addition to its efficiency advantages and lower cost, it simplifies electrical connections thereto because they can be made at any convenient place.

With some constructions of water heating apparatus using this invention, it is envisaged that it will be possible to reduce costs to a degree where the apparatus can be considered disposable.

Claims

1. Water heating apparatus comprising a body (14) having an inlet (18) thereto and an outlet (24) therefrom, a heating unit (26) within the body, the heating unit including printed circuit heater means (27), characterised in that the heating unit is in the form of a spiral, and in that water entering said body, in use, through said inlet (18) is circulated around the spiral from its centre to its periphery and then out of the body through said outlet (24).

2. Apparatus as claimed in claim 1, characterised in that the spiral heating unit is fitted between opposite ends (15, 16) of the body (14), which ends close the ends of the spiral respectively, and an extension (29) of the spiral heating unit protrudes outwardly through a slot (20) in said body for electrical connection thereto.

3. Apparatus as claimed in claim 1 or claim 2, characterised in that the inlet is in the form of an inlet pipe (18) extending axially through the centre of the spiral and having an axial slot (25) in its periphery to allow water to flow into the spiral heating unit.

4. Apparatus as claimed in any one of the preceding claims, characterised in that the heating unit comprises at least one printed circuit heater (27) sandwiched between a pair of plates.

5. Apparatus as claimed in claim 4, characterised in that the plates are metallic.

6. Apparatus as claimed in any one of the preceding claims, including one or more temperature sensors to monitor water temperature in the inlet and/or outlet and/or along the length of the heating unit and a control circuit (42, 43, 47) for increasing or decreasing the output of the heating unit, in use, in response to the or at least one of said sensors, to maintain a chosen water output temperature.

7. Apparatus as claimed in claim 6, characterised in that said control circuit comprises a resistance bridge circuit (53) to which sensors (39, 40) which monitor water temperature in the inlet and outlet respectively are connected, and which has a variable resistance (54) settable to correspond to a chosen water output temperature, the arrangement being such that with said resistance set to give a chosen water output temperature, a deviation from said chosen temperature causes adjustment of the current supply to the heating unit by means of a mains powered solid state switch or relay (51) controlled by an electrical signal from said bridge circuit passed through an operational amplifier (58) in said control circuit.

8. Apparatus as claimed in any one of the preceding claims, characterised by the provision of override sensor means (33, 38) operable to cut-off electrical supply to the heating unit if the water temperature exceeds a predetermined value.

9. Apparatus as claimed in claim 6 or claim 7, characterised in that said printed circuit heater means has at least one sensor (44) formed with it, and connections (46) to said printed circuit heating means and said at least one sensor are provided at an edge of a board carrying said printed circuit heating means.

10. Apparatus as claimed in any one of the preceding claims, characterised by a plurality of said bodies (14) connected in series so that the heating unit of each body can perform a stage of the water heating operation.

Patentansprüche

1. Wassererhitzer mit einem Gehäuse (14) einschließlich eines Einlasses (18) und eines Auslasses (24), mit einer im Gehäuse gelegenen Heizeinheit (26), die eine gedruckte Heizeinrichtung (27) aufweist, dadurch gekennzeichnet, daß die Heizeinrichtung die Form einer Spirale hat und daß das bei Gebrauch durch den Einlaß (18) in das Gehäuse eintretende Wasser von der Mitte der Spirale zu deren Umfang und dann durch den Auslaß (24) aus dem Gehäuse umgewälzt wird.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Spiralheizeinheit zwischen entgegengesetzten Enden (15, 16) des Gehäuses (14) eingepaßt ist, wobei die Enden jeweils die

Enden der Spirale schließen, und daß ein Fortsatz (29) der Spiralheizeinheit durch einen Einschnitt (20) im Gehäuse zur elektrischen Verbindung iermit nach außen ragt.

3. Vorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Einlaß die Form eines Einlaßrohrs (18) hat, das sich axial durch die Mitte der Spirale erstreckt und in seinem Umfang einen axialen Einschnitt (25) hat, um dem Wasser ein Strömen in die Spiralheizeinheit zu ermöglichen.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Heizeinheit wenigstens ein zwischen zwei Platten angeordnetes gedrucktes Heizelement (27) aufweist.

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Platten metallisch sind.

6. Vorrichtung nach einem der vorhergehenden Ansprüche mit einem oder mehreren Temperaturfühlern zum Überwachen der Wassertemperatur im Einlaß und/oder Auslaß und/oder auf der Länge der Heizeinheit und mit einer Steuerschaltung (42, 43, 47) zum Erhöhen oder Herabsetzen der Ausgangsleistung der Heizeinheit bei Gebrauch in Abhängigkeit von dem oder wenigstens von einem der Fühler zum Aufrechterhalten einer gewählten Wasseraustrittstemperatur.

