



(22) Date de dépôt/Filing Date: 2001/01/16

(41) Mise à la disp. pub./Open to Public Insp.: 2002/07/16

(45) Date de délivrance/Issue Date: 2008/08/05

(51) Cl.Int./Int.Cl. *F24H 3/02* (2006.01),
F23D 14/10 (2006.01), *F23L 17/00* (2006.01),
F23M 9/08 (2006.01), *F24H 9/18* (2006.01),
F28D 7/08 (2006.01), *F28F 13/12* (2006.01)

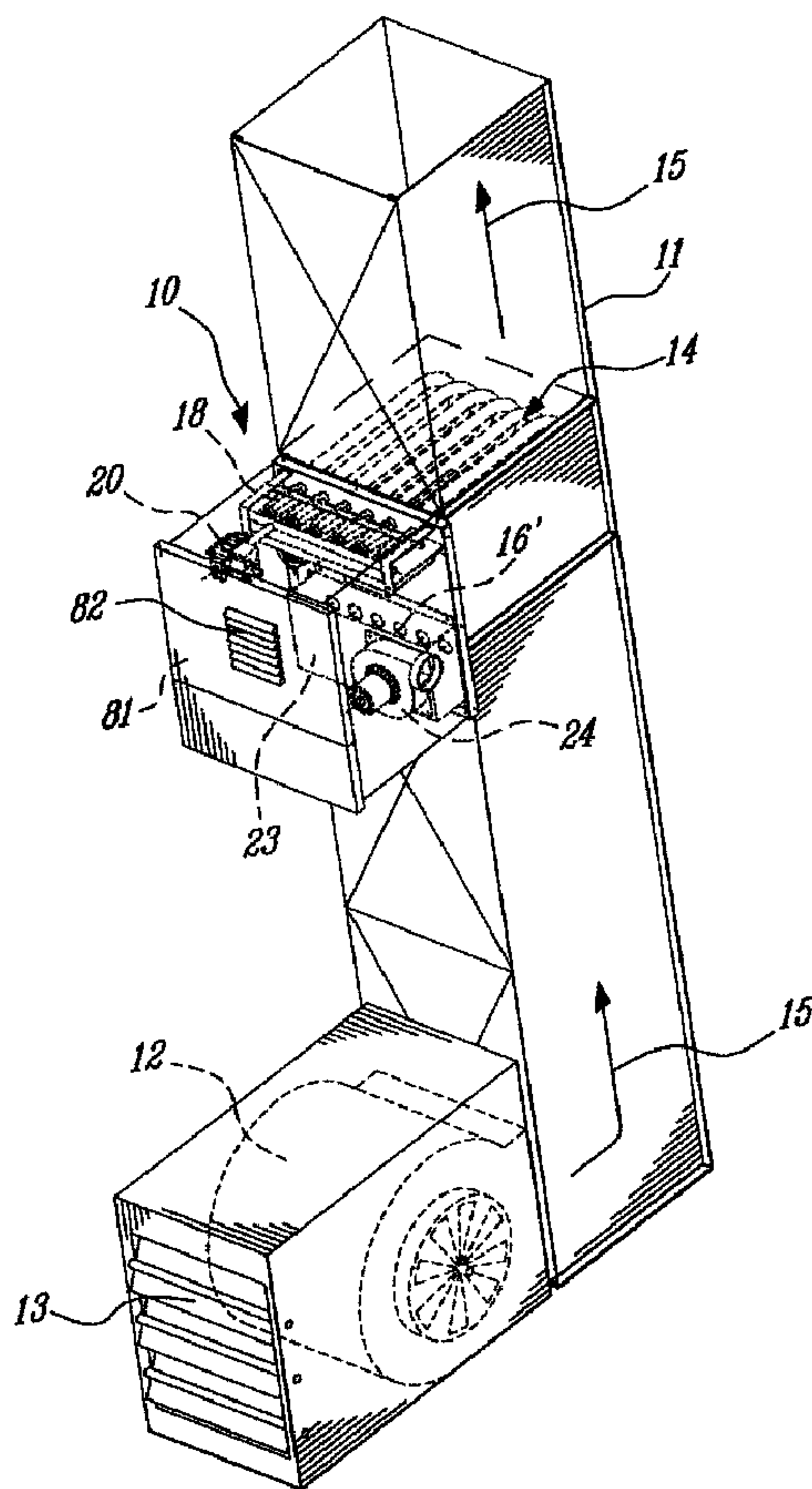
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(54) Titre : SYSTEME ECHANGEUR DE CHALEUR FLEXIBLE A GAZ

(54) Title: FLEXIBLE GAS-FIRED HEAT EXCHANGER SYSTEM



(57) Abrégé/Abstract:

A compact, highly flexible and efficient, multi-positionable, multi-dimensional and multi-stage gas-fired heat exchanger system as described. The system is connectable in a forced air duct regardless of the angular position and size of the duct. The heat

(57) **Abrégé(suite)/Abstract(continued):**

exchanger comprises one or more heat transfer tubes which are shaped and dimensioned as dictated by the customized use of the heat exchanger. The tubes are secured to a support panel as well as the gas burner associated with each of the inlet openings of the tubes. A position orientable gas valve is secured to a gas distribution manifold. A turbulator may be associated with at least some of the tubes to cause turbulence in the hot combustion flow in each of the tubes to modify the efficiency in heat transfer along one or more sections of the tubes by directing hot combustion gas along an inner circumferential wall of the tubes. The outlet of the tubes connect to a collector which has an exhaust fan which is position orientable to suit the installation of the heat exchanger in the duct.

FLEXIBLE GAS-FIRED HEAT EXCHANGER SYSTEM

ABSTRACT

A compact, highly flexible and efficient, multi-positionable, multi-dimensional and multi-stage gas-fired heat exchanger system as described. The system is connectable in a forced air duct regardless of the angular position and size of the duct. The heat exchanger comprises one or more heat transfer tubes which are shaped and dimensioned as dictated by the customized use of the heat exchanger. The tubes are secured to a support panel as well as the gas burner associated with each of the inlet openings of the tubes. A position orientable gas valve is secured to a gas distribution manifold. A turbulator may be associated with at least some of the tubes to cause turbulence in the hot combustion flow in each of the tubes to modify the efficiency in heat transfer along one or more sections of the tubes by directing hot combustion gas along an inner circumferential wall of the tubes. The outlet of the tubes connect to a collector which has an exhaust fan which is position orientable to suit the installation of the heat exchanger in the duct.

FLEXIBLE GAS-FIRED HEAT EXCHANGER SYSTEM

FIELD OF THE INVENTION

5 The present invention relates to a compact, highly flexible and efficient, multi-positionable, multi-dimensional and multi-stage gas-fired heat exchanger system for use in a forced air duct. The heat exchanger utilizes a cascaded array of serpentine heat transfer tubes. 10 Particularly, but not exclusively, the heat exchanger of the present invention was conceived to replace existing oil-fired or electric forced air heating systems and designed as a replacement thereof. Accordingly, the heat exchanger system of the present invention is adaptable to existing 15 duct regardless of the size and orientation of the duct.

BACKGROUND OF THE INVENTION

 It is very difficult to substitute a gas heater for an electric hot water or oil-fired heater, as this 20 requires a restructure of the existing ductwork. Accordingly, these conversions are extremely costly and not very practical and popular. However, there exists a commercial need to convert.

 There is on the marketplace a multitude of gas 25 heaters but these are all of substantially standard dimensions and installed in air convection ducts. There is no gas-fired heating equipment on the market today that can be used to economically and efficiently convert an electric heating system to gas. The problem is that the heating 30 equipment are of fixed dimensions, cumbersome and require large installation space. The installation of the equipment is also difficult as it must always be installed horizontal and this requires extensive modification to the ventilation ducts. Also, existing gas heaters need to be mounted 35 horizontal as electric equipment does not. Another problem with gas heaters is that the gas supply as well as the

exhaust gas fumes are very cumbersome and do not provide much flexibility to the installer.

An example of a gas-fired heater used in a forced air system is illustrated and described in U.S. Patent 5,368,010. It is a fixed system and it is located in a furnace unit which is supported on a floor located at the base of the ductwork. This patent deals primarily with the evacuation of combustion gases at the outlet of the heat exchange tubes. Reference is also made to U.S. Patent 5,042,453, 5,094,224 and 4,729,207 as other examples of gas-fired heaters used as a furnace associated with an air convection duct system.

SUMMARY OF THE INVENTION

It is a feature of the present invention to provide a compact, highly flexible and efficient, multi-positionable, multi-dimensional and multi-stage gas-fired heat exchanger system which is adaptable to existing forced air ducts, and which substantially overcomes the above-mentioned disadvantages of the prior art.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above-described which is easy to install in existing air ducts regardless of the size of the duct and the angular position thereof.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above described and which can be used to readily replace existing electric heaters which are more costly to operate.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above described and which is constructed in accordance with parameters of existing air ducts and wherein the physical characteristics of the construction can be determined by way of a dedicated computer software.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above described comprising a plurality of gas heaters and wherein the gas

heaters can be modulated to adjust the heating capacity from about 5% to 100%.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above described and wherein the main component parts of the system are all accessible on a support panel which is located exteriorly of the convection ducts and easily accessible.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above described and wherein a novel turbulator is used within the heat transfer tubes to increase the efficiency of the heat exchanger.

Another feature of the present invention is to provide a gas-fired heat exchanger system as above described and wherein the flue combustion gases can be evacuated regardless of the position of the heat exchanger and by simple means.

According to the above features, from a broad aspect, the present invention provides a compact, highly flexible and efficient, multi-positionable and multi-dimensional gas-fired multi-stage heat exchanger system for use in a forced air duct. The heat exchanger comprises two or more heat transfer tubes. The tubes are provided in numbers depending on the desired BTU/h capacity needs of the heat exchanger. The tubes are secured to a support panel. A gas burner is mounted on the support panel and disposed for directing a flame at an inlet opening of an associated one of the heat transfer tubes. A gas distribution manifold is provided for supplying gas to the burners. A position orientable modulating gas valve is secured to the manifold and connectable to a gas supply line for controlling the gas pressure to the burners and therefore the intensity of the flame. The gas valve is disposed horizontal regardless of the angular position of the system when secured to a duct. Two or more solenoid valves are secured to the manifold and to a respective one of the burners whereby to operate the

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burners independently from one another. The tubes each have an outlet connected to combustion product position orientable exhaust means secured to the support panel. Control means is provided to control the operation of the solenoid valves
5 whereby to operate the burners independently from one another dependent on heat requirements. The control means controls the temperature of the flame and the number of the burners activated whereby to control the temperature of the heat exchanger within the range of about 5% to 100%. The control
10 means further controls the speed of the exhaust fan in combination with the burners to adjust convection flow velocity.

According to a further broad aspect of the present invention there is provided gas flow turbulence inducing means associated with at least some of the tubes to cause turbulence in a hot flue-gas flow in each of the tubes to modify the efficiency in heat transfer along one or more sections of the tubes by directing hot flue-gas along an inner circumferential wall of the tubes.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The preferred embodiments of the present invention will now be described with reference to the accompanying drawings in which

FIG. 1 is a perspective view illustrating a gas-fired heat exchanger system of the present invention mounted in an air duct of a forced air system;

FIG. 2 is a perspective view showing the basic component part of the heat exchanger secured to a support panel and utilizing U-shaped tubes;

FIG. 3 is a perspective view similar to Figure 2 but showing W-shaped serpentine tubes;

FIG. 4 is an exploded perspective view showing the construction of the support panel and how the tubes are securable thereto;

FIG. 5 is an exploded perspective view showing the construction and associated attachments of the gas burners;

FIG. 6 is a front view of the gas distribution manifold and solenoid valves;

FIG. 7 is a side view of Figure 6;

FIG. 8 is an enlarged view showing the construction of the air/gas turbulator plate secured about the inlet of the tubes in proximity of the gas burner whereby to impart added turbulence to the flame;

FIG. 9 is a perspective view illustrating the construction of the combustion product collection housing and adjustable exhaust fan;

FIG. 10 is a side view of an elongated rectangular metal plate utilized to construct the flue-gas turbulator;

FIG. 11 is a side view showing the construction of the turbulator sections;

FIG. 12 is an end view of Figure 11 showing the disposition of the sections;

5 FIG. 13 is an exploded perspective view illustrating the mounting plate for mounting associated hardware with the equipment mounted on the support panel;

FIG. 14 is an electrical diagram illustrating the electric circuit utilized for a single stage heat exchanger;

10 FIG. 15 is an electrical diagram showing the electric circuit for a multi-stage system;

FIG. 16 is an electrical diagram illustrating the electric circuit for a modulated system; and

15 FIG. 17 is an exploded view of the entire heat exchange system with its front housing and herein utilizing U-shaped heat transfer tubes.

