Aug. 20, 1935. A. HOWARTH 2,012,100

LIQUID FUEL BURNER

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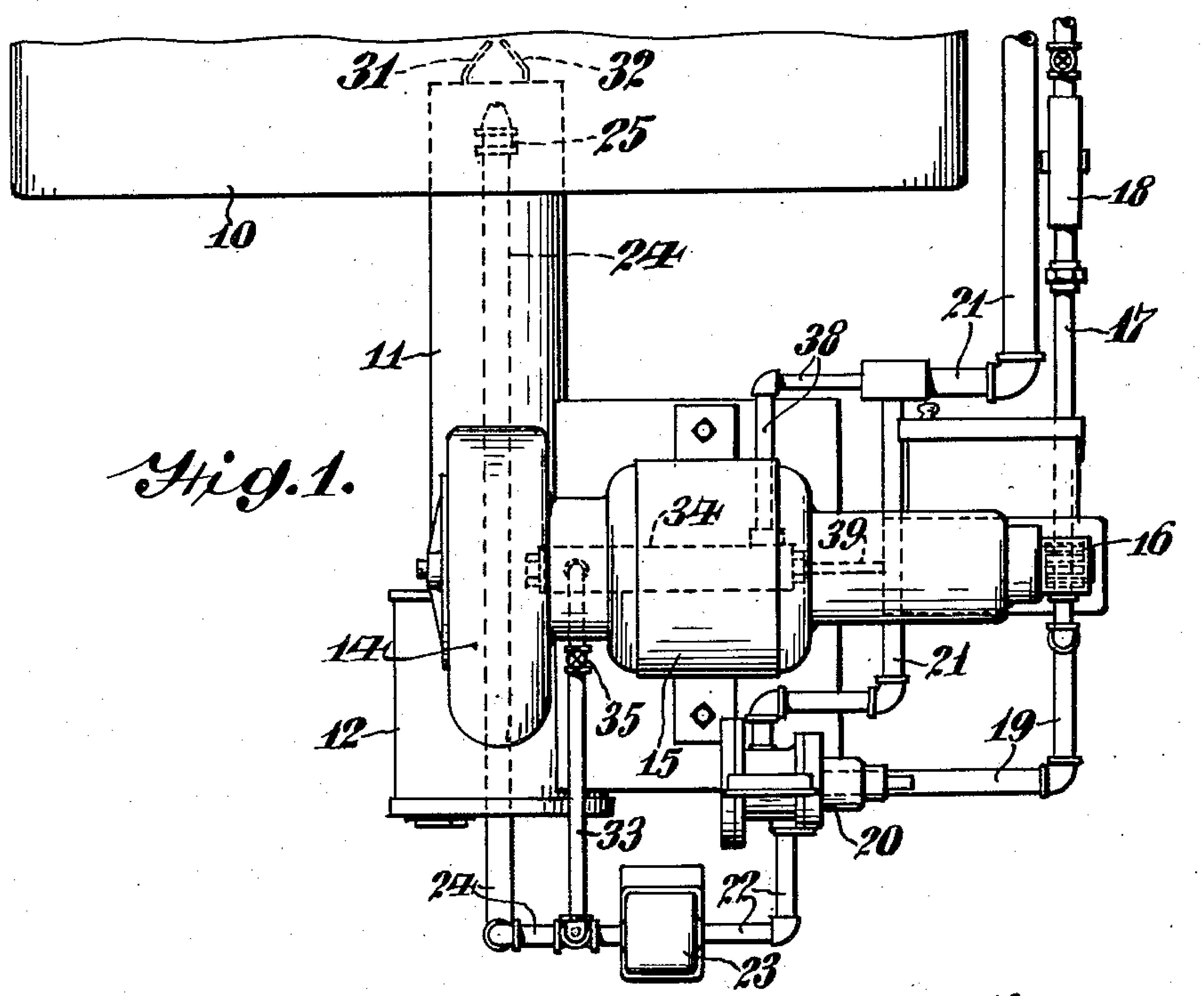

Fig. 1.