7. Vorrichtung nach Anspruch 6, dadurch gekennzeichnet, daß die Steuereinheit einer Widerstandsbrückenschaltung (53) aufweist, mit der die Wassertemperatur im Einlaß bzw. Auslaß überwachende Fühler (39, 40) verbunden sind und die einen veränderlichen Widerstand (54) aufweist, der so einstellbar ist, daß er einer gewählten Wasserausgangstemperatur entspricht, wobei die Anordnung so getroffen ist, daß bei derart eingestelltem Widerstand, daß sich eine gewählte Wasserausgangstemperatur ergibt, eine Abweichung von der gewählten Temperatur eine Einstellung der Stromzufuhr zur Heizeinheit durch einen netzbetriebenen Festkörperschalter oder ein Relais (51) bewirkt, das durch ein elektrisches Signal aus der Brückenschaltung gesteuert wird, das durch einen Operationsverstärker (58) in der Steuereinheit geleitet wird.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, gekennzeichnet durch eine Vorrangfühlereinrichtung (33, 38), die so betätigbar ist, daß sie die Stromzufuhr zur Heizeinrichtung abschaltet, wenn die Wassertemperatur einen gegebenen Wert übersteigt.

9. Vorrichtung nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß die gedruckte Heizeinrichtung wenigstens einen mit ihr ausgebildeten Fühler (44) aufweist und daß an einer Kante einer die gedruckte Heizeinrichtung tragenden Platte Anschlüsse (46) an die gedruckte Heizeinrichtung und den wenigstens einen Fühler vorgesehen sind.

10. Vorrichtung nach einem der vorhergehenden Ansprüche, gekennzeichnet, durch mehrere Gehäuse (14), die so in Reihe geschaltet sind, daß die Heizeinheit jedes Gehäuses einen Schritt des Wasserheizvorgangs ausführen kann.

Revendications

1. Appareil de chauffage d'eau comprenant un corps (14) comportant une entrée (18) dans ce dernier et une sortie (24) partant de ce dernier, une unité de chauffage (26) à l'intérieur du corps, l'unité de chauffage comprenant un moyen de chauffage à circuit imprimé (27), caractérisé en ce que l'unité de chauffage se présente sous la forme d'une spirale, et en ce que l'eau qui pénètre dans ledit corps, en utilisation, par ladite entrée (18) est mise en circulation autour de la spirale en partant de son centre et en allant vers sa périphérie, puis en sortant du corps par ladite sortie (24).

2. Appareil selon la revendication 1, caractérisé en ce que l'unité de chauffage en spirale est fixée entre les extrémites opposées (15, 16) du corps (14), lesquelles extrémités ferment respectivement les extrémités de la spirale, et un prolongement (29) de l'unité de chauffage en spirale fait saillie vers l'extérieur par une fente (20) pratiquée dans ledit corps en vue d'une connexion électrique.

3. Appareil selon la revendication 1 ou la revendication 2, caractérisé en ce que l'entré se présente sous la forme d'un tuyau d'entrée (18) s'étendant axialement dans le centre de la spirale et possédant une fente axiale (25) sur sa périphérie pour permettre à l'eau de s'écouler dans l'unité de chauffage en spirale.

4. Appareil selon l'une des revendications précédentes, caractérisé en ce que l'unité de chauffage comprend au moins un dispositif de chauffage à circuit imprimé (27) pris en sandwich entre deux plaques.

5. Appareil selon la revendication 4, caractérisé en ce que les plaques sont métalliques.

6. Appareil selon l'une des revendications précédentes, comprenant au moins un ou plusieurs capteurs de température pour surveiller la température de l'eau à l'entrée et/ou à la sortie et/ou le long de la longueur de l'unité de chauffage, et un circuit de commande (42, 43, 47) pour augmenter ou diminuer la sortie de l'unité de chauffage, en utilisation, en réponse aux dits capteurs ou à au moins l'un des dits capteurs, pour maintenir une température de sortie donnée de l'eau.

