Feb. 6, 1951

E. A. NORMAN, JR

2,540,280

GAS-FIRED FORCED AIR HEATER

Filed Sept. 1, 1948

3 Sheets-Sheet 1

Fig. 1.

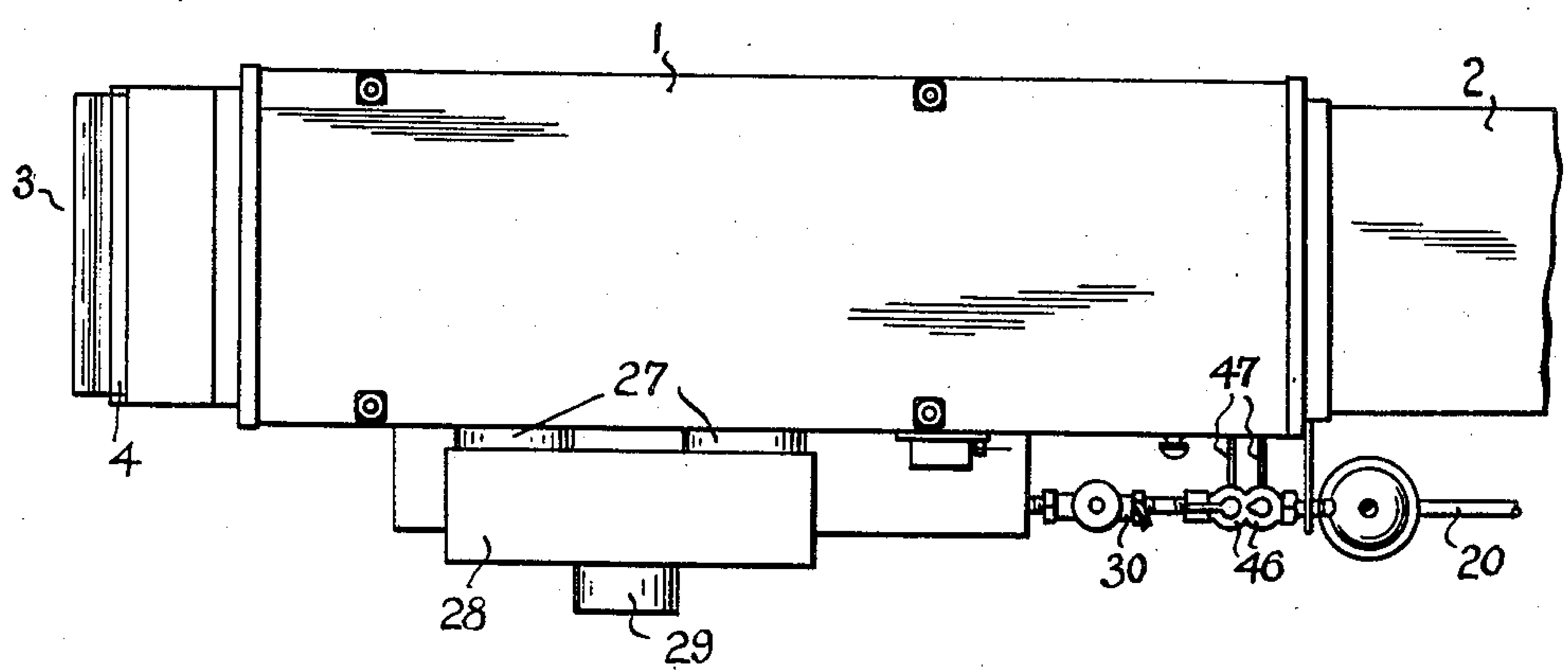
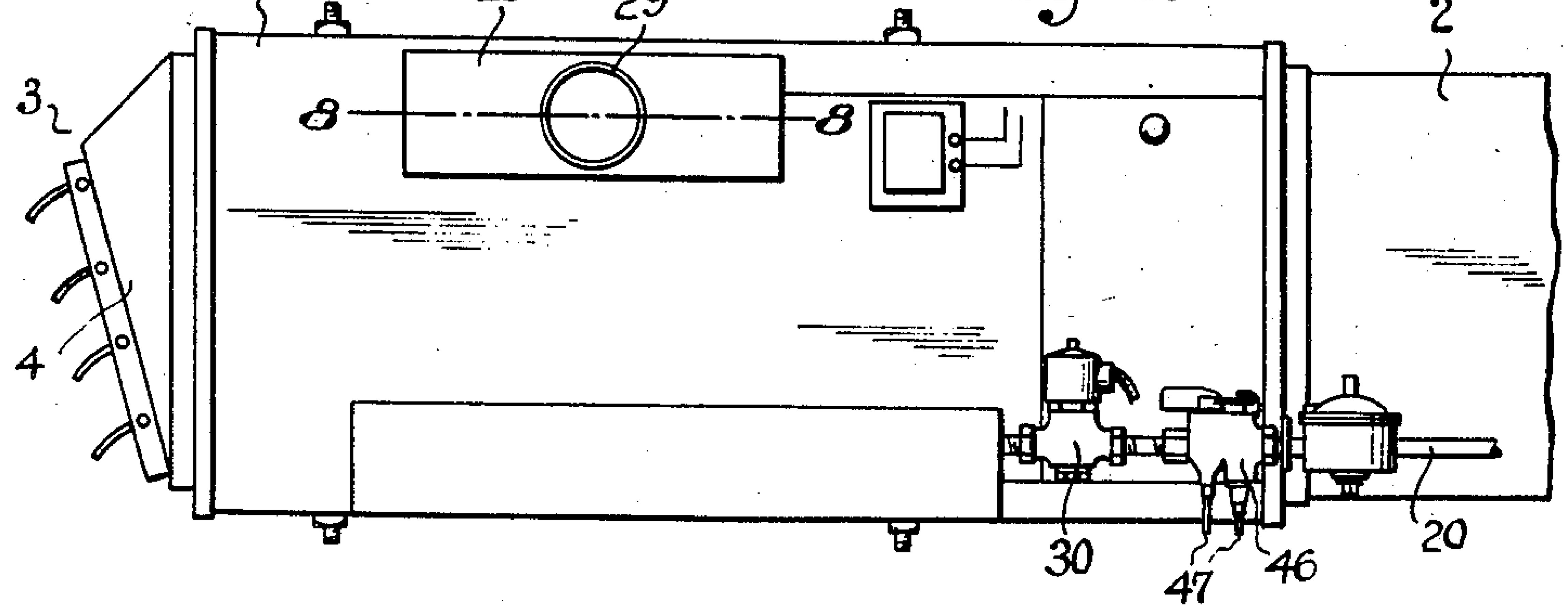


Fig. 2.