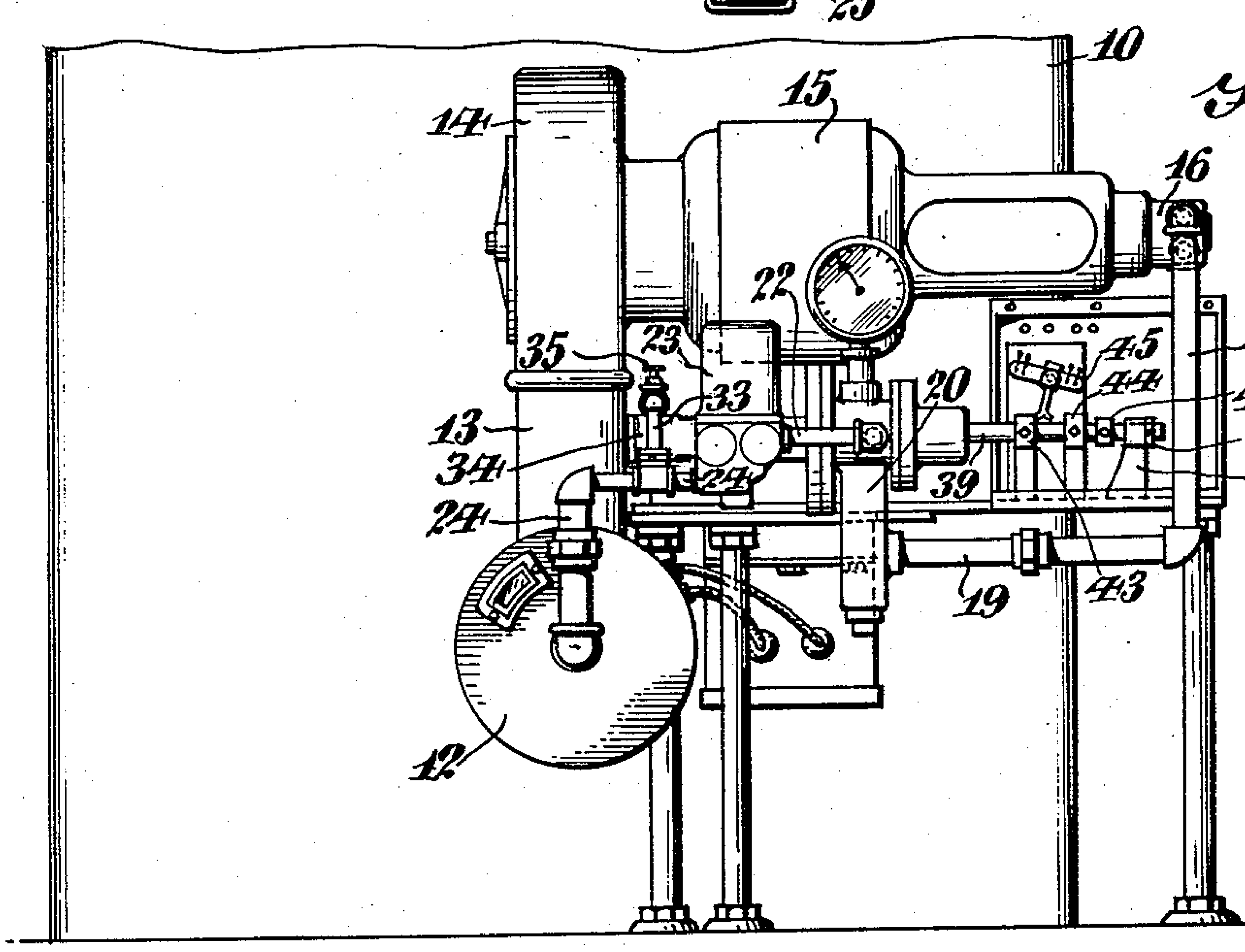

Fig. 2.

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Fig. 3.

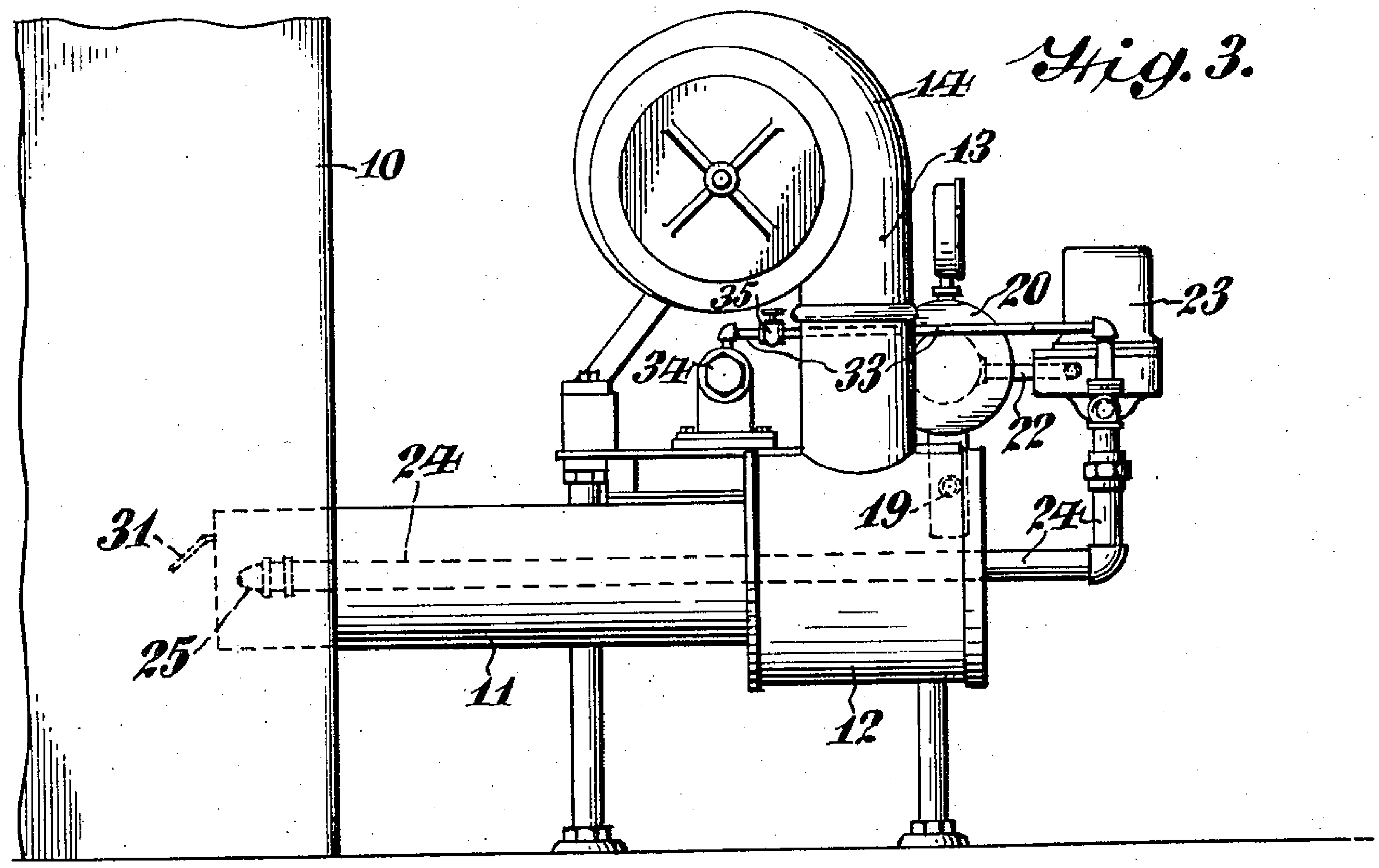

Fig. 5.