DESCRIPTION OF PREFERRED EMBODIMENTS

20 Referring now to Figure 1 there is shown generally at 10 the compact, highly flexible and efficient, multi-positionable, multi-dimensional and multi-stage gas-fired heat exchanger system of the present invention and as herein mounted in a forced air duct 11. An independent blower 12 circulates air from an air entry duct 13 through the multi-

25 stage heat transfer tubes 14 in the direction of arrow 15.

Referring now to Figures 2 to 4 there will be described the basic component parts of the heat exchanger of the present invention. As shown in Figure 2 the heat transfer tubes 14 are U-shaped tubes and are secured at

30 opposed ends 16 and 16' to a support panel 17. The end 16 of the tubes 14, is the inlet end, and end 16' is the outlet end. A plurality of gas burners 18, herein venturi type burners are positioned in front the inlet end of the tubes 14 and direct a flame in each of the inlet end sections 16

35 of each tube. The gas burners 18 are secured to a gas distribution manifold 19. A position orientable gas valve 20, which may be a single or two-stage or modulated valve,

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is secured to the manifold and through its coupling 21 is always positioned horizontally. For example, as shown in Figure 1 the heat exchanger system 10 is herein shown as being mounted sideways (horizontal) with the gas valve 20 having been positioned in the horizontal plane (90° to its position shown in Fig. 3).

As more clearly shown in Figure 4 gas flow turbulators 22 are disposed in the outlet end sections 16'' of the tubes, herein a W-shaped heat transfer tube 14' whereby to induce turbulence in the hot flue-gas flow in each of the tubes to modify the efficiency in heat transfer along the outlet section 16''. What the turbulators do is to direct the hot flue-gas along the inner circumferential wall of the tubes and there is virtually no gas flow along the central longitudinal axis of the tubes in the outlet section 16'' where the turbulator is positioned. Although not shown a turbulator section could also be positioned in the inlet end section 16''' of the U-shaped tube 14 as shown in Figure 2 but in an area space behind the flame of the burners, which flame projects into the inlet end section of these tubes. This would also increase the efficiency of the heat transfer tubes.

As shown in Figure 3 the outlet end 16' of these tubes 14, 14', which are secured to the support panel 17, open in a collection housing 23 which receives combustion gas from the tubes. An exhaust fan 24 is secured to an outlet port 25 formed in an outer wall 26 of the housing 23 to create a suction within the collection housing to draw the hot combustion products through the tube and to exhaust the combustion products into a chimney duct 27. The exhaust fan 24 has an adjustable shroud 28 which permits it to be positioned at various angles depending on the desired orientation of the chimney duct 27. Accordingly, regardless of the position of the heat exchange system when secured in a duct, the exhaust is flexible and permits the evacuation of combustion products along any desired path or angle.

As shown in Figure 4 the support panel 17 is provided with a plurality of pre-drilled holes 29 to mount to the inlet and outlet sections of the tubes. The panel also has internal flanges 30 to facilitate the connection of the support panel to a front housing as will be described later. It also provides for ease of location of a thermal insulating sheet 31 over the front surface of the panel to protect the panel against the intense heat of the flame of the burners and the combustion products in the collection housing 23. As also shown in Figure 4 an air/gas turbulator plate 32 is securable over the holes 29 facing the burners.

With added reference to Figure 8 it can be seen that the turbulator plate 32 is provided with an orifice 33 having inwardly extending deflector flanges 34 disposed side by side all about the circumference of the orifice whereby to increase turbulence at the inlet end opening 16 of the tubes where the flame is injected. These deflector flanges 34 diminish the laminar secondary air flow and maximizes thermal exchange with the tubes in the inlet end sections thereof.

With reference now to Figures 5 and 6 there is shown in greater detail the construction and mounting of the burner assemblies. As previously described the burners 18 are venturi type burners and they have a predetermined heat rate, such as, 17.5K BTU/h, 23.5K BTU/h, 30K BTU/h and 50K BTU/h. A solenoid valve 35 is also associated with each of the burners 18. These valves 35 are used to operate the burners 18 independently by controlling the solenoids whereby to control the heating capacity of the system from about 5% to 100% of its total thermal heat exchange capacity. These solenoids have a very quick response time and are connected to the gas distribution manifold 19 by threaded conduits 36 permitting quick assembly and disassembly of the burner units for assembly, replacement or repair. Nozzles 37 are also separately mounted between the solenoid and the burners 18 and provide ease of assembly and maintenance. The entire assembly is supported on the

support panel 17 by brackets 38. Accordingly, this assembly can be pre-assembled and then secured to the support panel 17. The brackets 38 are secured to flanges 39 welded to opposed ends of the manifold 19.

5 With reference now to Figures 10 to 12 there will be described the construction of the turbulator 22. As shown in Figure 10 the turbulator is constructed of an elongated rectangular flat metal plate 40 which is cut from opposed elongated edges 41 thereof to form opposed slits 42
10 whereby to form a plurality of deflection sections 43. The deflection sections 43 are octagonally shaped as shown in Figure 11 by bending the corner sections 44 in opposed directions whereby to form deflection plate sections 43 of octagonal contour. These deflection plate sections 43 are
15 also bent in the plane of the strip of the flat plate 40 at angles of approximately 45°, as shown in Figure 12 to form a twisted turbulator to force the combustion gas flow flowing therethrough away from the center of the tubes 14 to an inner surface 14' of the tubes, as illustrated in Figure 12.
20 The strip can also be cut at any desired length and preferably between the deflection plate sections 43, at areas such as illustrated by reference numeral 45, to fit in a desired section of a tube. Accordingly, the turbulator can have different quantities of deflection plate sections.
25 Although not shown, the sections 44 could be of different sizes to create turbulence.

 As shown in Figure 13 various components associated with the system are also mounted on a component mounting plate 50 forwardly of the support panel 17. The
30 mounting plate 50 extends outwardly on a vertical axis spaced from the burners 18 as can be seen in Figure 2. The mounting plate assembly 50 is provided to mount associated hardware and to make it readily accessible for servicing and repair. As hereinshown an igniting control device 51 is
35 secured to the component mounting plate assembly and the igniter 52 is secured to the side plate 50' at a position to ignite the burners. An igniter cable 53 connects the

igniter 52 to the igniter controller 51. A flame detector 54 is also mounted on the side plate 50' and has a detector cable 55 connected thereto, as is well known in the art. A pressure detector 56 is also secured to the horizontal panel 50" and a detector tube 57 is connected thereto. A high limit temperature detector 58 is also connected to the panel 50'. A voltage transformer 59 and a relay 60 are also connected to the horizontal panel for ready access and servicing.

10 With reference to Figure 17 there is shown the construction of a support frame 61 which is secured to the support panel 17. The support frame 61 comprises a bottom and top wall 62 and 63 respectively secured to the top and bottom internal flanges 30 of the front panel 17, and a rear wall 64 secured between rear edges 62' and 63' of the bottom and top plates 62 and 63, respectively. The top and bottom and rear walls all have contour flanges which help to secure same in an air duct such as the duct 11 as shown in Figure 1, to orient the tubes for heat exchange with air flow in the duct when a blower pushes air through the duct for heating the convected air. The dimensions of the plate are dictated by the cross-sectional dimension of the duct in which the system is to be installed.

As also shown in Figure 17 the top and bottom walls 63 and 62 are provided with air deflecting flanges 65 which project internally in the air flow to cause air turbulence of the convected air in the area of the transfer tubes to improve heat transfer between the tubes and convected air. As also hereinshown the rear wall 64 is provided with a vertical tube support flange 66 to support a far end section of the heat transfer tubes to maintain them in spaced parallel stack relationship. This flange is also illustrated in Figure 4 and as shown in that Figure heat exchange clamps 67 may also be secured to the tubes 14. The heat exchange clamps are provided with a plurality of projecting flanges 68 to dissipate heat into the air flowing through the heat exchanger tubes. Preferably the heat

exchange clamps are secured to at least some of the tubes along the inlet section thereof where the tubes are at a higher temperature. As previously described these tubes may be of U-shapes, W-shapes, square shapes or any other
5 suitable shapes for heat exchange with the convected air in the duct and to suit the application.

As previously pointed out, the gas-fired heat exchanger system of the present invention is customizable to suit air ducts of different sizes and different capacity
10 requirements. To this end there has been developed a computer software to calculate specific physical parameters for the construction of the heat exchanger of the present invention. The computer is inputted information relating to the dimension of duct where the heat exchanger is required
15 to be installed as well as information relating to the volume of air to be heated. Parameters of the static pressure of the forced air system are also inputted in the computer as well as the temperature of air to be convected upstream of the heat exchanger. Also inputted is the
20 desired temperature required downstream of the heat exchanger. This inputted information is analyzed and the software produces physical parameters for the design of the unit including the configuration of the heat transfer tubes, the quantity of the tubes required, the diameter and length
25 of the tubes and the thermal capacity of the burners. Accordingly, the size of the unit is adjustable whereby the length of its side L1, width L2, and height H, as shown in Fig. 2, are variable.

As shown in Figures 1 to 4 and 17 the heat
30 transfer tubes 14 are all connected in stack parallel spaced relationship and all attached to the support panel to produce a compact package. In most instances the heat exchanger will comprise a plurality of heat exchange tubes and these can be controlled in a "multi-stage" application
35 as shown by the schematic electrical diagram in Figure 15 or in a "modulated mode" as illustrated by the schematic diagram of Figure 16. In the "multi-stage" application the

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thermal capacity of the heat exchanger can be controlled by switching on and off some of the burners thereby utilizing only certain ones of the heat transfer tubes to satisfy the heat demand. In the "multi-stage" mode the gas valve 20
5 could be a two-stage valve which permits a control of the temperature in a range of from about 5% to 100% of its total capacity. In that mode, with the two-stage valve 20 the first burner is ignited at 50% of its maximum capacity and later its capacity is increased to 100%. The other burners
10 are then ignited one after the other and this is how the temperature control of the heat exchanger is varied.

In the "modulated mode" all of the burners function at the same time, the modulation is obtained by the principal valve 20 which is a modulated type valve. With
15 this valve the gas pressure to all of the burners is modulated in accordance with the heat requirement. In this mode the modulation of the maximum heat produced by the heat exchanger can be varied between approximately 40% to 100% of the maximum capacity of the heat exchanger.

20 Figure 14 is a circuit diagram for a single stage heat exchanger capable of generating a predetermined heat capacity which is non-variable.

As illustrated in Figures 2 and 3 the heat exchange system 10 may be mounted at any desired position
25 along the X, Y or Z axis as illustrated by arrows 71, 72 and 73. Regardless of the positioning of the unit the gas valve 20 is adjusted to lie in a horizontal plane. This is done by using a suitable coupling 21 or simply rotating the gas valve on the threaded end of the pipe coupling 21 depending
30 on the position of the unit. But this is predetermined by the application.