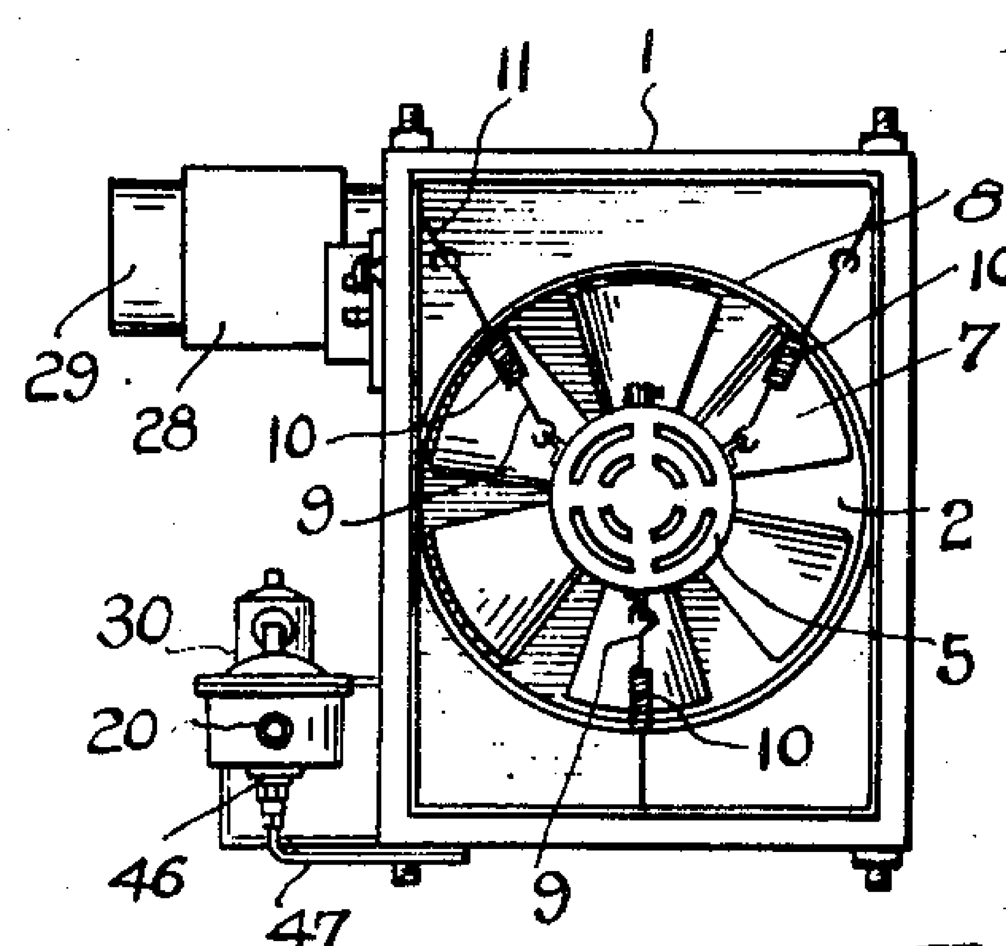


Fig. 3.

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Feb. 6, 1951 E. A. NORMAN, JR 2,540,280

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Filed Sept. 1, 1948 3 Sheets-Sheet 2

Fig. 4.

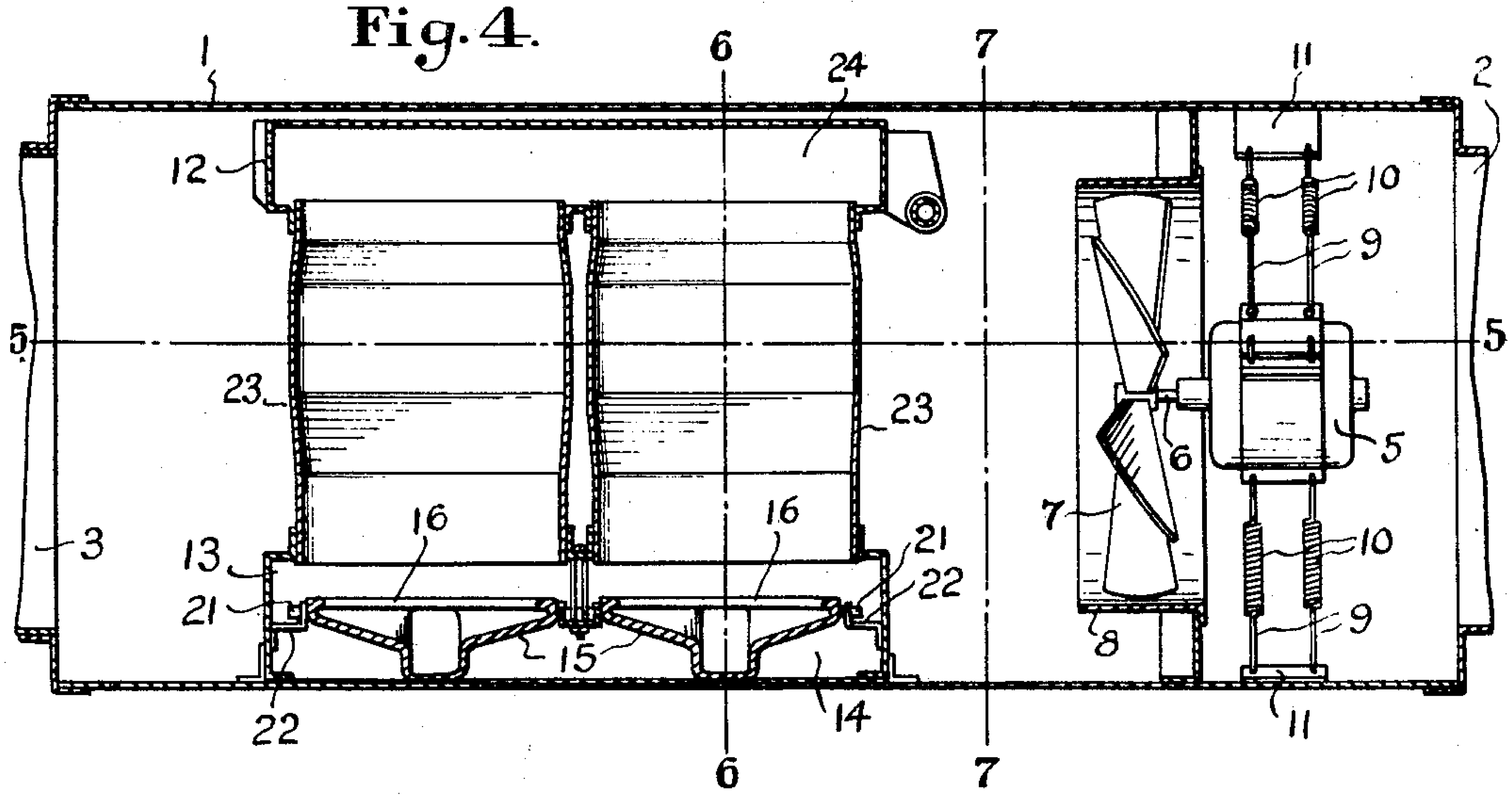
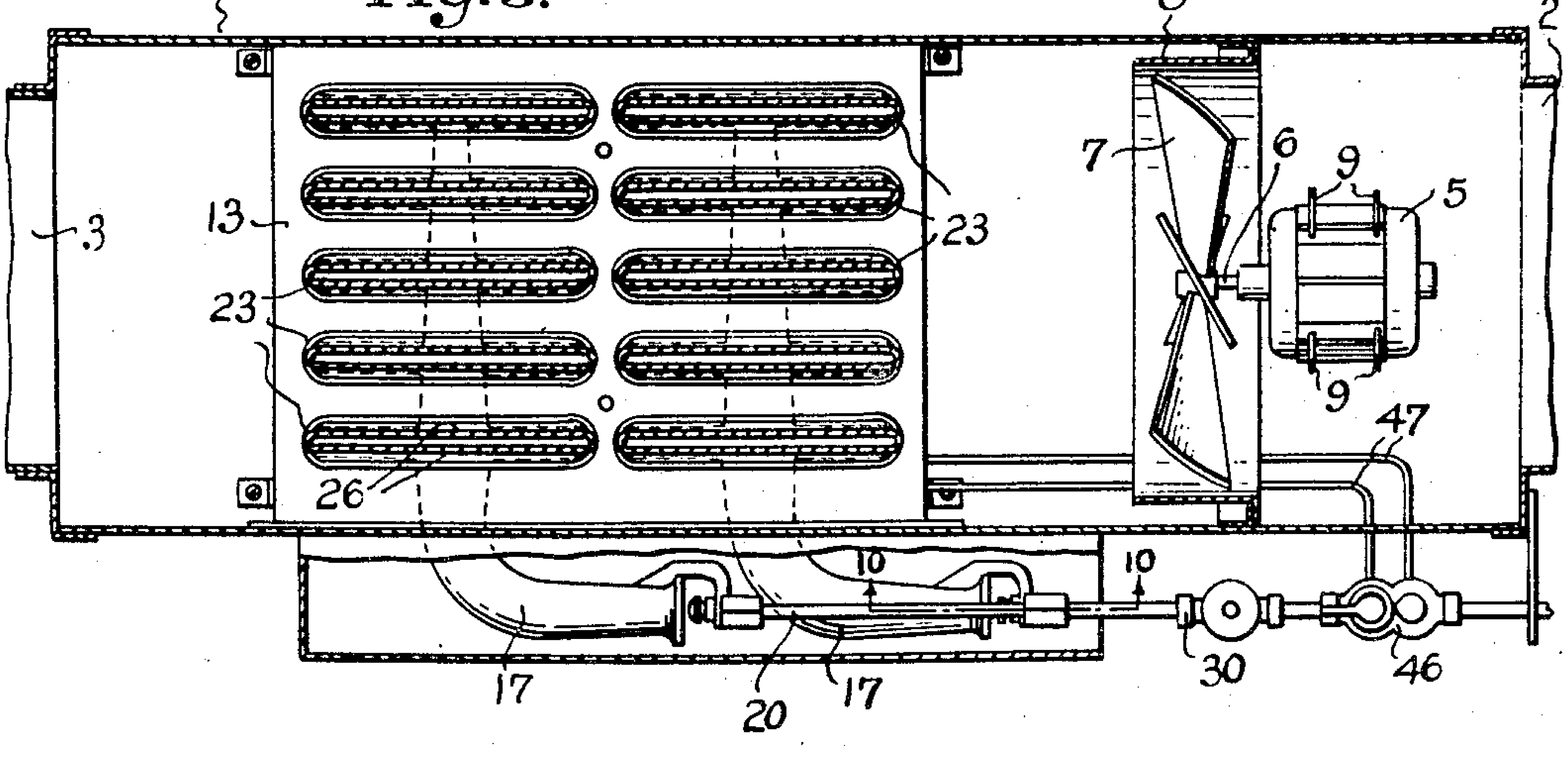