7. Appareil selon la revendication 6, caractérisé en ce que le circuit de commande comprend un circuit pont à résistances (33) auquel sont reliés des capteurs (39, 40) qui surveillent la température de l'eau respectivement à l'entrée et à la sortie, et qui comprend und résistance variable (54) pouvant être réglée pour correspondre à une température de l'eau choisie, l'agencement étant tel que lorsque ladite résistance est réglée pour fournir une température de sortie de l'eau choisie, une déviation par rapport à ladite température choisie provoque une régulation du courant amené à l'unité de chauffage au moyen d'un commutateur ou d'un relais (51) à l'état solide et recevant sa puissance du secteur, commandé par un signal électrique provenant dudit circuit pont

et ayant passé par un amplificateur opérationnel (58) dans ledit circuit de commande.

8. Appareil selon l'une des revendications précédentes, caractérisé en ce qu'il est prévu un moyen capteur à priorité de commande (43, 38) apte à couper l'alimentation électrique envoyée à l'unité de chauffage si la température de l'eau dépasse une valeur prédéterminée.

9. Appareil selon la revendication 6 ou la revendication 7, caractérisé en ce que lesdits moyens de chauffage à circuit imprimé comprennent au moins un capteur (44) formé avec eux, et des connexions (46) avec lesdits moyens de chauffage à circuit imprimé et ledit capteur sont prévues sur un bord d'une plaquette supportant lesdits moyens de chauffage à circuit imprimé.

10. Appareil selon l'une des revendications précédentes, caractérisé par plusieurs desdits corps (14) montés en série de manière que l'unité de chauffage de chaque corps puisse constituer un étage pour le chauffage de l'eau.

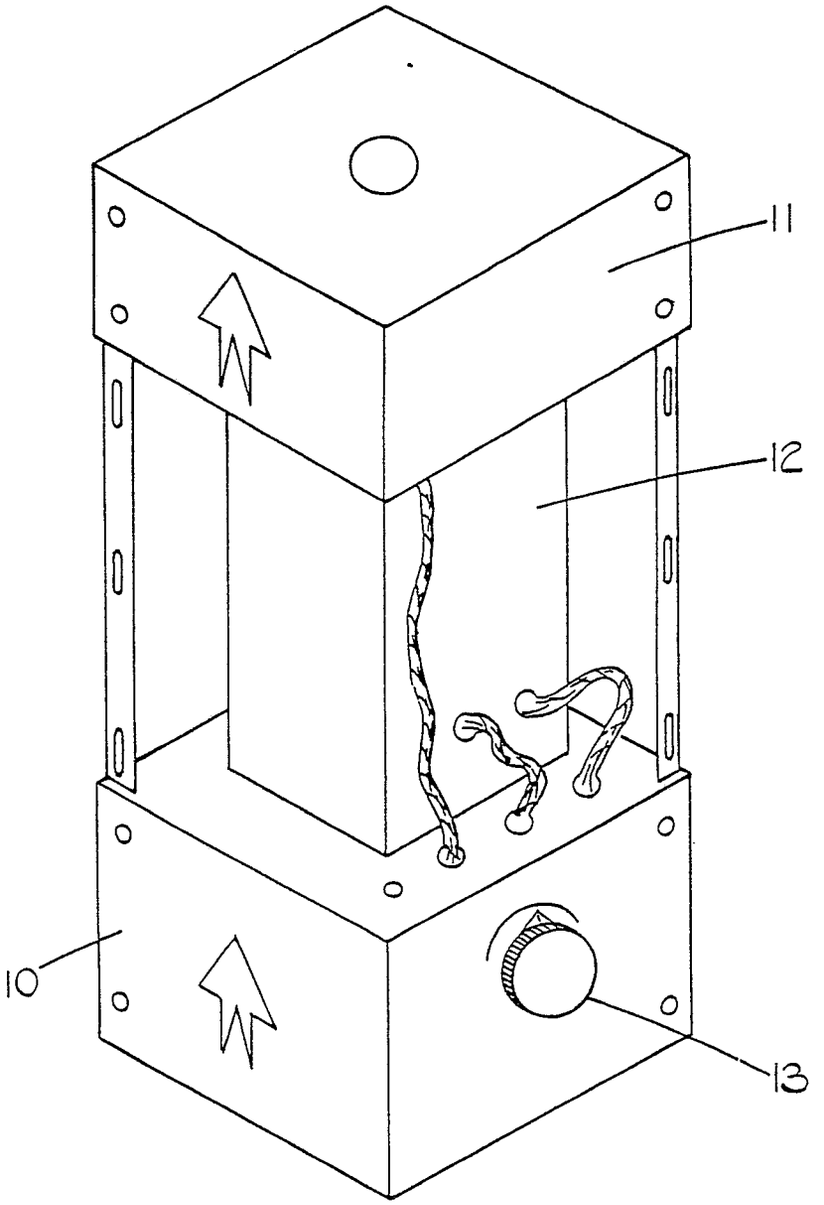


FIG. 1.