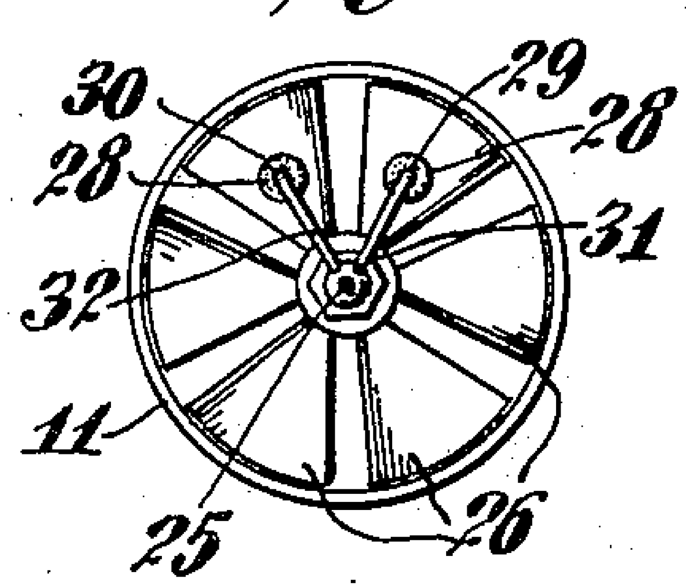

Fig. 4.

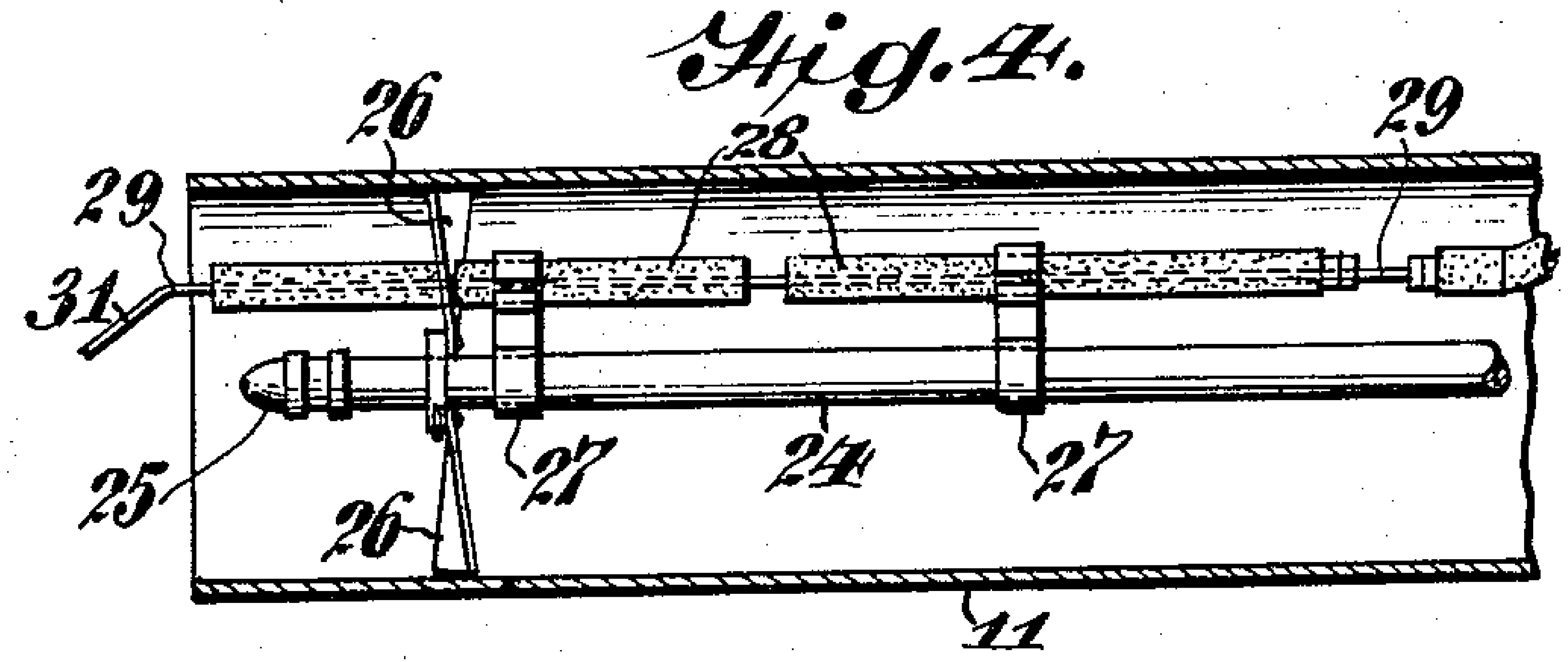

Fig. 6.