Fig. 5.



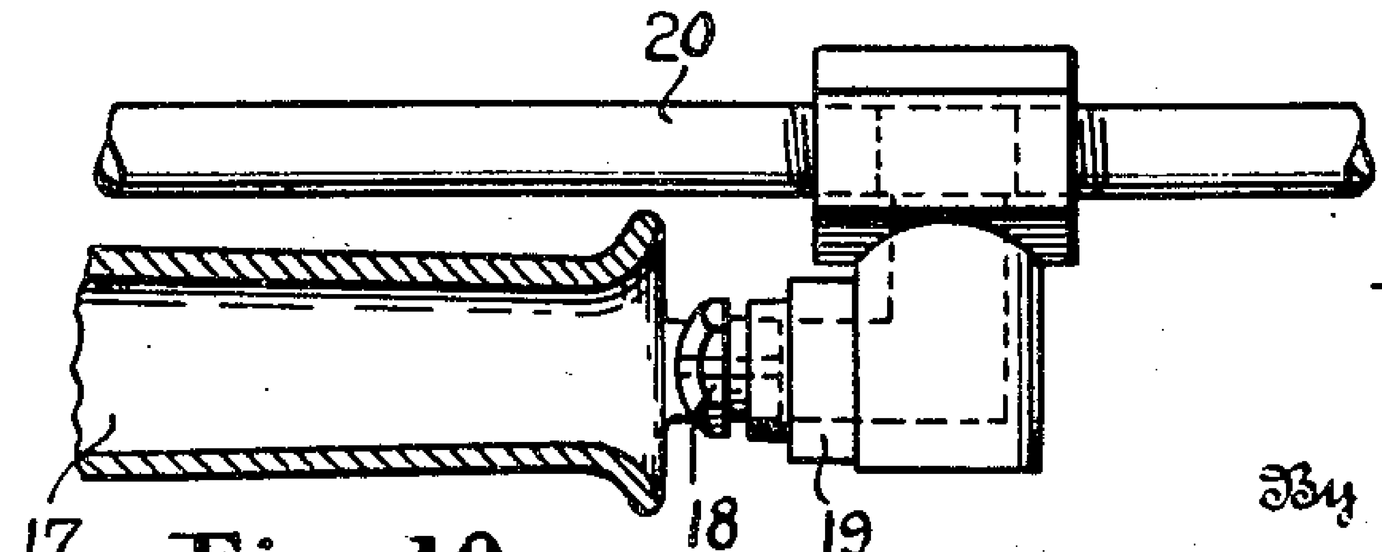


Fig. 10.

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Feb. 6, 1951 E. A. NORMAN, JR 2,540,280