As also shown in Figure 17 a protective housing 80 having an access panel 81 for access to the support panel 17 may also be provided. For security a lock could also secure
35 the front panel 81 to the housing. As hereinshown the front panel 81 is provided with an air intake 82 to admit combustion air to the burners. A gas line entry port 83 may

be provided on the front panel around the side and as hereinshown is protected by a grommet 84. The exhaust fan 24 may also be secured to either the side walls 85 or top and bottom walls 86 and 87 of the housing depending on the position of the installation and the flue pipe. Accordingly, there is provided a flexible extension tube 88 having couplings 89 at opposed ends thereof to connect the collection housing 23 to the exhaust fan 24. The exhaust fan 24 is also provided with a coupling 90 to secure to an exhaust pipe and attaching flange and gaskets 91 and 92 respectively. An extension pipe 93 may also be secured to the exhaust fan, if necessary.

Although the electric circuit diagrams of Figures 14 to 16 have not been described in detail it is only necessary to describe that in the single stage application the heat exchanger also operates in a single maximal heat generating mode when the valve 20 is "on" to supply gas to the burners.

In operation, the system is actuated by a heat requirement on the low voltage created by the thermostat and the system firstly monitors the safety equipment associated therewith. The relay 60 then connects the gas, herein natural gas, and upon detecting the gas pressure, the ignition control commands the opening of the gas valve and the igniter. As soon as the flame is detected by the flame detector 54 the apparatus is in operation. Once the thermostat sends the signal that the temperature has reached its setting, the gas supply to the valve 20 is cut and the burners extinguished.

In the modulating mode as illustrated by Figure 16 the pressure of the gas is modulated through a gas modulating valve. In this particular application there is provided a stack of heat transfer tubes. The gas modulating valve can vary the temperature of the flame and therefore heat exchanger between 40% and 100% of its maximum value. The purpose of the burner modulation is to maintain the temperature of the air to be heated substantially constant.

The gas modulating valve is controlled by a variable control device 100 as shown in Figure 15. The control circuit is illustrated by Figure 14.

5 With reference to Figure 15 there is shown the multi-stage operation wherein each of the burners 18 is controlled independently by the solenoid valves 35. The burners are ignited, or not, one at a time to satisfy the temperature demands. If the main gas valve is a two-stage valve the first burner can be positioned to generate a low
10 temperature flame which is usually half of the maximal intensity or at a high temperature flame. By controlling the temperature of the flame and the number of burners that are activated it is possible to control the temperature of the heat exchanger within the range of about 5% to 100%, as
15 previously described. This way it is possible to provide a more precise control of the air temperature for comfort. In addition the speed of the exhaust fan 24 can be controlled in combination with the burners by suitable control circuitry.

20 It is within the ambit of the present invention to cover any obvious modifications of the preferred embodiment described herein, provided such modifications fall within the scope of the appended claims.

Claims:

1. A compact, highly flexible and efficient, multi-positionable and multi-dimensional gas-fired multi-stage heat exchanger system for use in a forced air duct, said heat exchanger comprising two or more heat transfer tubes, said tubes being provided in numbers depending on the desired BTU/h capacity needs of said heat exchanger, said tubes being secured to a support panel, one or more gas burners mounted on said support panel and disposed for directing a flame at an inlet opening of an associated one of said heat transfer tubes, a gas distribution manifold for supplying gas to said burners, a position orientable modulating gas valve secured to said manifold and connectable to a gas supply line for controlling the gas pressure to said burners and therefore the intensity of the flame, said gas valve being disposed horizontal regardless of the angular position of said system when secured to a duct, two or more solenoid valves secured to said manifold and to a respective one of said burners whereby to operate said burners independently from one another, said tubes each having an outlet connected to a collection housing which receives combustion gases from said tubes, a position orientable exhaust fan secured to said collection housing to exhaust said combustion gases, and control means to control the operation of said solenoid valves whereby to operate said burners independently from one another dependent on heat requirements, said control means controlling the temperature of the flame and the number of said burners activated whereby to control the temperature of said heat exchanger within the range of about 5% to 100% of the total capacity of said burners, said control means further controlling the speed of said exhaust fan in combination with said burners to adjust convection flow velocity.

2. A heat exchanger system as claimed in claim 1 wherein there is further provided gas flow turbulence inducing means associated with at least some of said tubes to cause turbulence in a hot combustion flue-gas flow in each said tubes to modify the efficiency in heat transfer along one or more sections of said tubes by directing hot combination flue-gas along an inner circumferential wall of said tubes.

3. A heat exchanger system as claimed in claim 2 wherein said support means is a support panel provided with attachment means to secure same in a hole formed in a ventilation duct regardless of the angle of disposition of said duct.

4. A heat exchanger system as claimed in claim 2 wherein said gas flow turbulence inducing means is comprised by an elongated rectangular flat plate having a plurality of deflection sections, said deflection sections having corner angled sections extending to opposed sides of said flat plate to form deflection sections of octagonal contour, said deflection sections being disposed at an angle with respect to one another to form a twisted turbulator to force said combustion gas flow away from the center of said tubes to an inner surface thereof.

5. A heat exchanger system as claimed in claim 4 wherein said twisted turbulator is positioned in an outlet section of said tubes.

6. A heat exchanger system as claimed in claim 4 wherein said deflection sections are of different sizes along elongated sections of said plate, said twisted turbulator being severable into a desired length.

7. A heat exchanger system as claimed in claim 4 wherein said deflection sections are disposed at predetermined equidistantly spaced angles with respect to a longitudinal central axis of said turbulator whereby these sections extend all about said central axis, larger ones of said deflection sections having a transverse maximum length for frictional engagement with said inner surface of said tubes.

8. A heat exchanger system as claimed in claim 6 wherein said tubes are U-shaped tubes, there being disposed a further twisted turbulator in a forward section of said tubes spaced from said inlet opening of

said tubes in an area where there is no flame when the associated burner is operative.

9. A heat exchanger system as claimed in claim 1 wherein there is further provided an air/gas turbular plate having one or more orifices each said orifices being dimensioned to fit about a respective one of said inlet opening of said one or more tubes, each said one or more orifices having inwardly extending deflector flanges disposed side-by-side thereabout to increase turbulence at said inlet openings where said flame is injected to diminish the laminar secondary air flow and to maximize thermal exchange with said tubes.

10. A heat exchanger system as claimed in claim 1 wherein said position orientable exhaust means comprises a collection housing for receiving combustion gas from said outlet of said one or more tubes and an exhaust fan secured to an outlet port of said collection housing, said exhaust fan having an adjustable shroud with an exhaust whereby said exhaust port can be oriented at a desired angle for connection to a flue regardless of the angular position of said support panel and consequently said collection housing.

11. A heat exchanger system as claimed in claim 1 wherein said two or more heat transfer tubes are dimensioned in accordance with a desired diameter, length, and shape dependent on a desired heat generating capacity and the dimension of a space in said duct where said heat exchanger is to be secured.

12. A heat exchanger system as claimed in claim 1 wherein said control means is a control circuit having a plurality of control connections for controlling the operation of each said solenoid valve secured to each said burner associated with each said heat transfer tubes,

thermostatic controls feeding command signals to said control circuit whereby said control circuit will operate said burners independently to control air temperature dependent on said command signal.

13. A heat exchanger system as claimed in claim 12, wherein said burners are venturi type burners have a predetermined heat rate of 17.5K BTU/h, 23.5K BTU/h, 30K BTU/h and 50K BTU/h.

14. A heat exchanger system as claimed in claim 12, wherein said heat transfer tubes are connected in a stack, each tube having said inlet and outlet end thereof secured to said support panel whereby said tubes extend in a horizontal plane and parallel to one another with respect to said support panel, a burner support bracket to support said burners in alignment and spaced a predetermined distance from said inlet end of each said tubes, said inlet ends being aligned with one another along a vertical axis of said support panel, said gas distribution manifold being comprised of a vertical pipe to which said solenoid valves are connected, said support panel being accessible exteriorly of said air duct.

15. A heat exchanger system as claimed in claim 14, wherein a thermal insulating sheet is secured to an outer surface of said support panel to protect said panel from hot flames of said burners.

16. A heat exchanger system as claimed in claim 14, wherein said heat exchanger is secured in a support frame comprising a bottom and top wall secured to a bottom and top edge of said support panel, and a rear wall secured between rear edges of said top and bottom walls; said rear wall, top and bottom walls having predetermined dimensions and flange means to secure same in said air duct to orient said tubes

for heat exchange with air flow in said duct when a blower pushes air through said duct for heating convected air.

17. A heat exchanger system as claimed in claim 16, wherein said top and bottom walls are provided with air deflecting flanges projecting in said air flow to cause air turbulence in said convected area of said heat transfer tubes to improve heat transfer between said tubes and said convected air.

18. A heat exchanger system as claimed in claim 16, wherein said rear wall is provided with a vertical tube support flange to support a far end section of said heat transfer tubes to maintain them in spaced parallel relationship.

19. A heat exchanger system as claimed in claim 14, wherein there is further provided heat exchange clamps having a plurality of projecting flanges, said heat exchange clamps being secured to at least some of said tubes along an inlet section thereof where said tubes are at a higher temperature for additional heat exchange with convected air displaced in said duct.

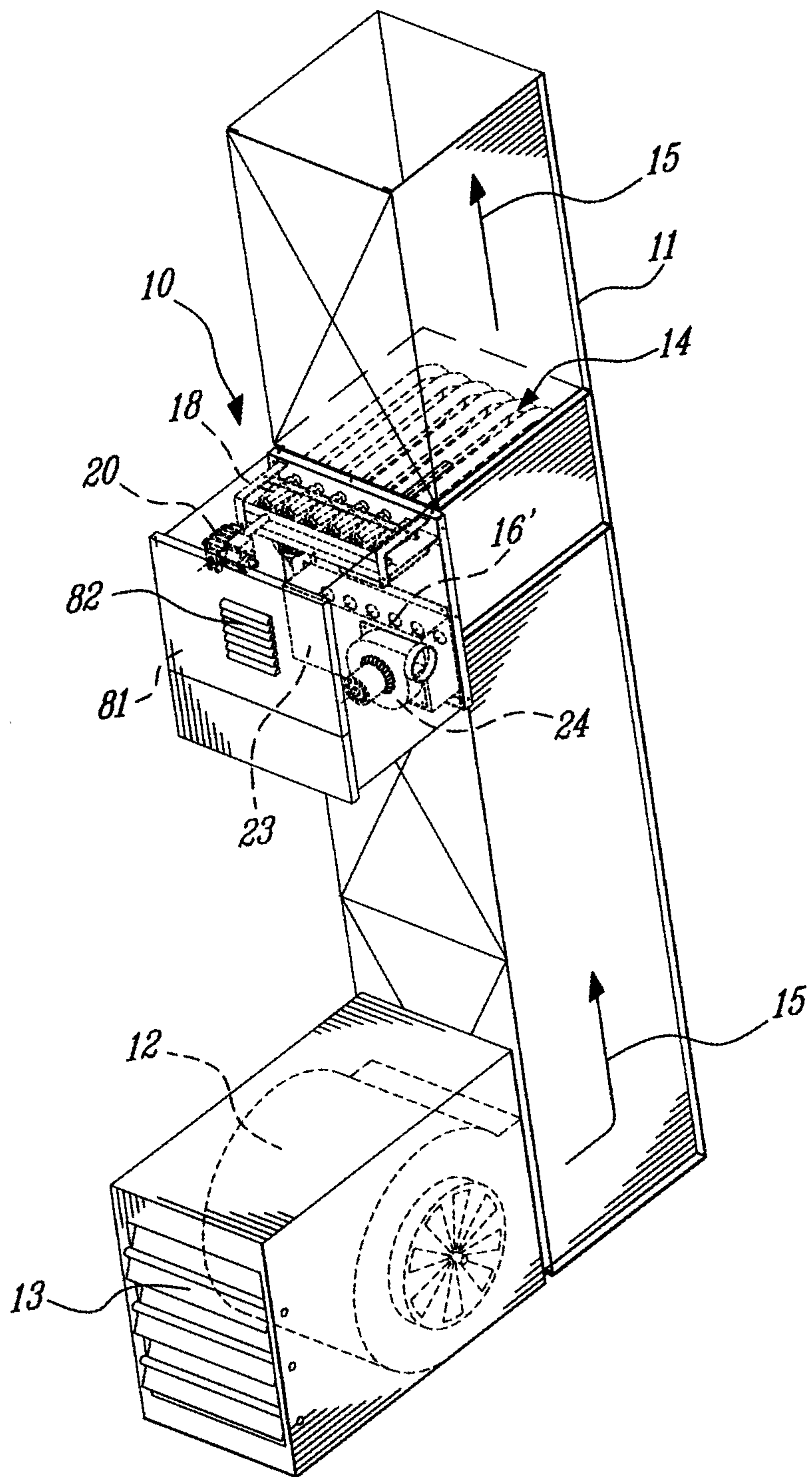
20. A heat exchanger system as claimed in claim 1, wherein said heat transfer tubes are one of U-shape, W-shape, square-shape, or other suitable shape for heat exchange with convected air displaced in said duct.