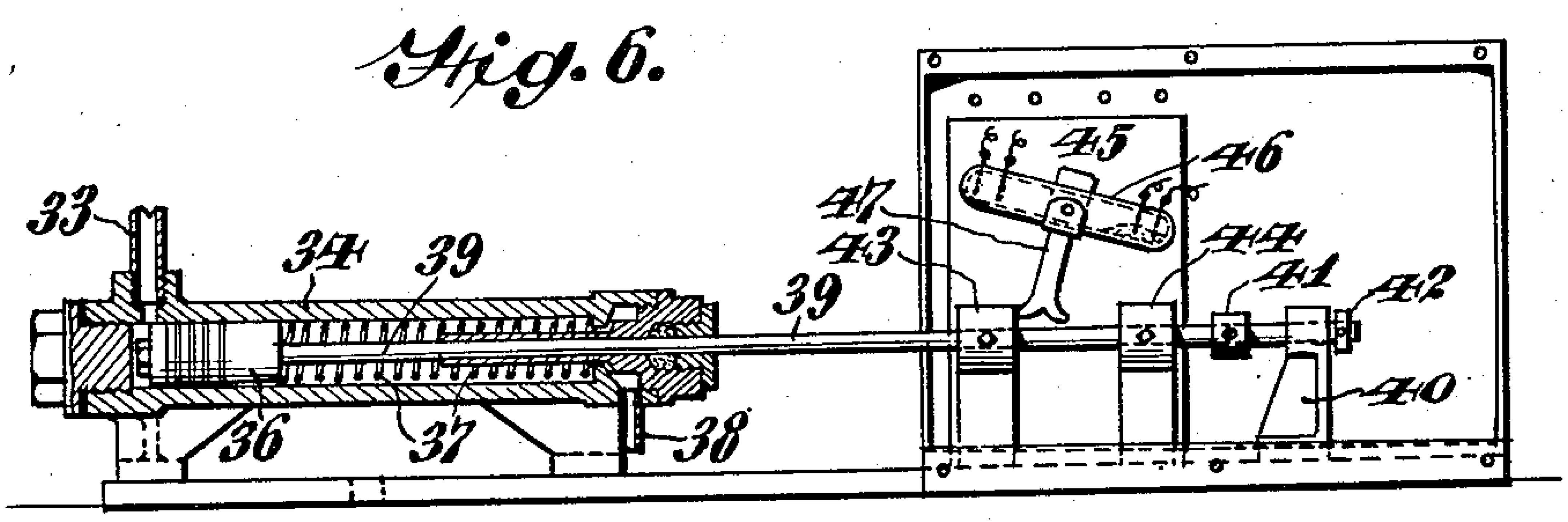

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Fig. 7.

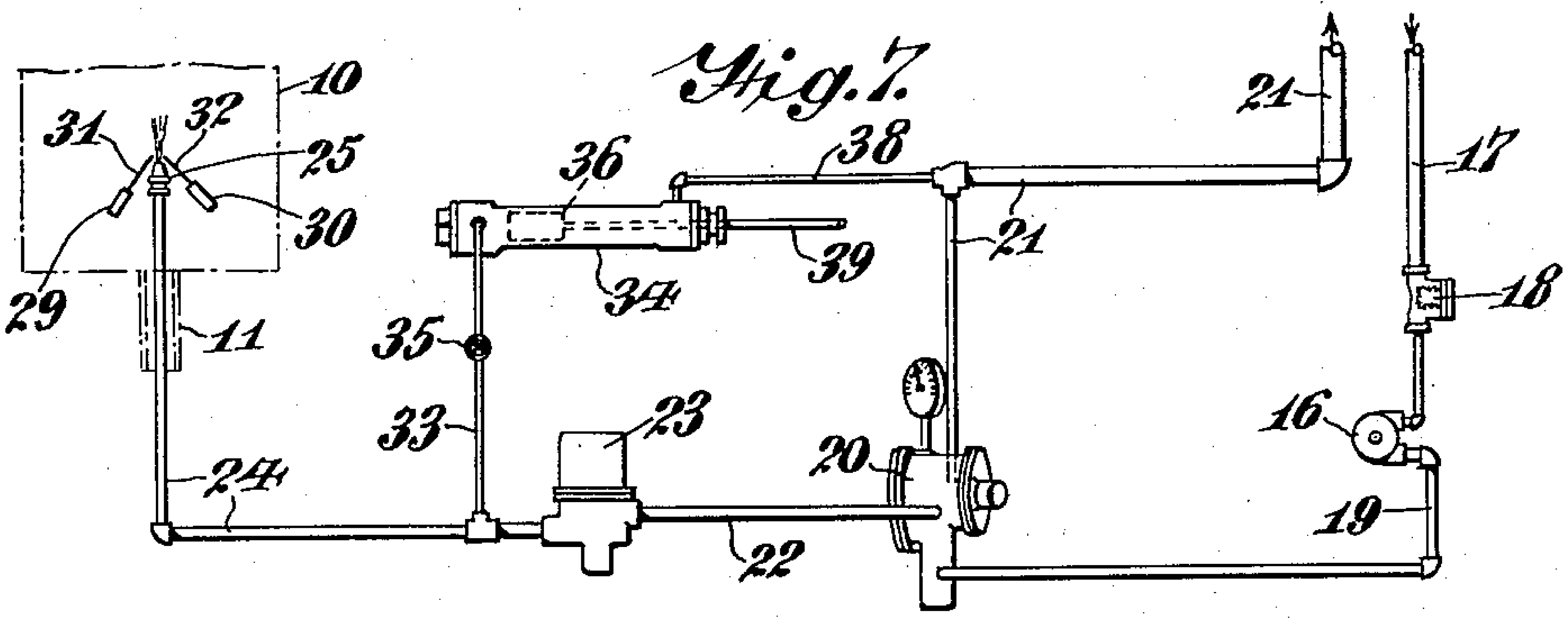
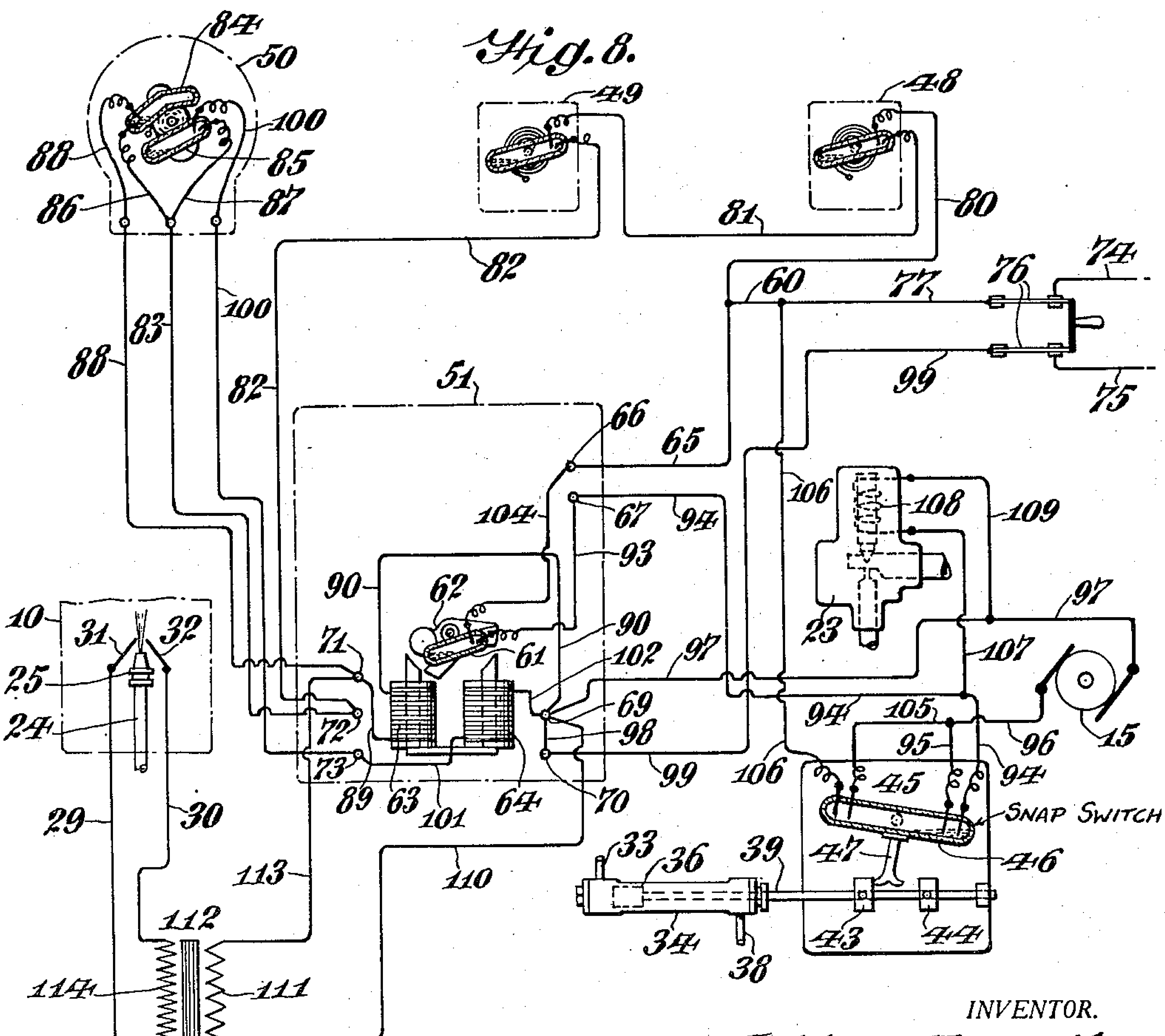