GAS-FIRED FORCED AIR HEATER

Filed Sept. 1, 1948 3 Sheets-Sheet 3

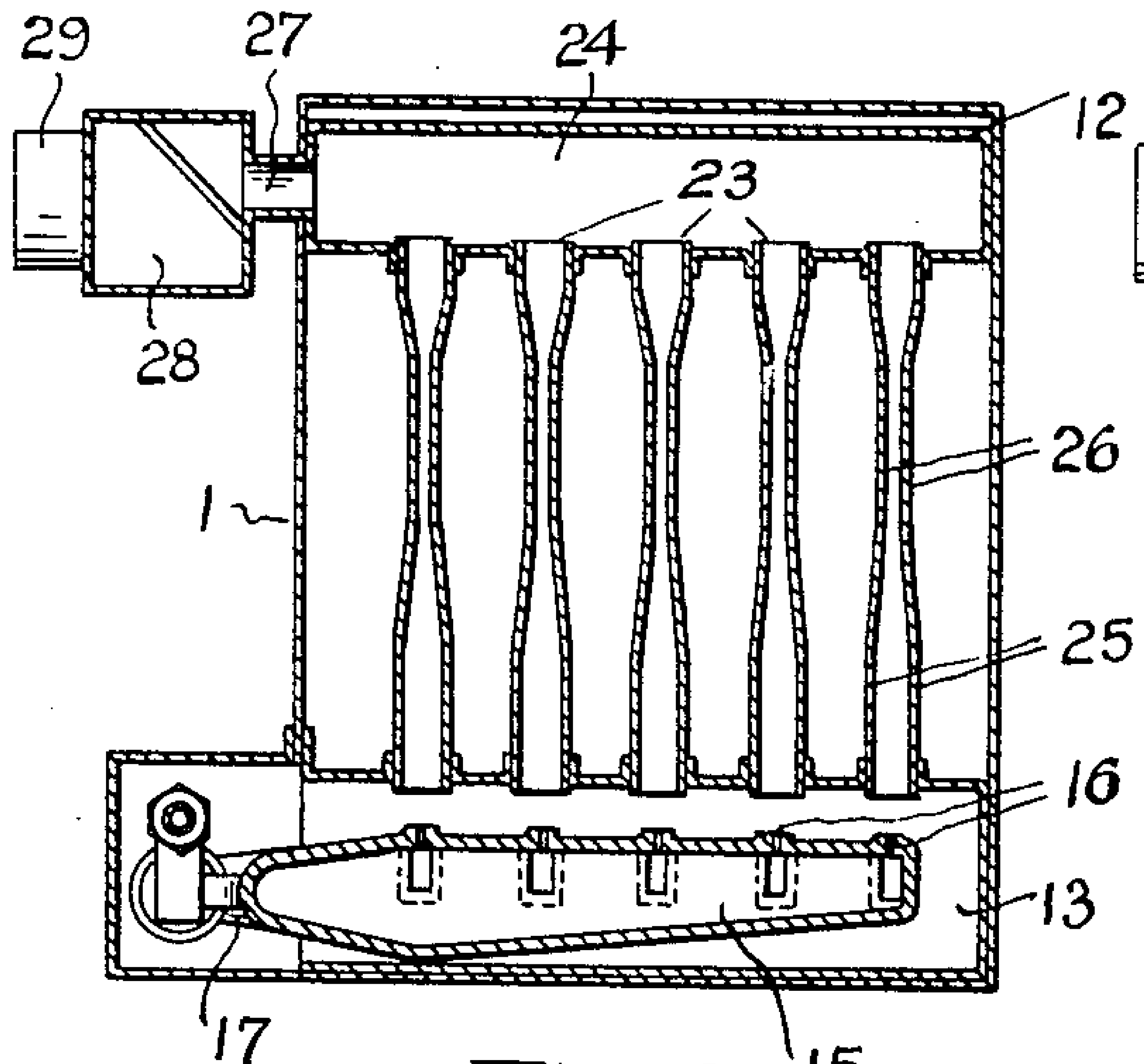

Fig. 6.

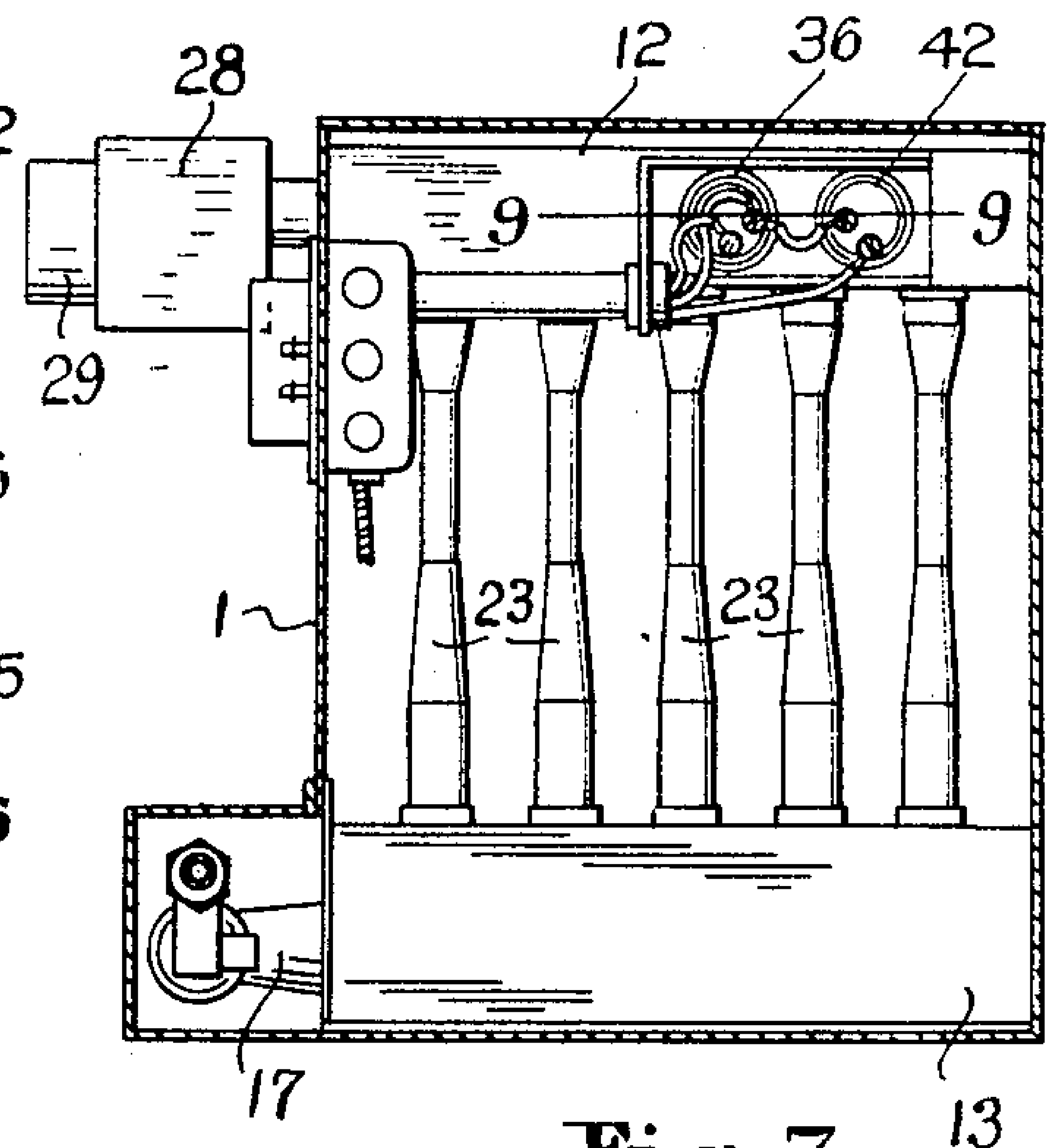

Fig. 7.