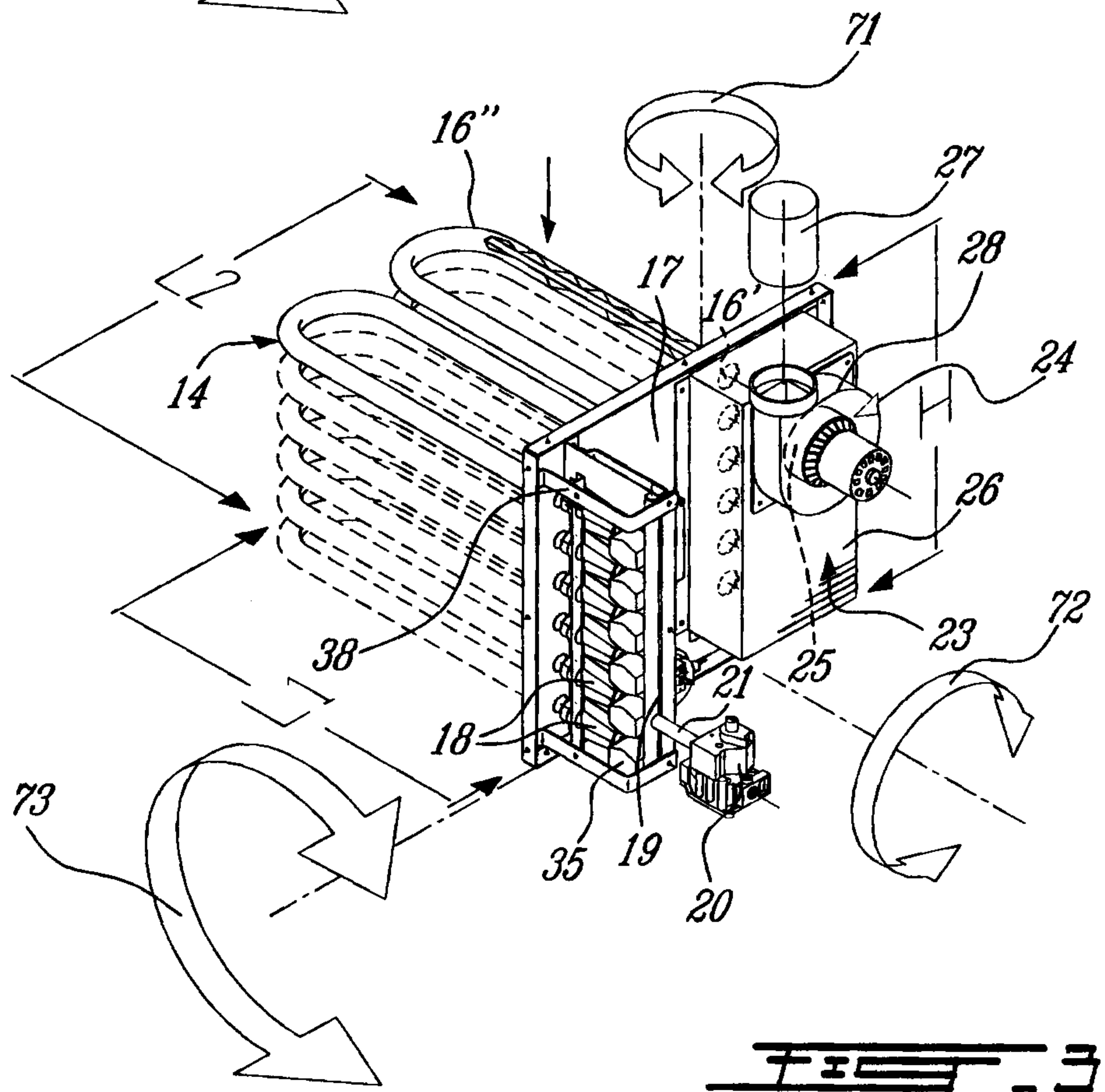
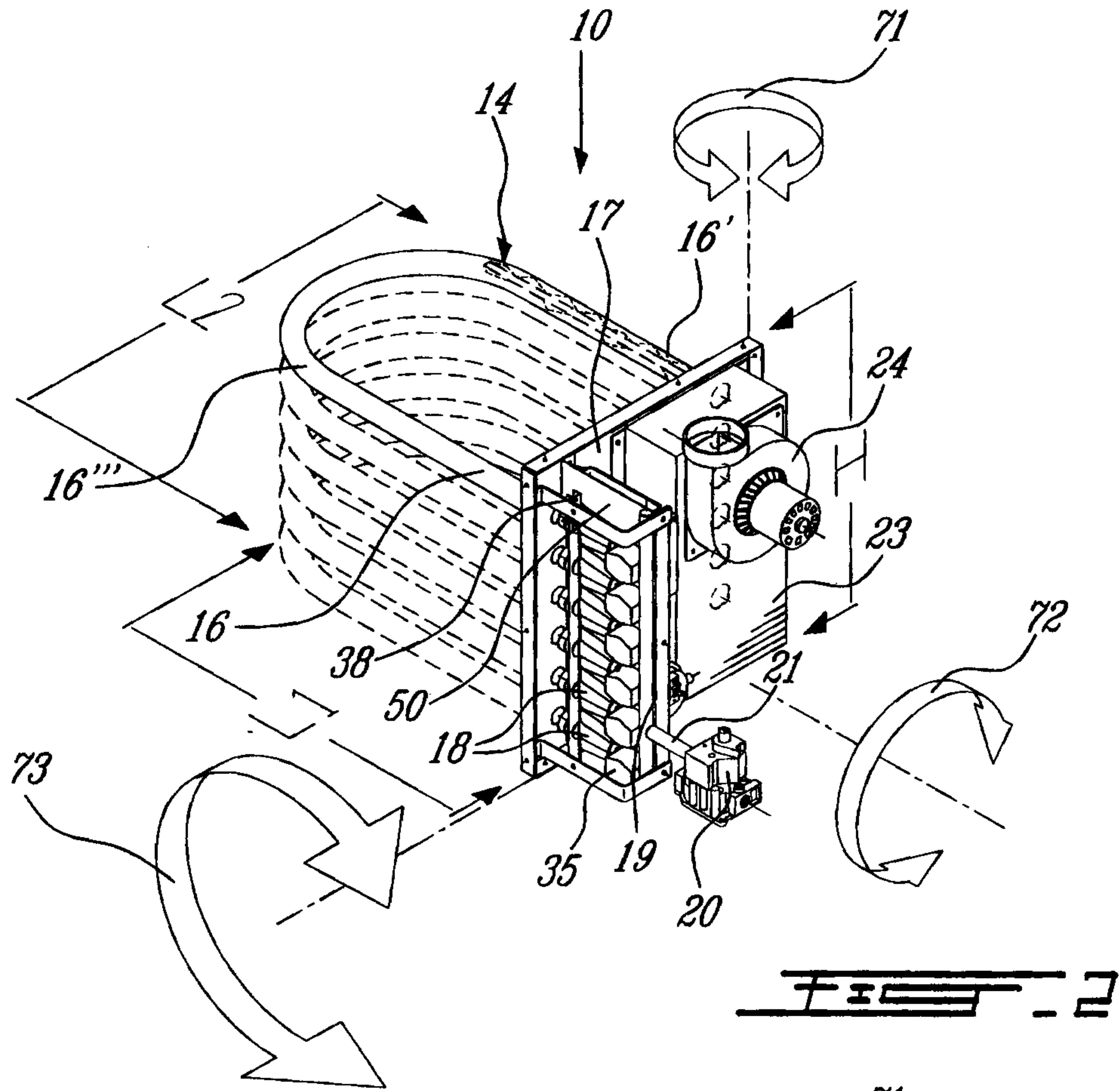
21. A heat exchanger system as claimed in claim 12, wherein said position orientable gas valve is a single or two stage or full modulated valve; said burners being operated independently by control of said solenoids; said position orientable gas valve, when a two stage valve, permitting the control of the temperature of said heat exchange in said range of from about 5% to 100% of the maximum thermal heat exchange capacity of said heat exchanger.

22. A heat exchanger system as claimed in claim 11, wherein there is further provided a computer software to calculate specific physical parameters for the construction of said heat exchanger dependent on input information relating to (i) the dimension of said duct where said heat exchanger is required to be installed, (ii) the volume of air to be heated, (iii) the static pressure of the forced air system, (iv) the temperature of air convected upstream of said heat exchanger and (v) the desired temperature downstream of said heat exchanger; said physical parameters including the configuration of said heat transfer tubes, the quantity of said tubes, the diameter and length of said tubes and the thermal capacity of said burners.

23. A heat exchanger system as claimed in claim 1, wherein said heat exchanger is mounted in a protective housing having an intake means, a gas line entry port, electric wiring connections and exhaust ports to permit said heat exchanger to be oriented in a duct at any desired position.

24. A heat exchanger system as claimed in claim 14, wherein a component mounting plate assembly is secured to said support panel and extends outwardly on a vertical axis spaced from said burners and manifold for housing associated hardware and to make them accessible on said support panel to provide ease of maintenance, repair and modification to said heat exchanger system.