Fig. 8.



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Patented Aug. 20, 1935 2,012,100

UNITED STATES PATENT OFFICE

2,012,100

LIQUID FUEL BURNER

Ashton Howarth, Philadelphia, Pa., assignor of one-half to Edwin Pierce Weber, Philadelphia, Pa., and one-half to Henry S. Boyce, Wayne, Pa.

Application December 17, 1931, Serial No. 581,647

11 Claims. (Cl. 158—28)

My invention relates to liquid fuel burners, and it relates more particularly to apparatus which is adaptable for use in connection with domestic heating furnaces, for supplying thereto, at the proper times, a suitable quantity of burning liquid fuel.

The principal object of my invention is to provide a liquid fuel burner of the character aforesaid, which will be entirely automatic in its action, and relatively inexpensive in construction and operation.

A further object of my invention is to provide an oil burner of the automatic type, which is so constructed and arranged that the supply of liquid fuel to the atomizing nozzle is automatically shut off in advance of the discontinuance of the operation of the air blower, to the end that the gases in the fire chamber will be entirely consumed, or at least ejected therefrom, thus obviating any likelihood of subsequent explosion of the same.

The nature and characteristic features of my invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part hereof, in which:

Figure 1 is a top or plan view of an oil burner embodying the main features of my present invention;

Fig. 2 is a rear elevation thereof;

Fig. 3 is a side elevation thereof;

Fig. 4 is a sectional view, showing the arrangement of the air inlet flue, and illustrating the fuel atomizer, the pipe line leading thereto, and the ignition electrodes;

Fig. 5 is a front elevation of the structure shown in Fig. 4;

Fig. 6 is a detail view, partly in section and partly in elevation, illustrating a preferred form of mechanism for controlling certain of the electrical circuits used, whereby the motor may be permitted to operate for a definite time period after the supply of oil to the nozzle is discontinued;

Fig. 7 is a diagrammatic view of the piping arrangement, illustrating the relative location of certain of the parts of the apparatus with respect thereto; and

Fig. 8 is a diagrammatic view illustrating an arrangement of circuits which may be employed.

It should, of course, be understood that the description and drawings herein contained are illustrative merely, and that various changes and modifications may be made in the structure disclosed without departing from the spirit of the invention.

Referring to the drawings, in the particular embodiment of my invention therein shown, 10 is a boiler, heater, or other similar device, in the combustion chamber of which the liquid fuel is burned. An air flue 11 extends thereto from a housing 12 forming an enlarged air chamber to which the outlet pipe 13 of a blower 14 extends. The blower 14 may be of any preferred type, the impeller (not shown) of which is actuated by an electric motor 15.

The electric motor 15 also serves to actuate a pump 16, which also may be of any preferred construction, and consequently, the internal arrangement thereof is not shown.