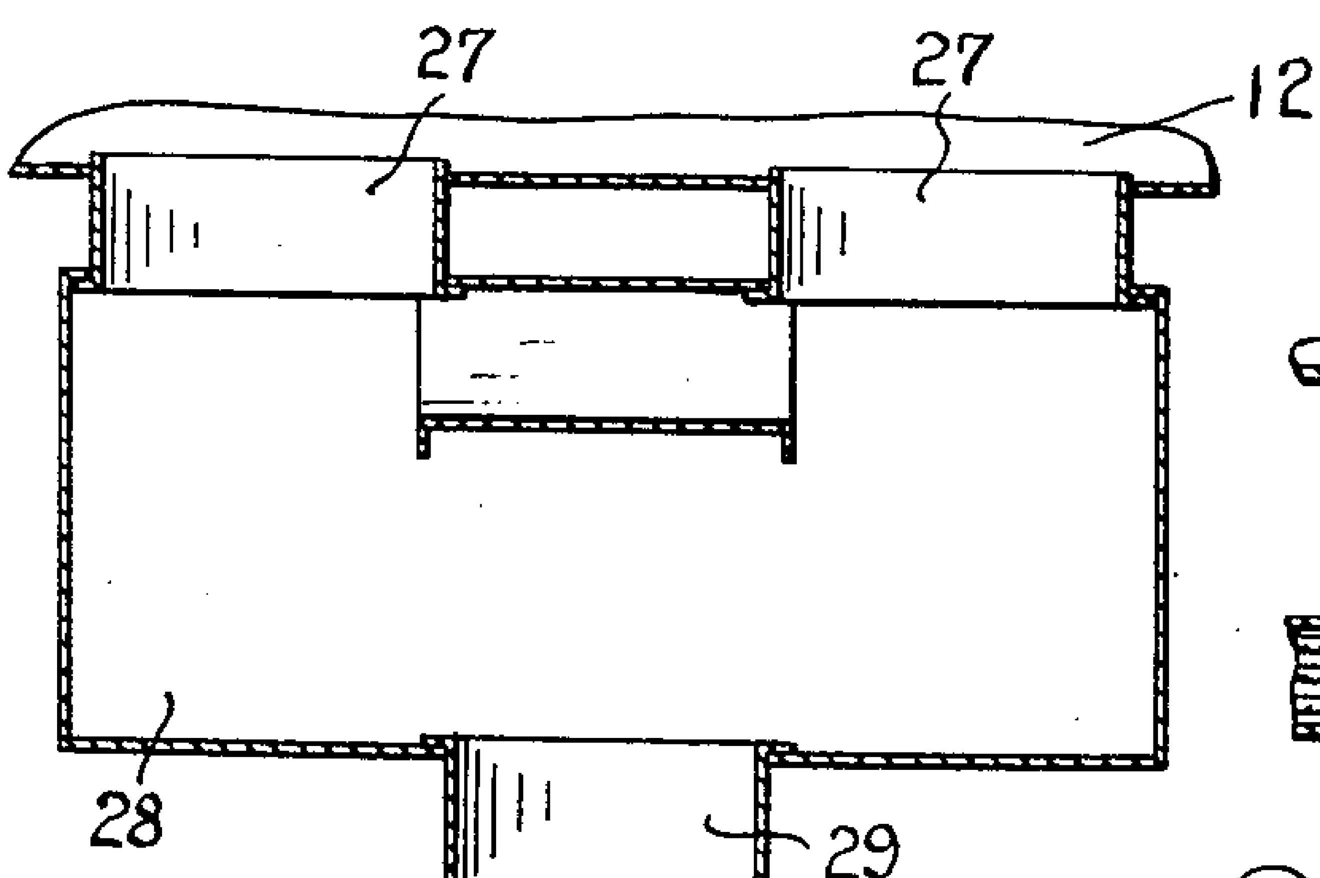

Fig. 8.

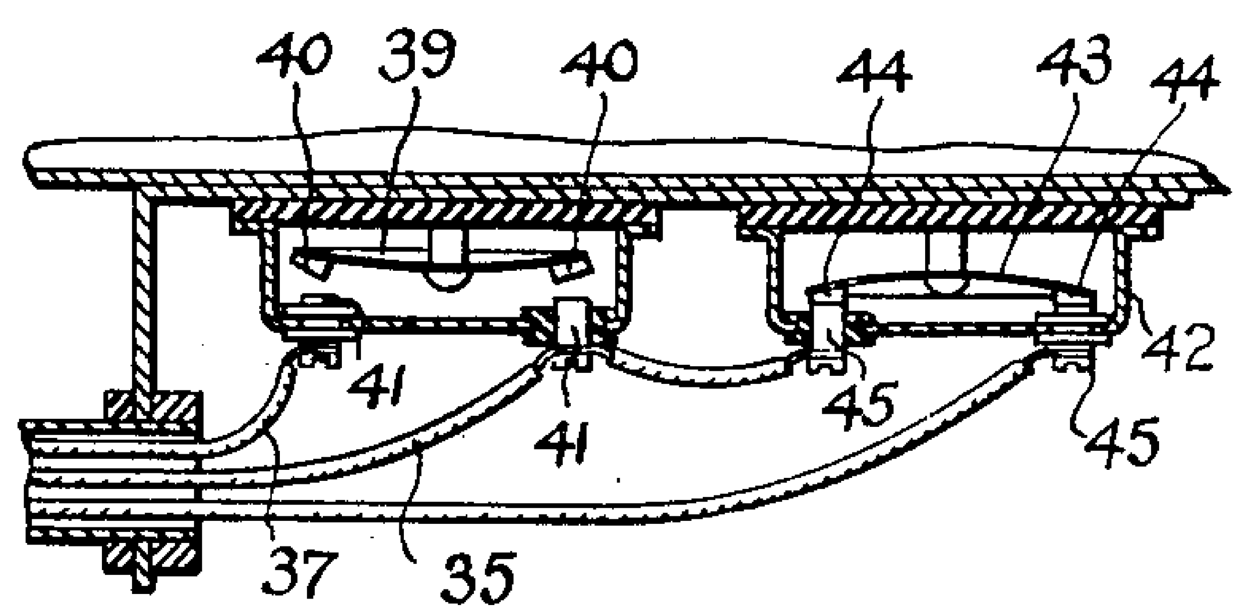

Fig. 9.