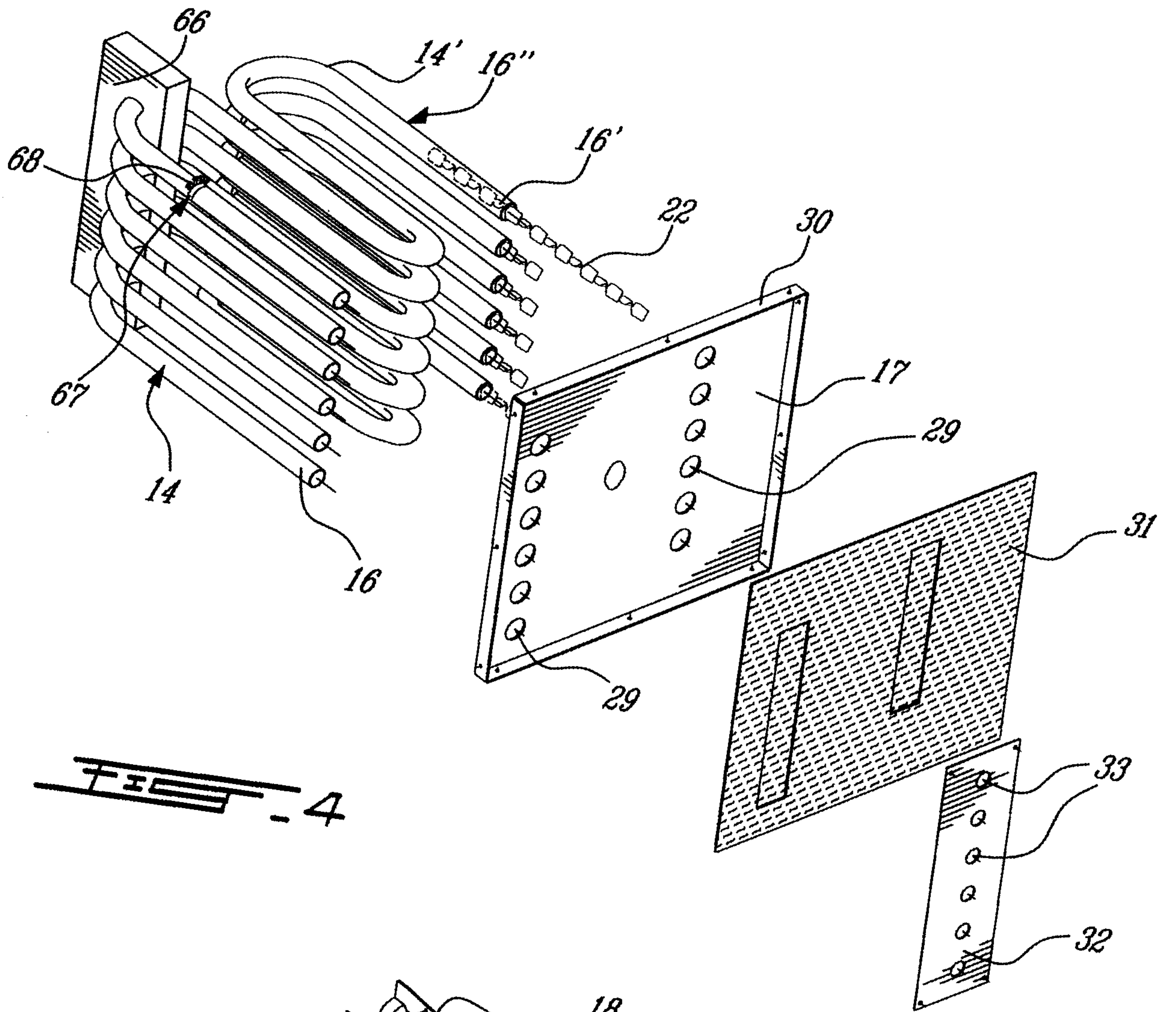


FIG. 4

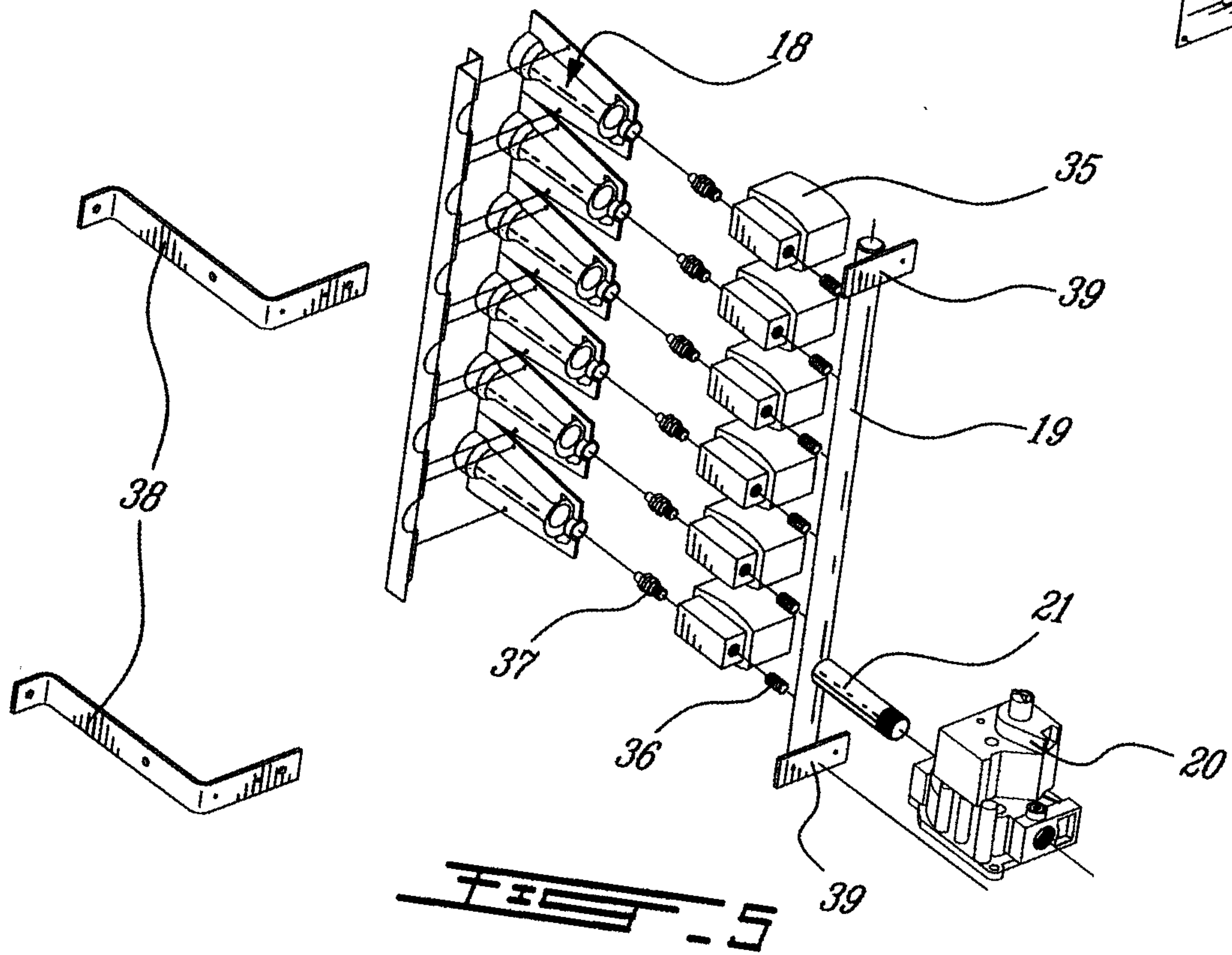
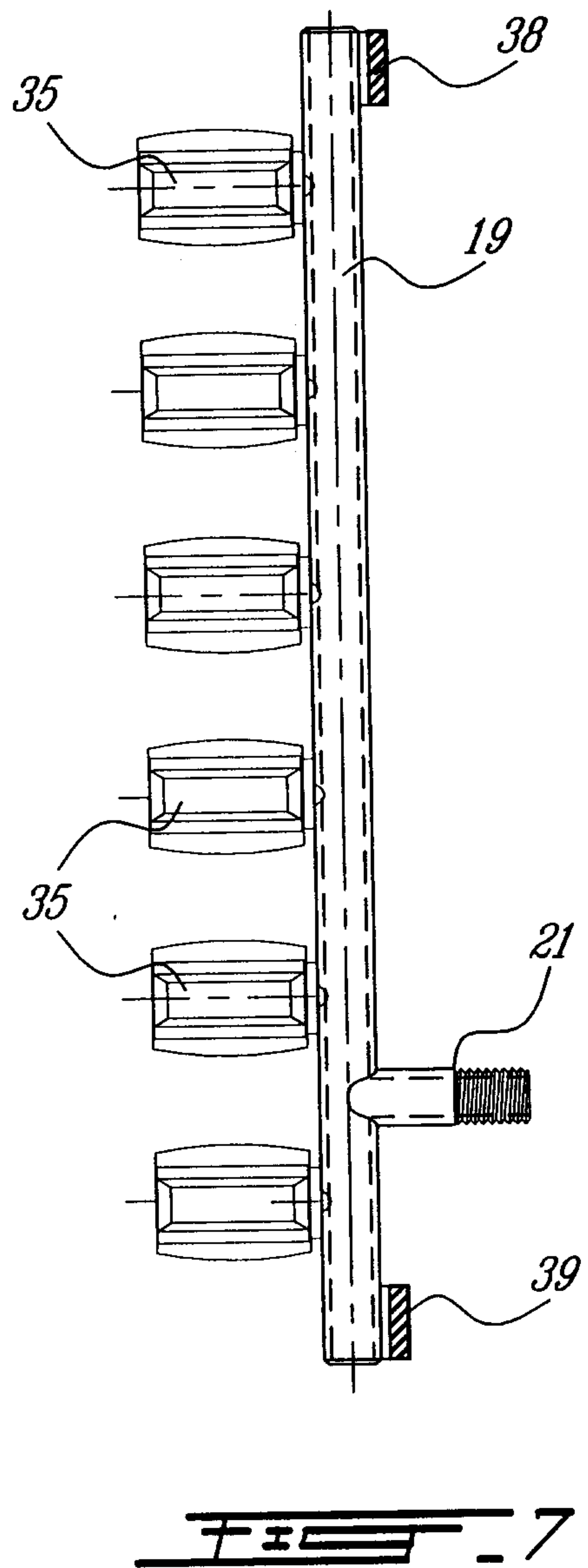