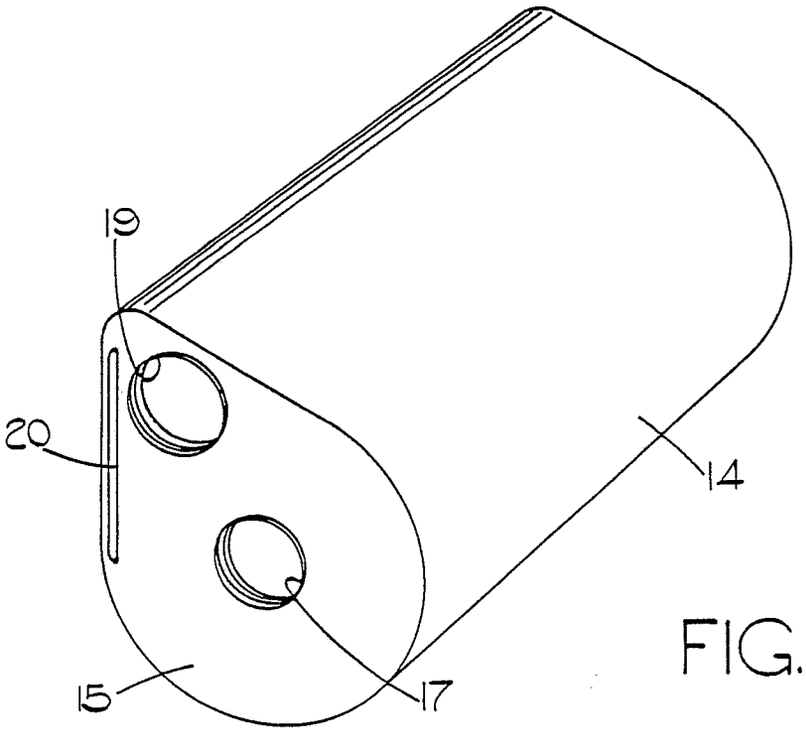


FIG.2.

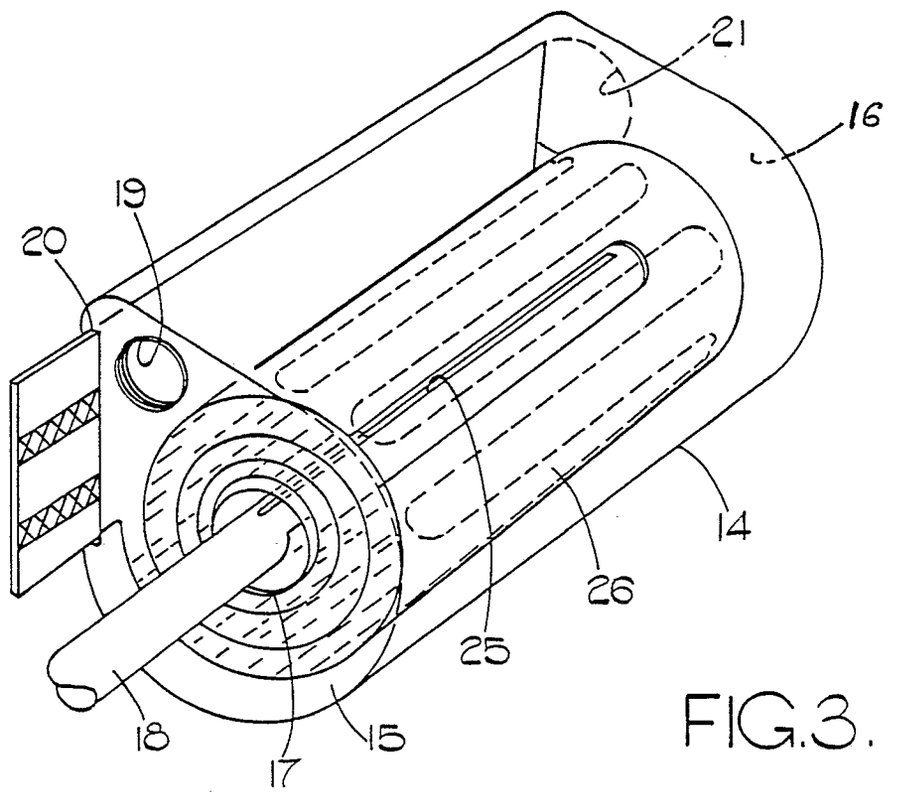


FIG.3.