A supply pipe 17 extends from the liquid fuel reservoir (not shown) to the pump 16, and a strainer 18, of any preferred type, may be interposed in this pipe 17 if desired. Another pipe 19 extends from the outlet side of the pump 16 to a pressure regulating valve 20. The pressure regulating valve 20 may be of any of the preferred types which are readily procurable, for the purpose of insuring delivery of the liquid fuel to the burner atomizer at a constant pressure, notwithstanding variations in pressure in the supply line.

An overflow pipe 21 extends from the pressure regulating valve 20 back to the reservoir. The liquid fuel which passes to the burner atomizer from the pressure regulating valve 20 is carried by means of a pipe 22 to a solenoid shut-off valve 23, of the common and well known type. A pipe 24 extends from the solenoid shut-off valve 23, through the air chamber provided by the housing 12, thence through the air flue 11, to the combustion chamber of the furnace of the boiler 10, being provided on the end thereof with an atomizing nozzle 25 of the usual type.

Within the air flue 11, adjacent the atomizing nozzle 25, there is mounted a device (see Figs. 4 and 5) for agitating the air passing therethrough, comprising a plurality of radially disposed inclined blades 26. A plurality of brackets 27 are carried by the pipe 24 which extends to the atomizing nozzle 25, these brackets 27 serving to support porcelain sleeves 28, through which the high tension ignition wires 29 and 30 extend.

Each of the ignition wires 29 and 30 is bent inwardly at its end, so as to bring the terminals thereof in proximity to each other, to provide electrodes 31 and 32 in the path of the liquid fuel sprayed from the atomizing nozzle 25, so that when the high tension current is supplied to the wires 29 and 30, in the manner to be hereinafter described, the liquid fuel will thereby be ignited.

A branch pipe 33 extends from the pipe 24 to one end of a cylinder 34. A regulating valve 35 is interposed in the branch pipe 33. A piston 36 is slidably mounted in the cylinder 34, and is normally impelled toward the front end thereof by a coil spring 37, which is mounted within the cylinder at the rear of the piston 36. The rear end of the cylinder 34 is connected by a pipe 38 to the drain pipe 21 which extends from the pressure regulating valve 20 to the reservoir, so that the rear end of the cylinder 34 is maintained free of any appreciable pressure, and any of the liquid fuel which leaks past the piston 36 will be readily drained away.

The piston 36 is mounted on the front end of a rod 39, which extends through the rear end of the cylinder 34, any suitable form of packing being provided to prevent leakage of the liquid fuel at this point. The rear end of the rod 39 is guided in a suitable bracket 40, and is provided with collars 41 and 42, which serve to limit the extent of longitudinal movement of the rod 39, and the piston 36 carried at the forward end thereof.

Collars 43 and 44 are also positioned at suitable locations upon the rod 39, and serve to actuate a mercury switch 45. The mercury switch 45 is of the usual type, comprising a glass bulb 46 closed at its ends, and having a globule of mercury adapted to make contacts with a pair of electrodes at either end, accordingly as the tube is tilted in one direction or the other. The switch 45 is preferably of the "snap" type, and is moved to its respective positions by means of an arm 47, which is engaged and actuated by the collars 43 and 44 accordingly as the piston 36 is moved within the cylinder 34.

The circuits employed for the operation and control of the various parts, as well as the devices not hereinbefore described for controlling said circuits, may now be described, reference being more particularly had to Fig. 8 of the drawings.

There is provided a thermostatic switch 48, which may be of the type usually employed in a room of a dwelling or other building which is to be heated by the heating plant in connection with which the burner is used, so as to be responsive to temperature changes in the living portions of the building.

There may also be provided a thermostatic switch 49, which, in the case of hot water heating plants, for instance, may be mounted upon the riser pipe of the heater, so as to be responsive to temperature changes in the water passing therethrough. This switch 49 may also be of any of the usual types which are used for this purpose.

There may also be provided a thermostatic "stack switch" 50, which is mounted on the smoke pipe so as to be responsive to temperature changes in the flue gases, and which is adapted to switch the current from one line to another, according to whether or not the flue is heated by the passing of the burned gases therethrough. This switch also may be of the type customarily employed for such purpose.

There may also be provided a switch device 51, for controlling certain of the circuits.

The switch device 51 is provided with a mercury switch comprising a tiltable tube 61, having a pair of electrodes at one end thereof, adapted to make contact and thereby control certain of the circuits, as will hereinafter appear. The tube 61 is mounted upon a rockable member 62, having armatures which are adapted to be attracted by the pole pieces of magnets 63 and 64.

For convenience in making the connections, the switch device 51 is provided with binding posts 66 and 67, arranged near the top of the structure; binding posts 69 and 70, arranged near the bottom at the right hand side of the structure; and binding posts 71, 72, and 73, arranged near the bottom at the left hand side of the structure.

The current is supplied by means of power leads 74 and 75, passing through a main switch 76, which is adapted to be opened when it is desired to disconnect the device. The current passes from power lead 74 to line 77, to lines 60 and 65, to binding post 66.

Line 80 is connected from lines 77 and 60 to the thermostatic switch 48, which is open when the room temperature exceeds the desired amount, and closed when it is less than the desired amount.

Line 81 extends from thermostatic switch 48 to thermostatic switch 49, which is open when the temperature of the water passing through the riser of the heating system exceeds the desired amount, and closed when the temperature of said water falls below the desired amount.

Line 82 extends from the thermostatic switch 49 to binding post 72, and line 83 extends from binding post 72 to thermostatic "stack switch" 50. The stack switch 50 is provided with two mercury switches, having glass tubes 84 and 85, respectively, which are adapted to be tilted in unison. Said tubes 84 and 85 have electrodes at the respective opposite ends thereof, so that the circuits respectively controlled thereby will be closed when the tubes are tilted in one direction or the other, according to whether or not the burner is functioning.