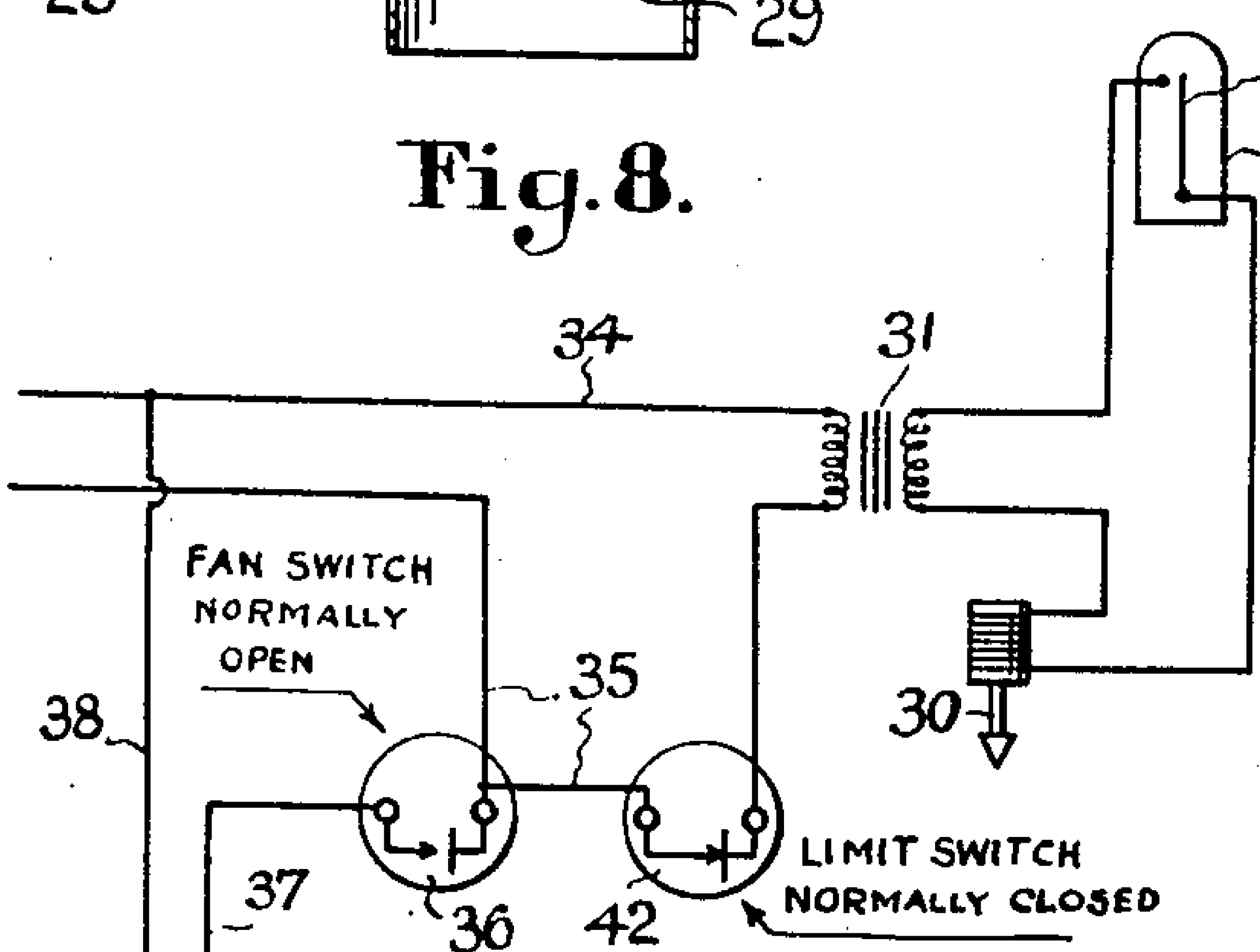

Fig. 11.

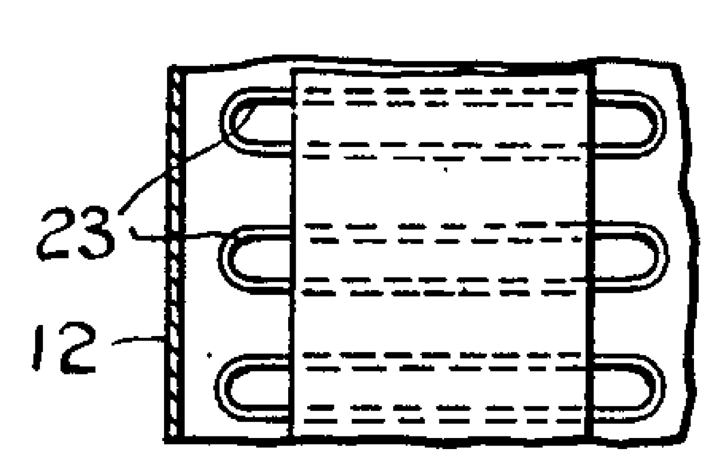

Fig. 12.

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UNITED STATES PATENT OFFICE

2,540,280

GAS-FIRED FORCED AIR HEATER

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Application September 1, 1948, Serial No. 47,282

9 Claims. (Cl. 126—110)

1

This invention relates to house heaters or furnaces and, more particularly, to automatically controlled heaters or furnaces of the gas-fired type in which air under forced flow is caused to travel over heat-exchanging surfaces.

Centralized house-heating furnaces of the forced air and gas-fired types now in general use possess characteristically relatively large cubical dimensions. Normally the same require installation on the floor of a basement or furnace room which, in many small homes, renders their use objectionable or prohibitive from a standpoint of space requirements; for example, housing in which conventional cellar or furnace rooms are not provided. In meeting the heating requirements of such small homes, it is a common practice to utilize one or more room heaters, known commercially as space heaters, which ordinarily are incapable of effecting uniform heating of all rooms of such residential buildings in a manner comparable to heating obtained through the use of duct-equipped central furnaces.

With these conditions, among others, under consideration, it is an object of the present invention to provide an automatically controlled house-heating furnace of such lightweight and small physical dimensions as to adapt the same for installation under the lower floors of basementless houses, in low attics, small closets, or suspended from any suitable room ceiling or other overlying support.

Another object of the invention is to provide a lightweight compact furnace unit of such construction as to enable the same to be readily installed in presently built houses, as well as those undergoing construction, and which, following installation, will be disposed in out-of-the-way and space-saving locations.

It is another object of the invention to provide a gas-fired unit heater or furnace having a high heat output when the compactness and comparatively small dimensions of the heater are taken into consideration.

With these and other objects and advantages in view, which will appear as the description proceeds, the invention consists in the novel features of construction, combinations of elements and arrangements of parts hereinafter more fully detailed and pointed out in the appended claims.

In the accompanying drawings:

Fig. 1 is a top plan view of a gas-fired heater or furnace constructed in accordance with the present invention;

Fig. 2 is a side elevational view thereof;

2

Fig. 3 is an end view from the cold air inlet side of the heater or furnace;

Fig. 4 is an enlarged vertical longitudinal sectional view taken through the heater or furnace and showing the air circulating fan and the associated heat-exchanging tubes;

Fig. 5 is a horizontal sectional view, the plane of which being indicated by the line 5—5 of Fig. 4;

Fig. 6 is a vertical transverse sectional view taken through the heater on the plane disclosed by the line 6—6 of Fig. 4;

Fig. 7 is a similar view on the line 7—7 of Fig. 4;

Fig. 8 is a detail horizontal sectional view on the line 8—8 of Fig. 2;

Fig. 9 is a sectional view on the line 9—9 of Fig. 7 and illustrating the fan motor controlling switches;

Fig. 10 is a detail sectional view taken through one of burner tubes on the plane indicated by the line 10—10 of Fig. 5;

Fig. 11 is a diagrammatic view disclosing the electrical circuits employed in the automatic control of the heater;

Fig. 12 is a detail top plan view illustrating the heat-exchanging tubes and disclosing a means for varying the effective area of the open upper ends of the tubes.

Referring more particularly to the drawings, the numeral 1 designates the outer casing of my improved heater or furnace. Preferably, the casing is formed to provide a straight longitudinal duct of sheet metal, the walls of which being suitably joined in rigidly connected relationship and internally braced, the duct being substantially rectangular in its transverse cross section. One end of the duct is provided with a cold air inlet 2, while the opposite end thereof is formed with a hot air outlet 3. It will be understood that the inlet 2 may be joined with ducts or pipes, not shown, for the return of air from the room or rooms of a house heated by the furnace, while the hot air outlet 3 may be connected with pipes or ducts leading to the room or rooms to be heated.