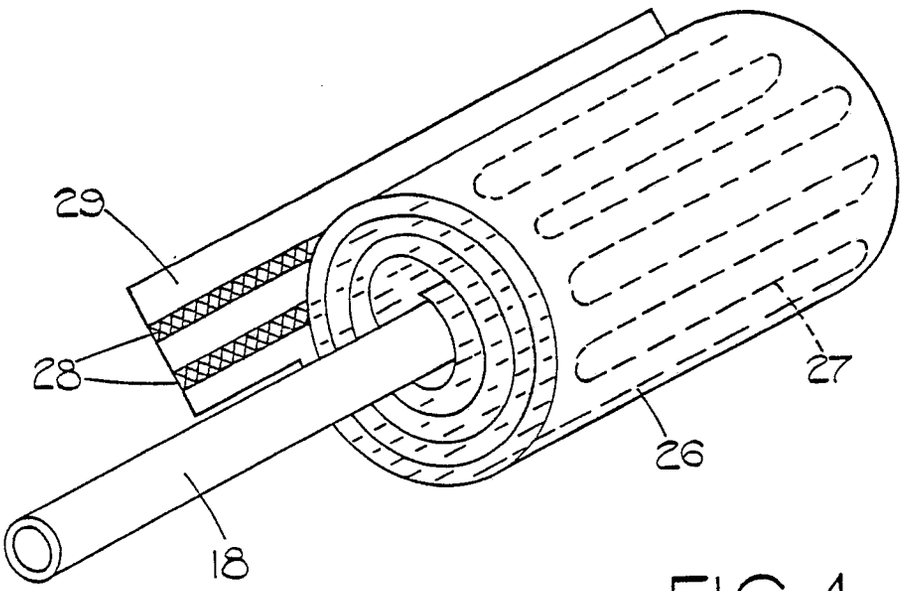


FIG. 4.

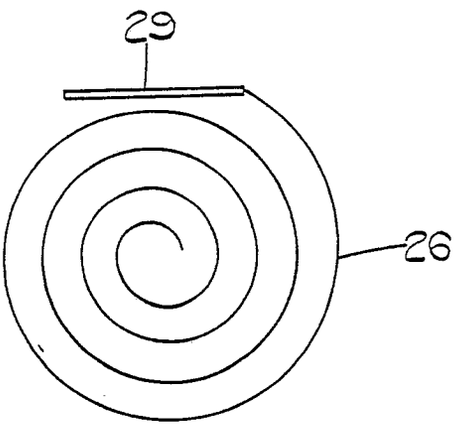


FIG.5

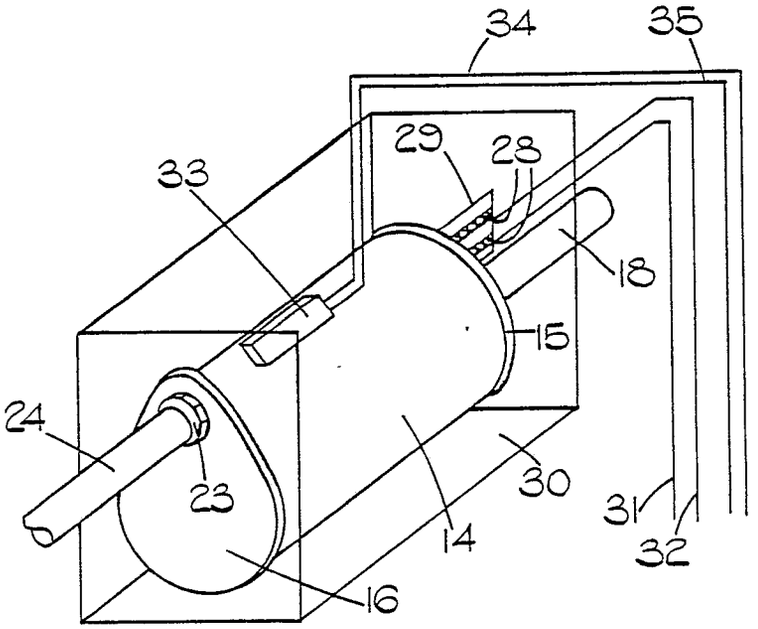

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FIG.6.