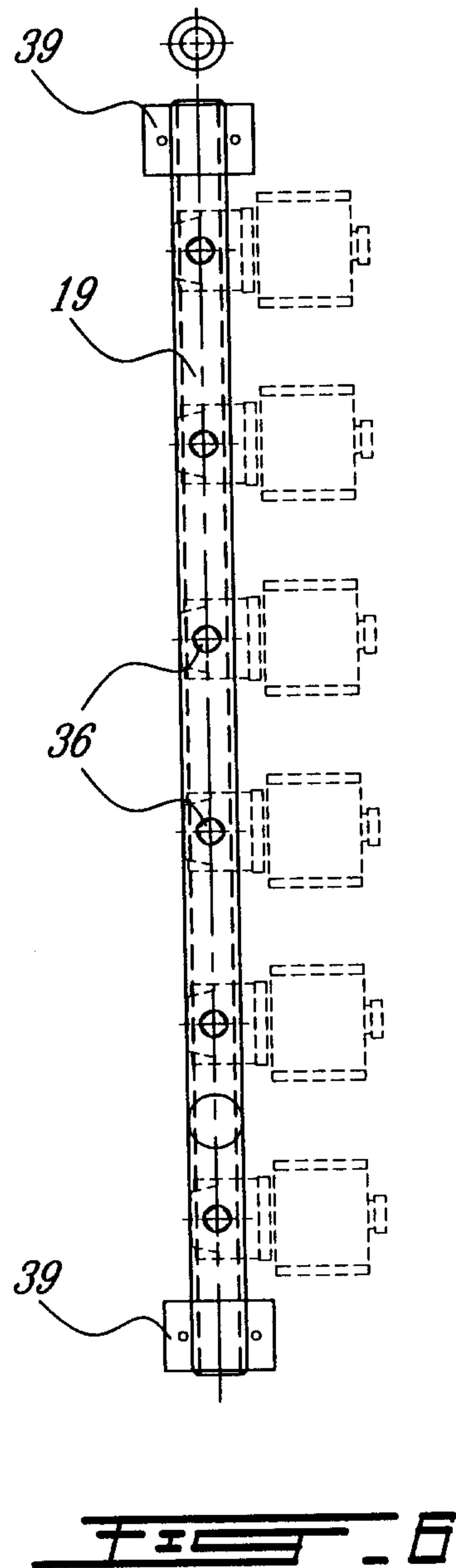
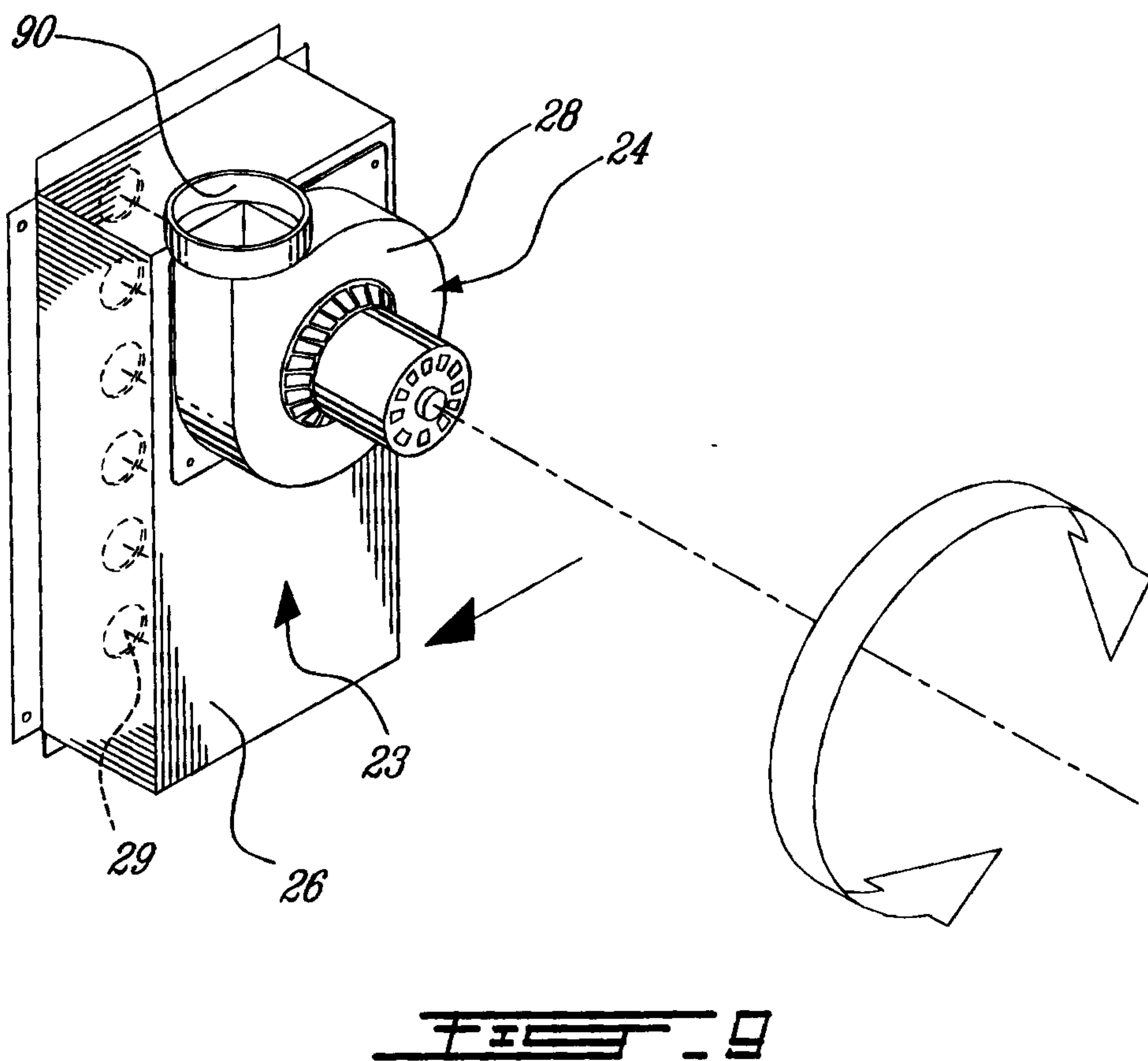
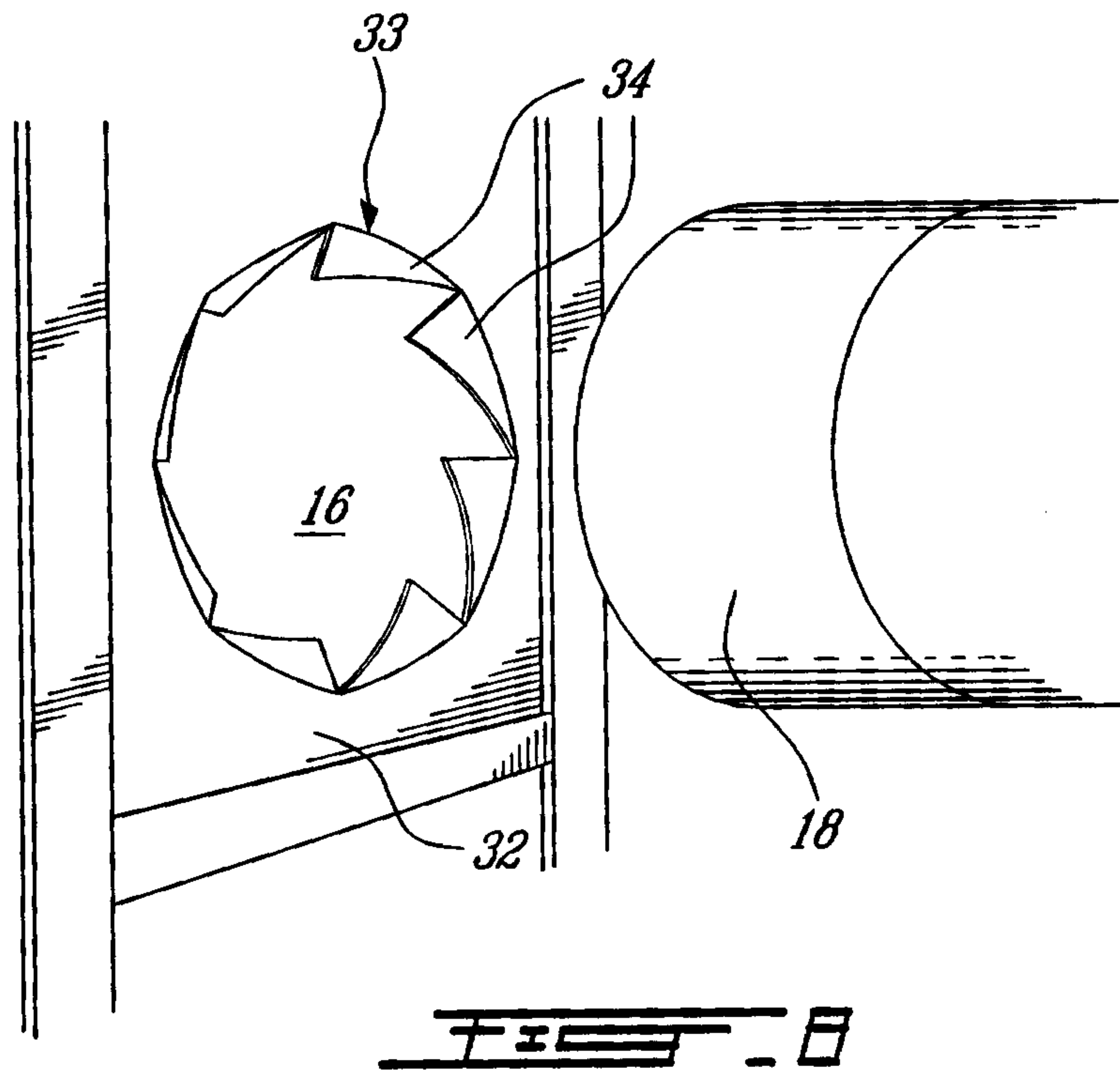