The line 83 which extends to stack switch 50 is connected by line 86 to one of the electrodes at one end of the tube 84, and is also connected by wire 87 to one of the electrodes at the opposite end of the tube 85. It will, of course, be understood that each of the tubes 84 and 85 is provided with a globule of mercury for establishing the electrical contacts through the electrodes provided at the opposite ends of said tubes, the arrangement being such that when said tubes are tilted in one direction, when the smoke pipe or stack is "cold", one circuit will be established by one of said tubes, and when said tubes are tilted in the other direction, when the smoke pipe or stack is "hot", another and different circuit will be closed. The tubes are shown in Fig. 8 of the drawings in the "cold" position.

The electrode at the end of the tube 84, other than that to which the line 86 is connected, is connected by line 88 to binding post 71. Binding post 71 is connected by line 89 to one end of the magnet coil 63. The other end of the magnet coil 63 is connected by line 90 to binding post 69.

The tube 61 is provided with an electrode which is connected by line 93 to binding post 67. Line 94 extends from binding post 67 to an electrode at one end of the tube 46 of the mercury switch 45. The other electrode at the same end of the tube 46 is connected by line 95 to line 96 which extends to the motor 15. The motor 15 is connected by line 97 to binding post 69, which in turn is connected by line 98 to binding post 70. Binding post 70 is connected by line 99 to the main power lead 75, through the switch 76.

Referring again to the stack switch 50, the electrode at the same end of the mercury tube 85 as the electrode to which the line 87 is connected, is connected by line 100 to binding post 73, which in turn is connected by line 101 to one end of the magnet coil 64. The other end of the magnet coil 64 is connected by line 102 to binding post 69.

The tube 61, which is controlled by magnet coils 63 and 64, has an electrode which is connected by line 104 to binding post 66, the other electrode, as pointed out above, being connected by line 93 to binding post 67.

The end of the tube 46, opposite that to which the electrodes are connected by lines 94 and 95, is provided with electrodes, one of which is connected by line 105 to line 96 which extends to the motor 15, and the other of which electrodes is connected by line 106 to line 77 which extends from the main power lead 74, through the switch 76.

A shunt line 107 extends from line 94 to one end of the coil 108 of the solenoid shut-off valve 23. The other end of the coil 108 of the valve 23 is connected by line 109 to line 97 which extends from the motor 15.

Binding post 69 is connected by line 110 to one end of the primary coil 111 of a transformer 112. The other end of the primary coil 111 is connected by line 113 to binding post 71. The secondary coil 114 of the transformer 112 is connected by the high tension lines 29 and 30 to the ignition electrodes 31 and 32.

The operation of the apparatus may now be described. It will, of course, be understood that when the room temperature exceeds a certain amount, the thermostatic switch 48 will be open, and likewise when the temperature of the water in the heating system exceeds a certain amount, the thermostatic switch 49 will be open, and the device will be in the inoperative condition, as shown in Fig. 8 of the drawings.

When, however, both of these switches are brought to their operative positions, by the proper functioning of the same, current will flow from power lead 74 to line 77, thence by lines 60 and 80, through thermostatic switch 48, thence by line 81, through thermostatic switch 49, thence by line 82 to binding post 72, thence by line 83 to thermostatic switch 50.

As the tube 84 is initially tilted to the closed position, the current will pass by line 86 through the electrodes at one end of the tube 84, thence by line 88 to binding post 71, thence by line 89 to the magnet coil 63, thereby energizing the same, thence passing by line 90 to binding post 69, thence by line 98 to binding post 70, thence by line 99, through the switch 76, to the power lead 75.

At this stage of the operation, the tube 61 having been tilted by the energization of the magnet coil 63, the current will be permitted to pass from binding post 66, by line 104, through the electrodes at the right hand end of tube 61, to line 93, thence through binding post 67 and line 94, through the electrodes at the right hand end of tube 46 of mercury switch 45, thence by lines 95 and 96 to the motor 15, starting the same and thus bringing the blower and pump into operation.

The current will then pass by line 97 from the motor 15, to binding post 69, and thence, as hereinbefore described, by means of line 98, binding post 70, and line 99, through switch 76, to power lead 75.

When the current passes to the motor as aforesaid, the coil 108 of the solenoid valve 23 will be energized, the current for this purpose passing from line 94, through line 107, thence through coil 108, thence by line 109 to line 97, thus opening the valve and permitting the liquid fuel, under the pressure generated by the pump 16, to pass to the pipe 24, the pressure being regulated and held constant by means of the pressure regulating valve 28.

As the pressure builds up in the pipe 24 which extends to the burner atomizer, said pressure will be transmitted through the pipe 33 to the front end of the piston 36, causing the same to be moved within the cylinder 34 against the tension of the spring 37, and after the pressure has been sufficiently built up to cause the piston to be moved a certain distance, the collar 43 on the piston rod 39 will, by its engagement with the arm 47 of the switch 45, cause the tube 46 of said switch to be tilted, thereby opening the circuit through the electrodes at the right hand end thereof, and closing the circuit through the electrodes at the left hand end thereof.

The current will now pass directly from line 77, by means of line 106, through the electrodes at the left hand end of the tube 46, thence by lines 105 and 96 to the motor 15, thence by line 97, through the path hereinbefore described, to line 99, which is connected, through the switch 76, to power lead 75.

It may here be noted that, inasmuch as the tube 61 has been tilted to make the contact at the right hand end thereof, the coil of the solenoid valve will continue to be energized to maintain said valve in the open position, by means of the current passing from binding post 66, by line 104, through the electrodes at the right hand end of tube 61, thence by line 93 to binding post 67, thence by line 94 to line 107 which is connected to said coil, the remainder of the circuit being established by reason of the connection of line 109 to line 97.

So long as the parts of the stack switch are in the "cold" positions, the current will flow from binding post 71, through line 113, to the primary coil 111 of transformer 112, thence by line 110 to binding post 69, which is connected by various lines, hereinbefore described, to the main power lead 75. Consequently, by reason of the energization of the primary coil 111 of the transformer 112, the high tension current will be caused to pass through lines 29 and 30, to the electrodes 31 and 32, which are disposed in the proper location with respect to the atomizer to ignite the finely divided particles of liquid fuel sprayed therefrom.