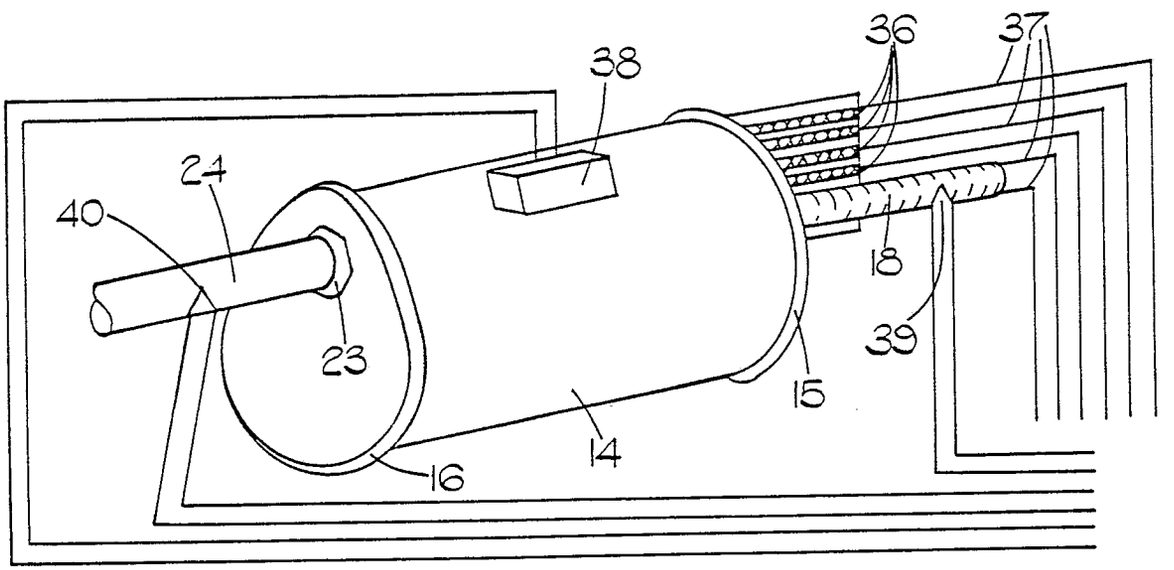

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FIG.7.