FIG. 5





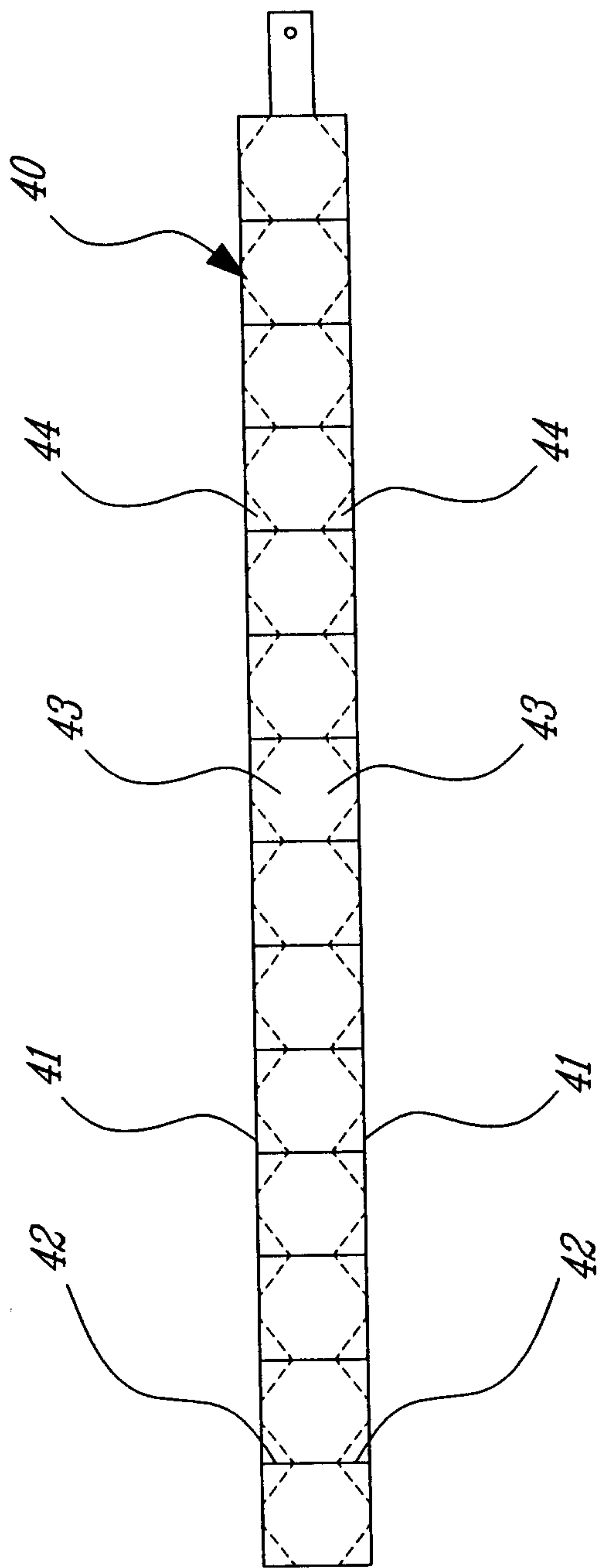


FIG. 10

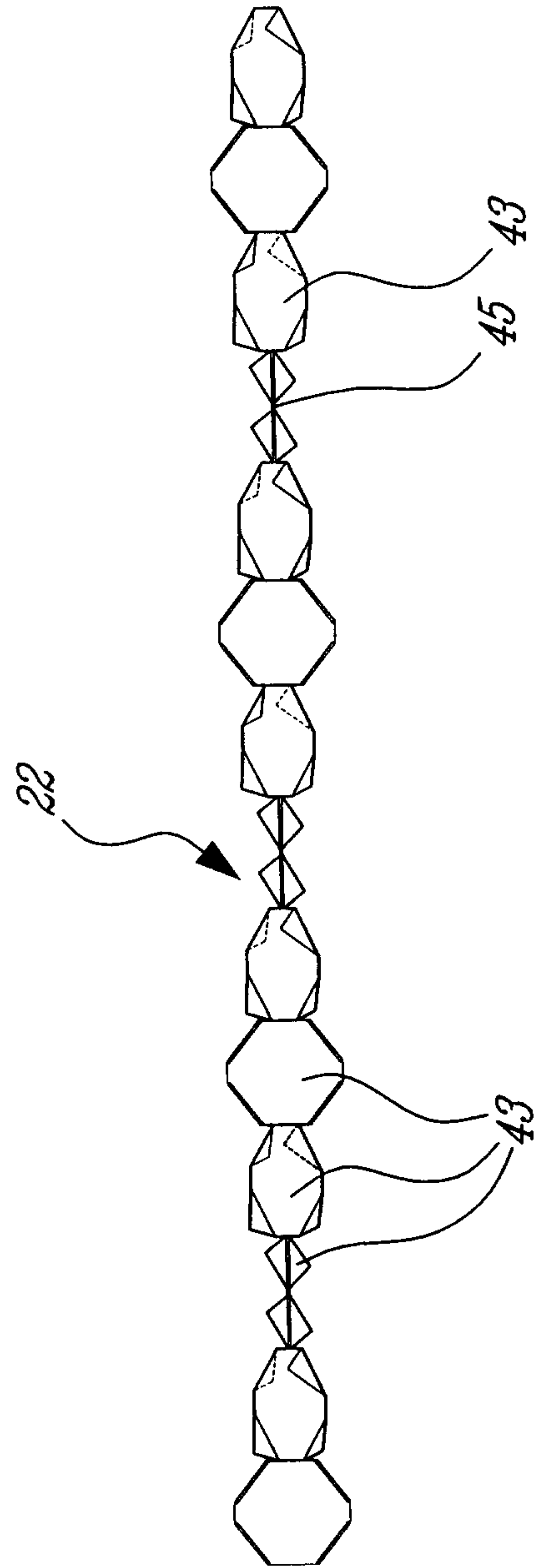


FIG. 11

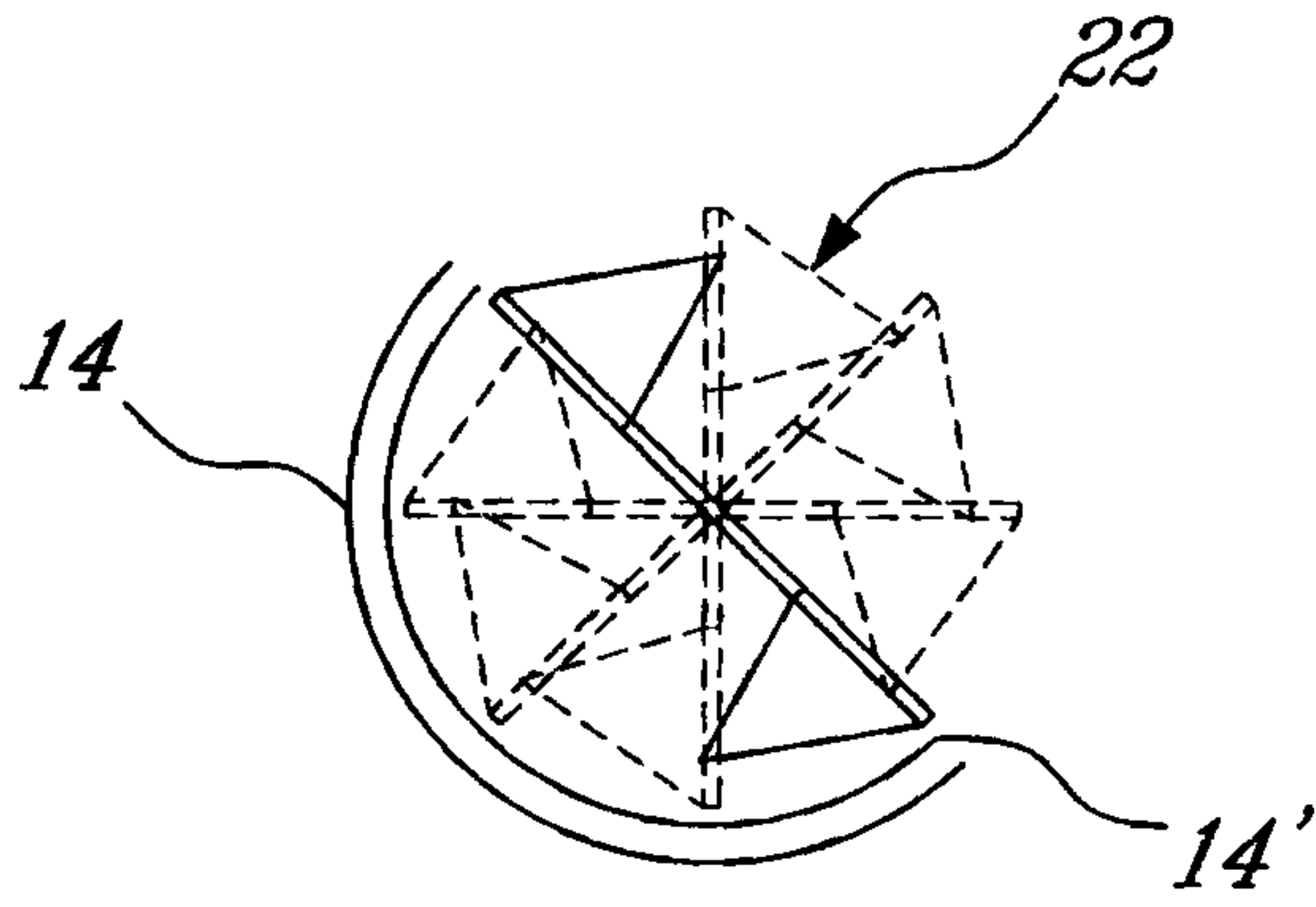


FIG. 12

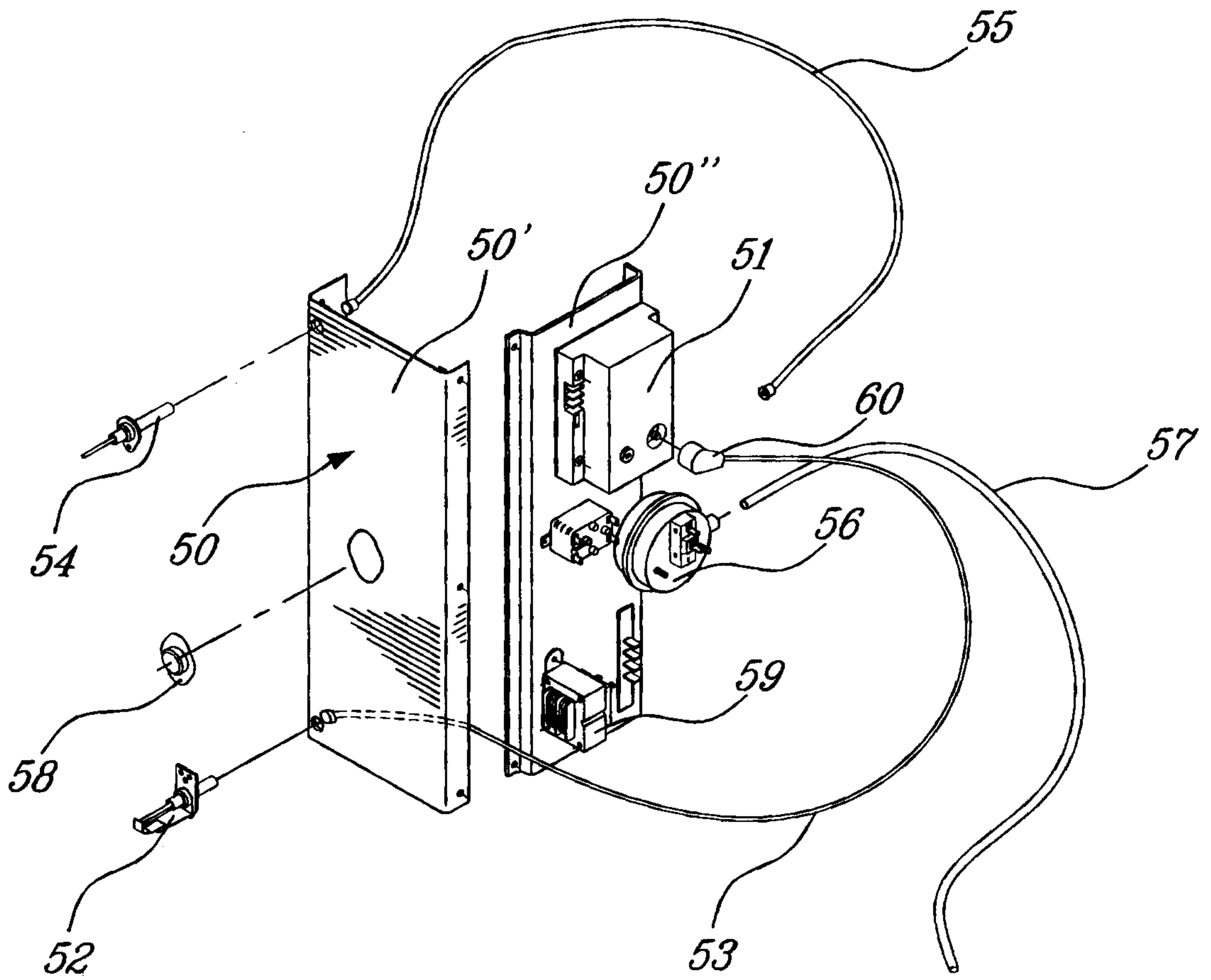