In certain installations, the hot air outlet may be joined with a shutter-controlled hood 4 for directing heated air into a room to be heated, after the manner of a ceiling or wall-mounted unit heater. Thus in commercial buildings of the type involving one comparatively large room, the single hot air outlet provided by the hood 4 may be used advantageously. In house heating applications, however, the inlet 2 and the outlet

3 are joined with associated ducts leading from the heater to the house rooms to be heated thereby. The construction is thus flexible in its adaptation to either type of heating.

Located in the casing 1 contiguous to the air inlet 2 thereof is an electric motor 5 having the armature shaft 6 thereof provided with fan or blower blades 7, the latter being arranged for rotation in a shroud 8. The motor 5 is preferably supported by means of eye members 9 which carry coil springs 10, the eye members having their inner ends suitably joined with the frame of the motor and their outer ends connected with duct-carried brackets 11. The motor is thus provided with a spring suspension by which vibration and noise incident to its operation are precluded or minimized. The fan or blower serves to draw air into the casing through the inlet 2 and positively advance the same longitudinally of the casing for discharge through the outlet 3 thereof.

Between the fan or blower 7 and the outlet 3, the casing is provided internally with heat-exchanging means embodying upper and lower boxings 12 and 13 respectively. The lower boxing is formed to provide a burner chamber 14 in which are positioned a pair of gas burners 15 having slotted burner orifices 16. The burners are provided with elbows 17 which extend laterally and externally of the casing along one side thereof. The open outer ends of these elbows are disposed in registration with apertured gas outlet heads or plugs 18 which are positioned in fittings 19 joined with a gas-supplying pipe line 20. As the gas issues from the heads or plugs 18, the same is drawn into and mixed with air entering the open outer ends of the elbows 17 and advanced through said elbows to the burners proper, in order that active fuel combustion may take place at or immediately above the orifices 16 of the burners 15. The burners are equipped with studs 21, as shown in Fig. 4, which are received in slots provided in bracket lugs 22 projecting inwardly from the walls of the burner chamber, in order to provide convenience in the mounting and replacement of the burners.

Carried by and positioned vertically between the upper and lower boxings 12 and 13 are relatively spaced heat-exchanging tubes 23. These tubes are in open communication at their lower ends with the burner chamber 14 and are so disposed as to register vertically with the slotted orifices 16 of the burners 15. At their upper ends, the tubes 23 are in open communication with a plenum chamber 24 provided by the upper boxing 12. Each of these tubes in horizontal cross section provides flat parallel side walls 25 which are united at their ends by arcuate edge walls.

I have found that the heat-exchanging efficiency of these tubes is substantially increased by bringing the side walls 25 thereof closer together intermediately of their lengths, as indicated at 26, so that the passage for the burner gases formed by each tube is restricted cross-sectionally in the region indicated at 26. This hourglass configuration of the tubes provides for a more effective wiping of the inner walls with the hot burner gases and the removal of heat therefrom by the forced travel of air over the outer surfaces of said tubes. The arrangement and configuration of the tubes contributes materially to the compactness in design of the heater as a whole, providing for a high degree of heat output, low stack temperatures and small physical dimensions on the part of the outer casing.

The plenum chamber communicates at one side of the heater with waste gas outlet collars 27 which support in connection with the casing a flue box 28, the latter being provided with an outlet 29 leading to an atmospheric vent.

The heater or furnace is adapted to be automatically controlled in accordance with the heat requirements of the room or rooms heated thereby. Thus the pipe line 20 employed in supplying gas to the burners 15 is provided ahead of the fittings 19 with a normally closed solenoid-actuated valve 30. The field windings of the solenoid of this valve are arranged in a low voltage circuit disposed on the secondary side of a transformer 31, and included in this low voltage circuit is a room-mounted thermostat 32. When a demand for heat exists in a room in which the thermostat is disposed, the thermostat, which may be of the customary bimetallic construction, operates to close a switch 33, thus completing the low voltage circuit and energizing the solenoid of the valve 30 to open the latter, providing for normal gas flow to the burners 15 to sustain active fuel combustion at required rates. When the heat demand has been satisfied, the thermostatic switch 33 opens and the solenoid of the valve 30 is deenergized to arrest gas flow to the burners.

The transformer 31 has its primary side connected with conductors 34 and 35 leading to a conventional source of electrical energy. Joined with the conductor 35 is a normally open fan switch 36 which, as shown in Fig. 7, is mounted on the upper tube boxing 12. This switch is joined with a conductor 37 which leads to the windings of the fan motor 5, and from the conductor 34, a conductor 38 extends to the other side of the motor windings. While the fan switch 36 may be of any suitable construction, the same in this instance has been shown as comprising a snap type bowed diaphragm 39 carrying contacts 40 which are adapted for engagement with stationary contacts 41 with which the conductors 35 and 37 are joined.

It will be seen by this arrangement that after the burners 15 have been in active operation for a predetermined period of time and the walls of the boxing 12 attain a desired temperature, the heating of such walls will result in the transference of heat to the diaphragm 39, causing the latter to quickly flex in a direction in which the contacts 40 thereof are brought into engagement with the contacts 41, thereby completing the fan-motor circuit. In this manner, the operation of the fan is controlled from the temperature of the heat exchanger. When the thermostat calls for heat, the fan does not start until the heat exchanger is hot enough to deliver warm air, thus preventing the apparatus from circulating unheated air. Similarly, when the operation of the gas burners has been discontinued by the opening of the thermostatic switch, the fan motor continues to operate, blowing air across the outer surfaces of the heat exchanger until the temperature of the heat exchanger drops to a point causing the diaphragm 39 to flex in a direction separating the contacts 40 and 41.

As a safety feature, I employ a normally closed limit switch 42, which is mounted on the boxing 12 contiguous to the fan switch 36. The limit switch may be of substantially the same construction as the fan switch, having a bowed diaphragm 43 carrying contacts 44 which are normally arranged in engagement with stationary contacts 45, the latter being joined with the conductor 35 leading to the primary side of the transformer. The switch 42 remains closed under the normal operating temperatures of the heater, but in the event there should be failure on the part of the fan motor to operate under prescribed temperature conditions, the resulting overheating of the heat exchanger, which includes the boxing 12, will cause the diaphragm 43 to flex in a direction separating the contacts 44 and 45, thus interrupting the flow of current to the primary side of the transformer and deenergizing the circuit of the solenoid valve. This arrests the flow of the combustible gaseous fuel to the main burners 15. The pipe line 20 ahead of the solenoid valve may be provided with the usual pilot fittings 46 from which small pipe lines 47 lead to pilot burners arranged adjacent to the main burners 15, the pilot burners operating, as usual, to maintain low stage combustion of fuel over the main burners to ignite fuel issuing from the orifices 16 thereof.