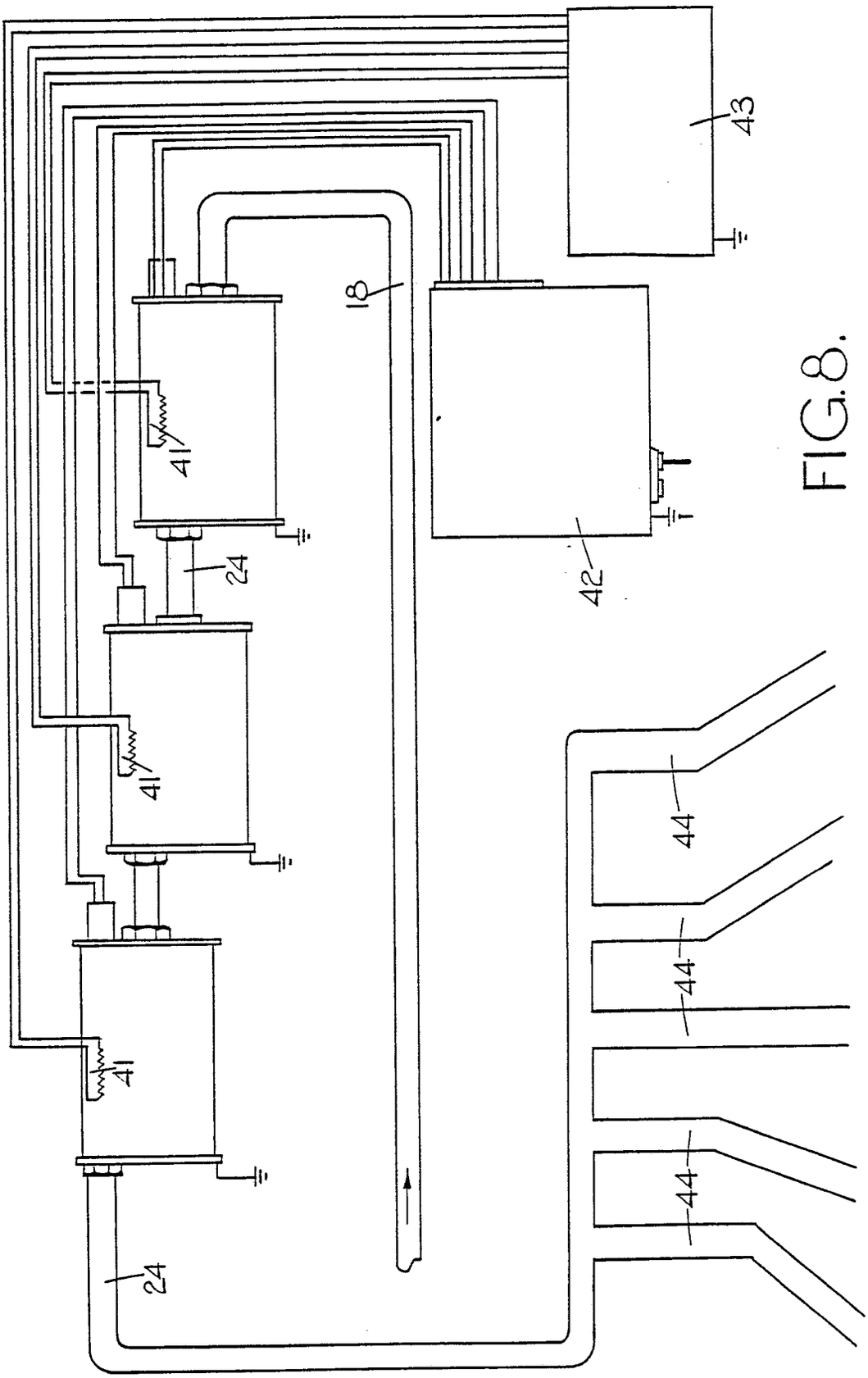


FIG.8.

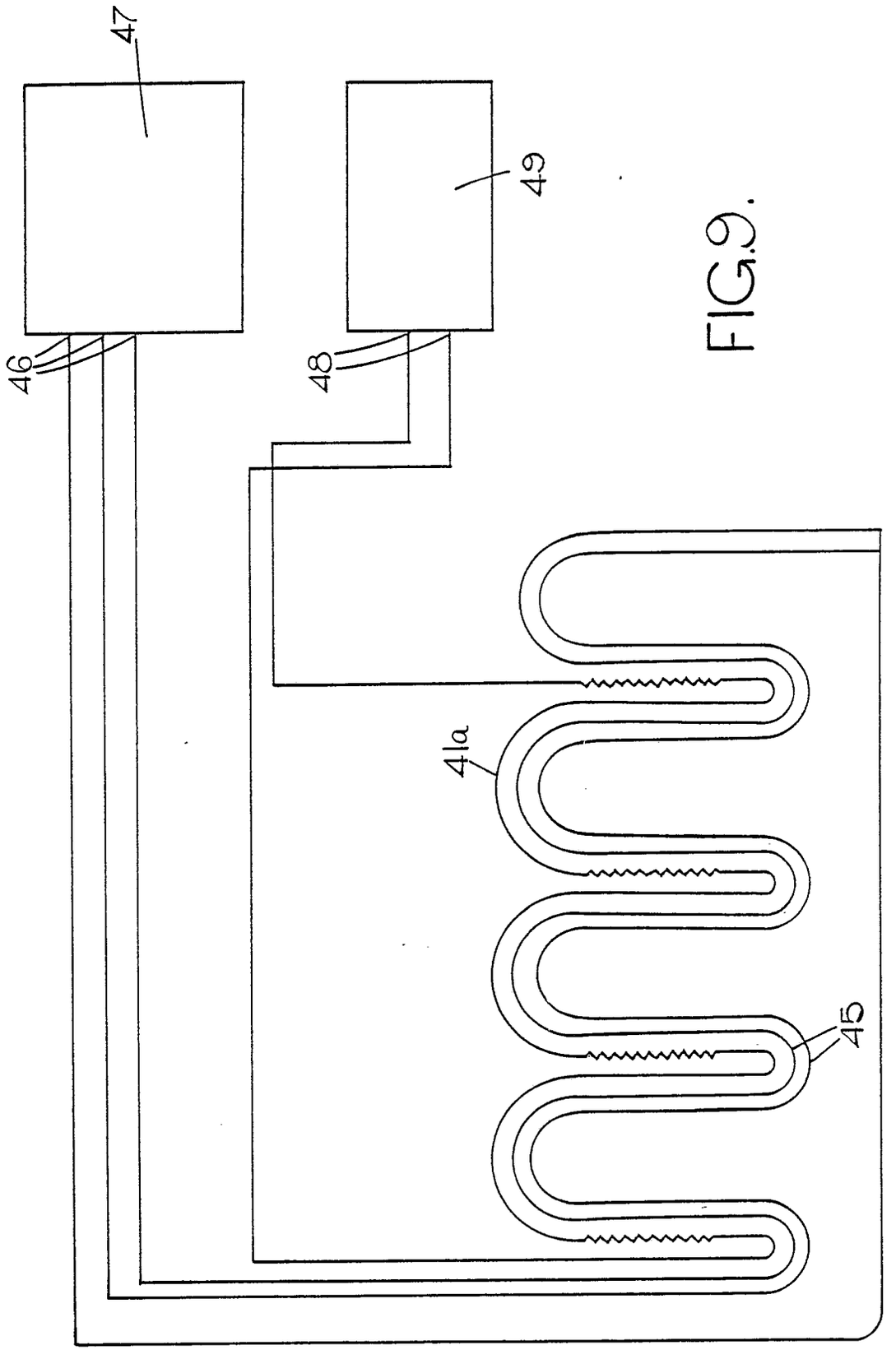


FIG.9.