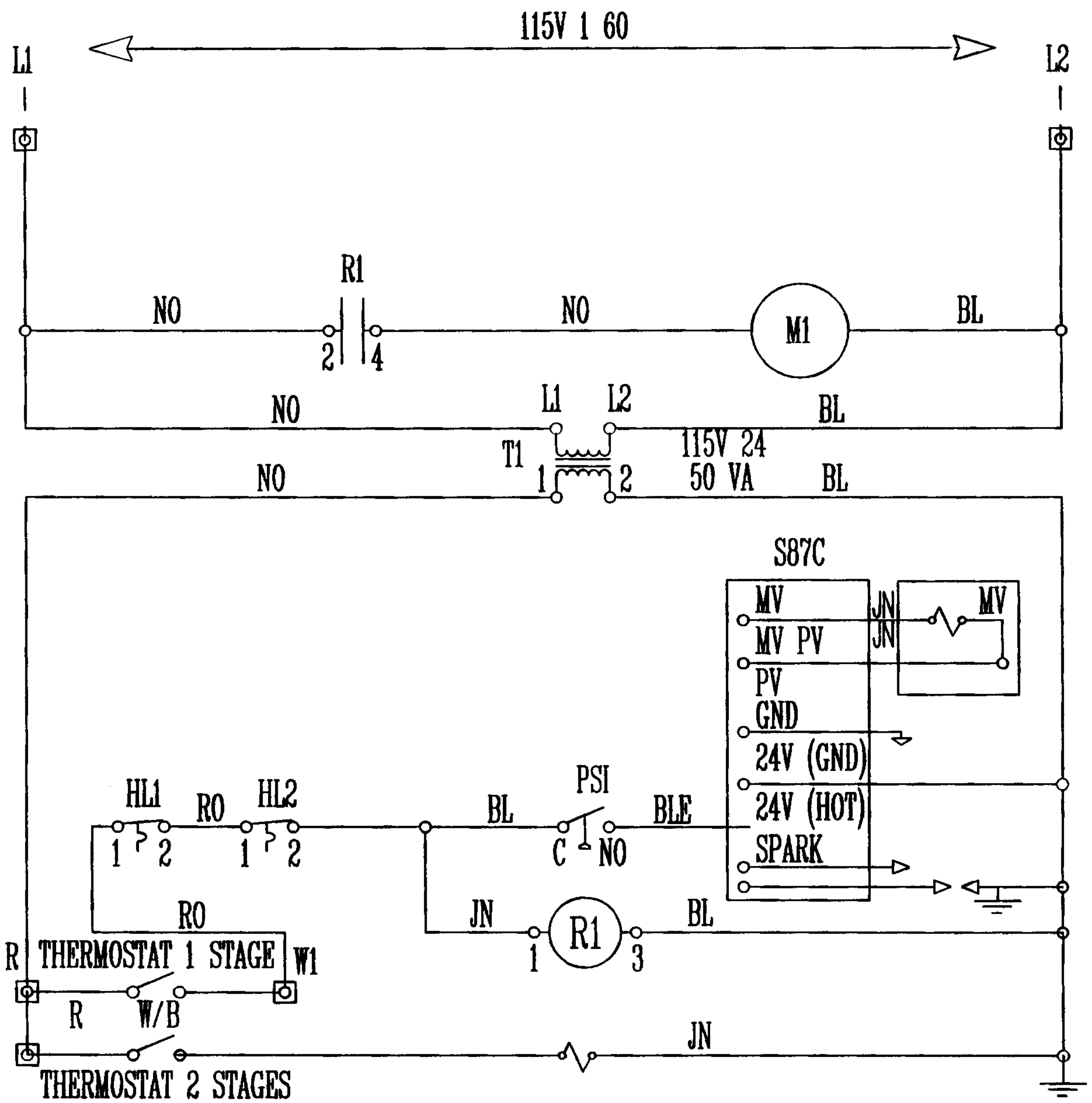
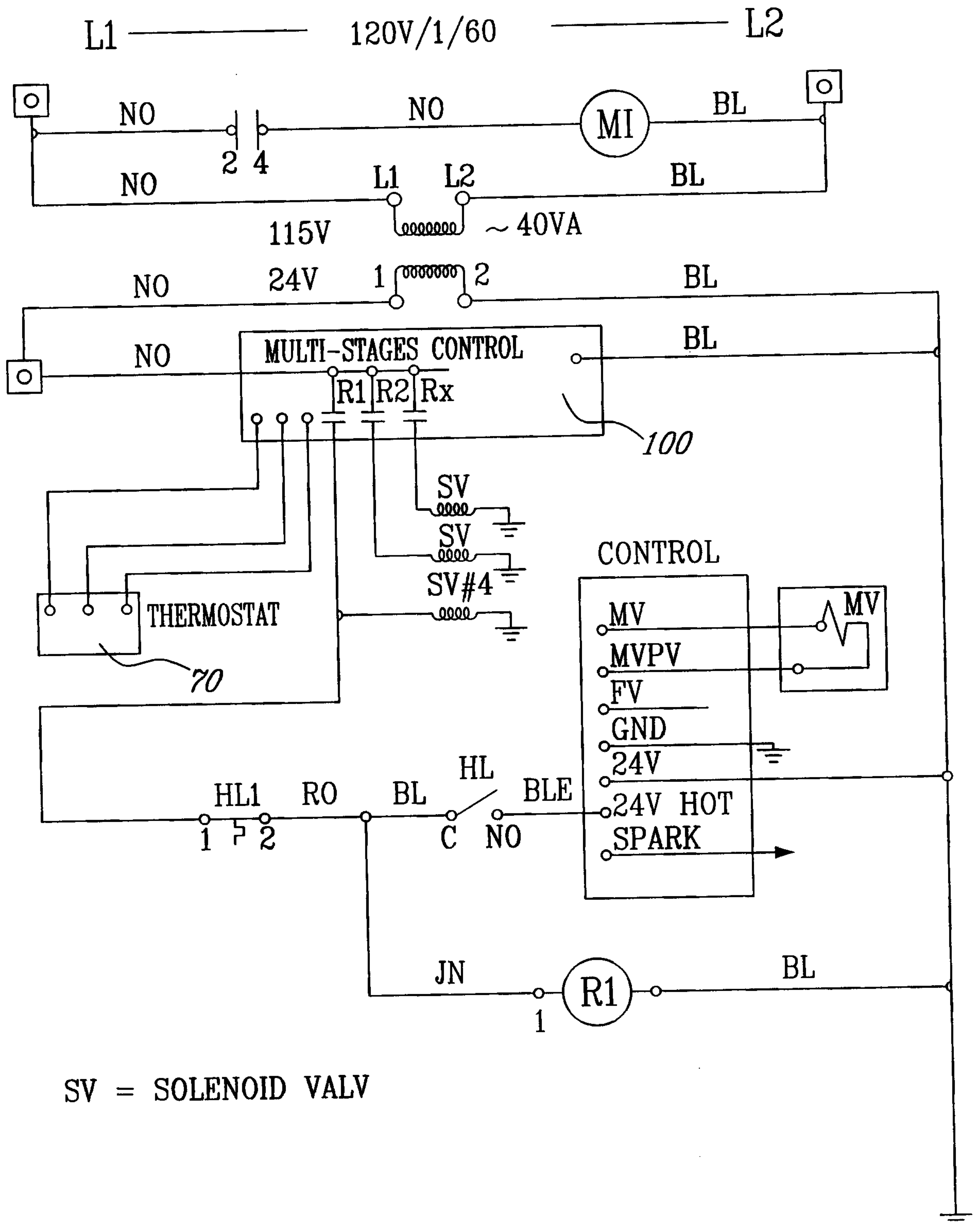
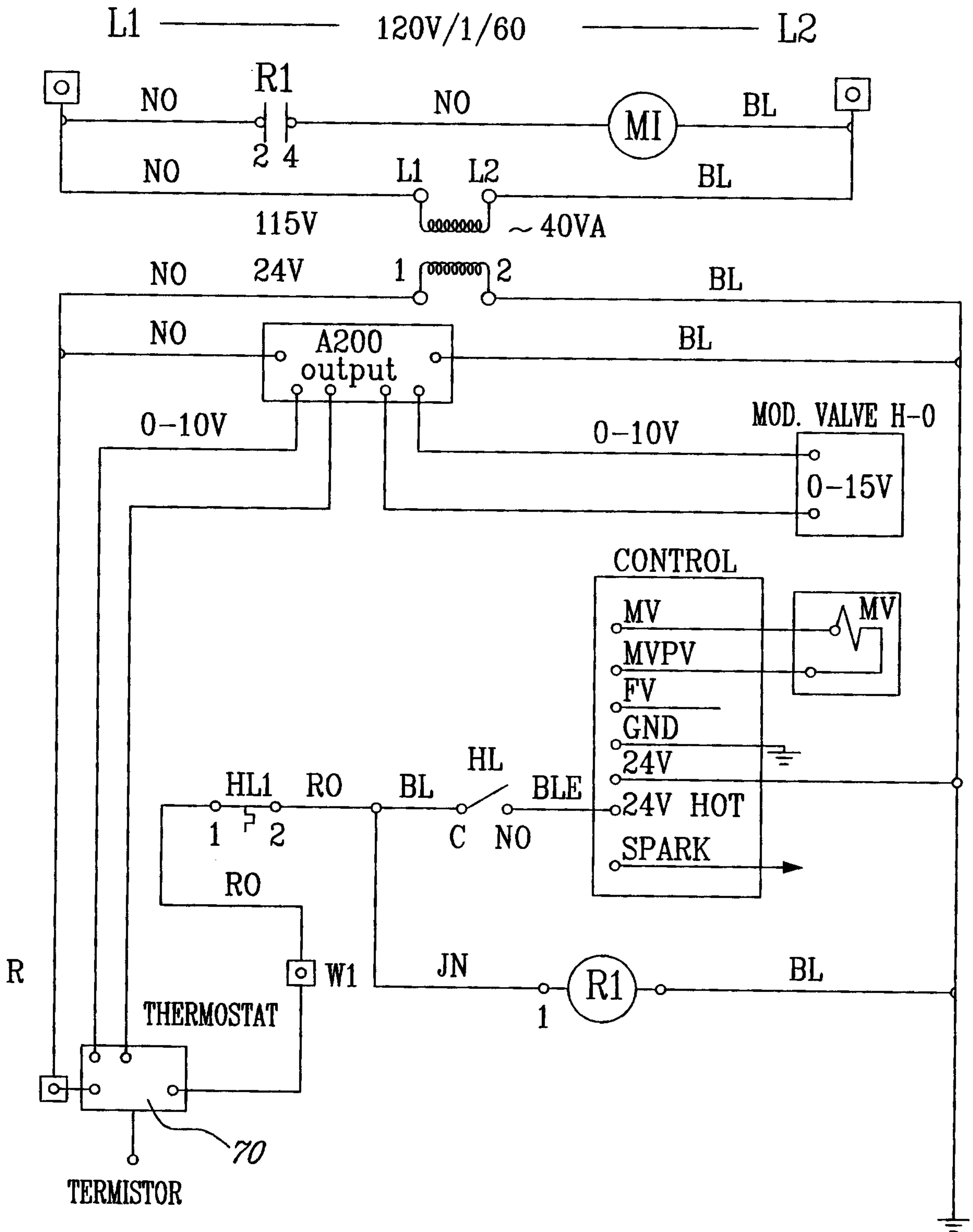


FIG. 13





SV = SOLENOID VALV



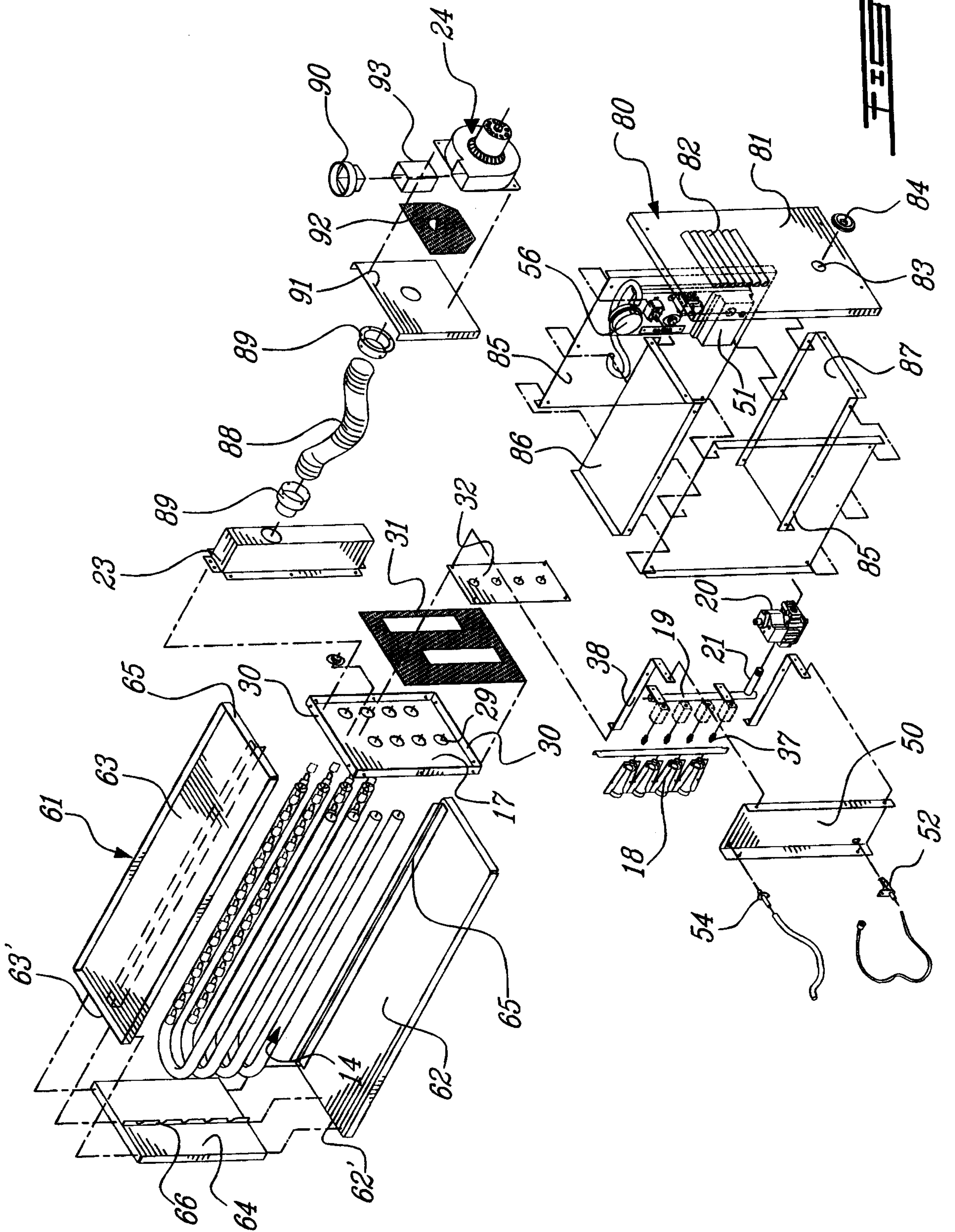


FIG. 17