In view of the foregoing, it will be seen that I have provided a simple and compact central heating system especially designed to meet the particular heating needs of small homes and commercial buildings. The apparatus can be easily and economically installed in all types of buildings, and no costly alteration expenses are involved to provide such buildings with automatic central heating. As stated, the apparatus may be suspended from a ceiling or under a floor, or disposed in a closet or back room. From such out-of-the-way locations, the heater provides a constant circulation of warmed air to all parts of a building communicating therewith, the apparatus being under thermostatic control to secure desired room temperatures. In installations where duct work is not used, the apparatus functions efficiently as a wall or ceiling-mounted unit heater, and in this respect, is highly efficient as a heating medium for store rooms and other commercial buildings.

I claim:

1. A unitary forced air heater comprising an elongated straight duct-like casing of substantially uniform cross-sectional area throughout its length, said casing having a length dimension substantially in excess of that of its width and height dimensions, there being an air inlet for cool air at one end of said casing and an outlet for heated air at its opposite end, a heat exchanger arranged within said casing between the inlet and outlet ends thereof, burner means carried by said casing for effecting the passage of hot combustion gases through said heat exchanger, said burner means having burner orifices located below said heat exchanger, a fuel-air mixture conveying conduit joined with said burner means, said conduit including an outer elbow disposed in parallel relation with and externally and laterally to one side of said casing, said elbow and burner means being disposed in the same horizontal plane, and a motor-driven fan mounted wholly within the confines of said casing between the air inlet end thereof and said outlet end thereof and operative to effect a forced passage of air drawn into said duct through the inlet end thereof over the heated surfaces of said heat exchanger and thence outwardly of said casing through the outlet end thereof while the air is passing through said casing in a straight longitudinal direction without change in its course of travel.

2. A forced air heater comprising an elongated straight duct-like casing of substantially uniform cross-sectional area throughout its length, said casing having a length dimension which is substantially in excess of that of its width and height dimensions, there being an air inlet for cool air at one end of said casing and an outlet for heated air at its opposite end, a heat exchanger arranged within said casing intermediately of its inlet and outlet ends, said exchanger including upper and lower boxings disposed within the confines of said casing, a plurality of vertically arranged relatively spaced flat-sided tubes joined at their ends with said boxings, gas burners positioned in the lower of said boxings, said burners having orifice-containing heads arranged below and in registry with open lower ends of said tubes, fuel mixture conveying conduits joined with said burner heads, said conduits having outer elbow portions extending parallel with and laterally and externally of a side wall of said casing and substantially at right angles to the portions of said conduits connected with said burner heads, and motor-driven air-displacing means arranged wholly within the casing between the air inlet end thereof and said heat exchanger.

3. A forced air heater as defined in claim 2, a gas-supplying pipe line extending parallel to said casing and said outer elbows, and orifice provided fittings carried by said pipe line, said fittings having the orifices therein disposed in registry with the outer ends of said elbows, whereby to deliver to said elbows a combustible mixture composed of a fuel gas drawn from said pipe line and atmospheric air.

4. A unitary forced air heater comprising an elongated straight ductlike casing having a length dimension substantially in excess of that of its width and height dimensions, there being an air inlet for cool air at one end of said casing and an outlet for heated air at its opposite end, a heat exchanger arranged within said casing between its inlet and outlet ends, said exchanger including a plurality of vertically arranged relatively spaced tubes, a gas burner arranged below said tubes and in registry therewith to project burning gases into the lower ends of said tubes for upward passage through the tubes, means for collecting burned gases discharged from the upper ends of said tubes and delivering the same exteriorly of the casing for discharge to the atmosphere, a fuel mixture conveying conduit joined with said gas burner, said conduit including an outer elbow disposed in parallel relation with and exteriorly of and latetrally to one side of said casing, the outer end of said elbow being open, a fuel gas supply pipe extending parallel with the outer side of said casing adjacent to said elbow, and an orificed fitting carried by said supply pipe, said fitting having the orifice therein disposed in registry with the open end of said conduit elbow to inject a mixture of fuel gas and atmospheric air into said elbow for travel through said conduit to the combustion region of said burner, and a motor-driven fan positioned wholly within said casing between said air inlet and heat exchanger, said fan serving to effect a positive flow of atmospheric air drawn into said casing over the heated surfaces of the tubes of said exchanger and the forced expulsion of the resultant heated air through the outlet end of said casing.

5. A unitary forced air heater comprising an elongated straight duct-like casing of substantially uniform cross-sectional area throughout its length, said casing having an over all length dimension substantially in excess of that of its maximum width and height dimensions, there being an air inlet for the entry of cool air at one end of said casing and an outlet for the discharge of heated air from the opposite end of the casing, a heat exchanger arranged within said casing between the inlet and outlet containing ends thereof, said exchanger including upper and lower boxings, a plurality of vertically arranged relatively spaced tubes joined at their opposite ends with said boxings, gas burners positioned in said lower boxing in registry with the lower ends of said tubes, pipe means extending parallel with and laterally and externally to an outer side of said casing for delivering a combustible mixture of fuel gas and air to said burners, and a motor-driven fan mounted wholly within the confines of said casing between said inlet and said heat exchanger, said fan serving to effect a positive advancement of air between and over the outer surfaces of said heat exchanger tubes and through said outlet.

6. A forced air heater as defined in claim 5 in combination with thermostatic switch means responsive to the temperature of the upper of said heat exchanger boxings for delaying operation of said motor-driven fan until the walls of said upper boxing attain a predetermined operating temperature.

7. A forced air heater as defined in claim 5, in combination with an electrically actuated control valve for governing the flow of gaseous fuel from a source of supply to said burners, said valve including an operating circuit, and a normally closed limit switch responsive to the temperature of the walls of the upper boxing of said heat exchanger for automatically opening the operating circuit of said valve and arresting gas flow to said burner when the walls of said upper boxing attain a temperature in excess of a predetermined operating temperature.

8. A forced air heater comprising an elongated duct-like casing of generally rectangular cross-sectional configuration provided at one end with a cold air inlet and at its opposite end with a hot air outlet, said casing having a length dimension

substantially in excess of that of its width and height dimensions; a heat exchanger arranged within said casing intermediately of its inlet and outlet ends, said exchanger including relatively spaced upper and lower boxings disposed within the confines of said casing and defining respectively a flue gas manifold and a burner- receiving manifold, said exchanger also including a plurality of open-ended vertically arranged transversely spaced flattened tubes extending between and communicating with said boxings, said tubes being arranged in a row extending transversely of said casing; an elongated gaseous fuel burner positioned in the lower boxing of said heat exchanger and extending transversely of said casing, said burner having flame orifices arranged below and in registration with the lower open ends of each of said tubes; a fuel-air supply conduit communcating at one end with said burner and extending laterally outwardly from the lower boxing of said exchanger in the plane of said burner and terminating laterally and externally of a side wall of said casing; and motor-driven air-displacing means positioned wholly within said casing for circulating air first through the inlet of said casing, across said heat exchanger, and outwardly through the outlet of said casing.

9. A forced air heater as defined in claim 8 in combination with a thermostatic switch positioned within said casing in thermal proximity to said heat exchanger and connected in series with said motor-driven air-displacing means for delaying operation of said air-displacing means until the temperature of said exchanger attains a given operating temperature.

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