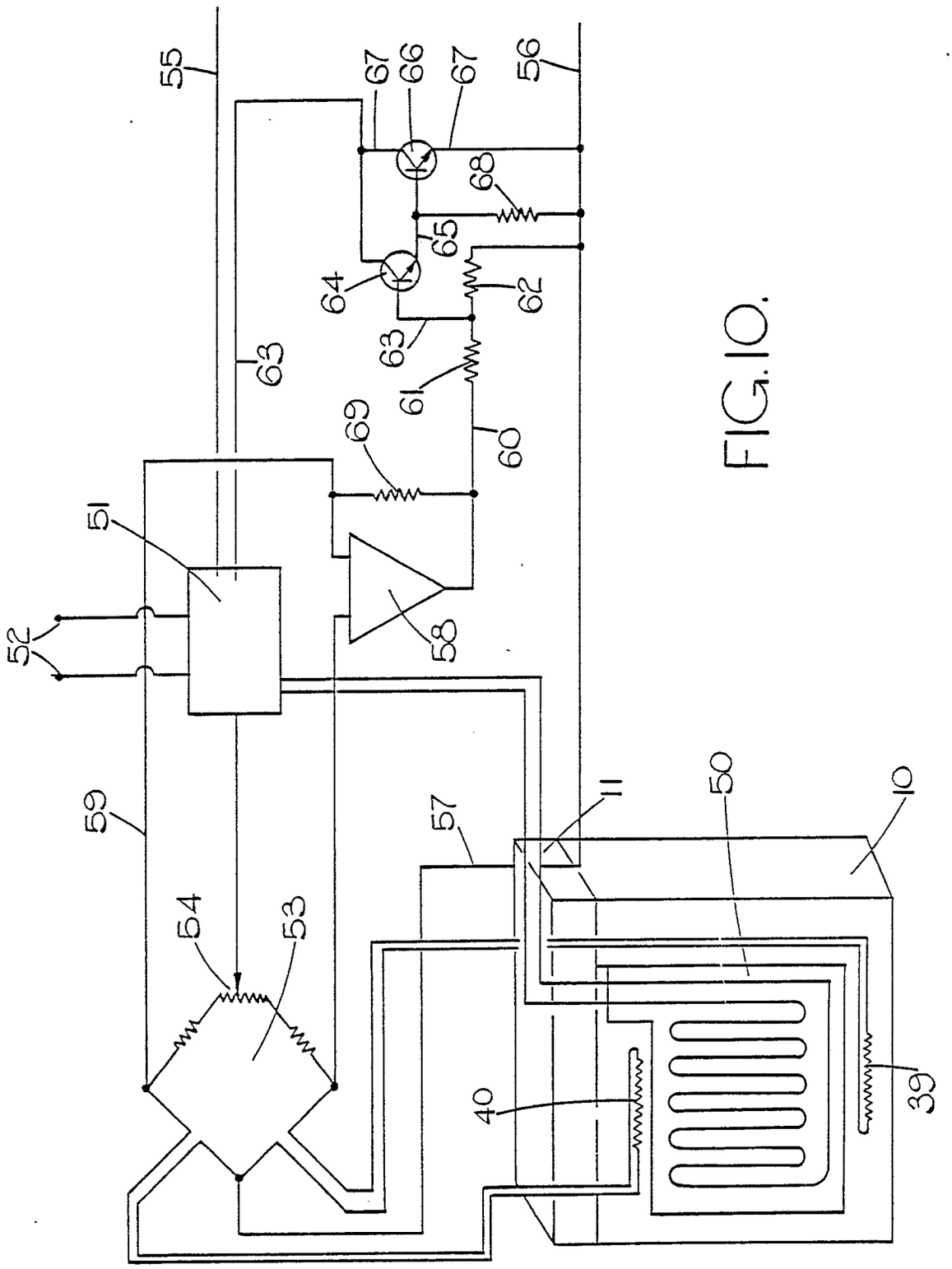

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FIG.10.