After the fuel emerging from the atomizer has been burning for a short time, it will be apparent that the smoke pipe or stack will become heated, causing the tubes 84 and 85 of the stack switch 50 to be tilted, whereupon the circuit theretofore maintained through the electrodes at the left hand end of he tube 84 will be opened, and the circuit controlled by the electrodes at the right hand end of the tube 85 will be closed. The current which comes through line 83 will be shifted, and will pass by means of line 87, through the electrodes cf the tube 85, thence by line 100 to binding post 73, thence by line 101 to the magnet coil 64, thence by line 102 to binding post 69, which is connected by lines hereinbefore described to power lead 75.

It will thus be apparent that when the magnet coil 63 becomes de-energized by the opening of the circuit in which it is included, the energization of the magnet coil 64 will thereafter continue to hold the tube 61 in a position to maintain the circuit through the electrodes at the right hand end thereof, so that the motor will continue to operate and the solenoid control valve will be maintained in the open position.

It will be obvious that when the current is shifted from binding post 71 to binding post 73, by means of the stack switch 50 the circuit in which the primary coil 111 of the transformer 112 is included, will be opened, and no more current will be permitted to pass to the ignition electrodes so long as the parts of the stack switch are in the hot positions.

When either the room temperature or the water temperature has been brought to the proper degree, the circuit controlled by the thermostatic switches 48 and 49 will be opened. Consequently, the current which has been passing to the magnet 64 will be cut off and said magnet will be de-energized.

When the magnet 64 is thus de-energized, the tube 61 will return to its initial position (as shown in Fig. 8), whereby the circuit extending from the binding post 66 through line 104, through the electrodes at the right hand end of tube 61, and by line 93 to binding post 67, will be opened. Consequently, the current will no longer be supplied from line 94 to the coil 108 of the solenoid valve 23, whereupon said valve will be closed, notwithstanding the fact that the motor will continue to operate for a short time, as hereinbefore set forth.

When the solenoid valve is thus closed, the supply of liquid fuel to the burner atomizer 25, through the pipe line 24, will be cut off. When the pressure in the pipe line 24 is thus relieved, there will be a back flow of the liquid fuel from the front end of the cylinder 34, and the piston 36 will thereby be permitted to travel slowly to its initial position at the front end of the cylinder 34, the time period of the return movement of the piston being determined by the adjustment of the regulating valve 35. As the piston 36 approaches its initial position, the collar 44 will encounter the lower end of the arm 47, thereby causing the tube 46 of the mercury switch 45 to be tilted to its initial position. The motor circuit established by the lines 105 and 106 will thus be opened after the proper time interval has elapsed from the time of the closing of the valve 23, and the motor will thus be stopped, this time interval being determined by the return movement of the piston 36, the speed of which is regulatable by means of the valve 35.

The motor operating circuit, during the burning of the residual fuel, may be traced as follows: From the power lead 74, through the switch 76, line 77, line 106, through the electrodes at the left hand end of the tube 46, lines 105 and 96, to the motor 15, line 97, binding post 69, line 98, binding post 70, line 99, and through switch 76 to the power lead 75. It will be noted that, during this phase of the operation, the solenoid valve 23 is closed so that no further fuel is supplied.

I will be seen that there is thus provided a liquid fuel burner, in which there is employed a single motor for operating both the blower and the fuel pump, which, however, is so constructed and arranged that the blower will continue to operate for a definite time period after the supply of fuel has been cut off from the atomizer, to the end that the fire chamber of the furnace will be effectively cleared of unconsumed gases.

The device is also so constructed and arranged that the current is automatically cut off from the ignition electrodes after the fuel has become ignited.

I claim:

1. In a liquid fuel burner, an electric motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, a shut-off valve in said pipe line, and means controlled by the pressure in said pipe line between the shut-off valve and the burner for causing the motor and the blower actuated thereby to be operated for a definite time period after the flow of fuel to the burner is shut off.

2. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, an electrically controlled valve interposed in said pipe line, a motor control switch in said circuit, and slow acting means for actuating said switch controlled by the pressure in the pipe line between the electrically controlled valve and the burner whereby the motor circuit will be maintained for a definite time period after the closing of the electrically controlled valve.

3. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, a pressure regulating valve interposed in said pipe line, an electrically controlled valve interposed in said pipe line between the pressure regulating valve and the burner, a motor control switch in said circuit, and slow acting means for actuating said switch controlled by the pressure in the pipe line between the electrically controlled valve and the burner whereby the motor circuit will be maintained for a definite time period after the closing of the electrically controlled valve.

4. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, an electrically controlled valve interposed in said pipe line between the pump and the burner, means for maintaining the motor circuit for a definite time period after the closing of the electrically controlled valve, said means including a branch pipe line extending from said pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, and a switch in said motor circuit controlled by said piston.

5. In a liquid fuel burner, an electric motor an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, an electrically controlled valve interposed in said pipe line between the pump and the burner, means for maintaining the motor circuit for a definite time period after the closing of the electrically controlled valve, said means including a branch pipe line extending from said pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a

piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, said time period being determined by the return movement of the piston, and a switch in said motor circuit controlled by said piston.

6. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, an electrically controlled valve interposed in said pipe line, a branch pipe line extending from said pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, and an electric switch in the motor circuit and controlled by said piston so constructed and arranged that the motor circuit is maintained for a definite time period after the closing of the electrically controlled valve.

7. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, a pressure regulating valve interposed in said pipe line, an electrically controlled valve interposed in said pipe line between the pressure regulating valve and the burner, a branch pipe line extending from said pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, and an electric switch in the motor circuit and controlled by said piston so constructed and arranged that the motor circuit is maintained for a definite time period after the closing of the electrically controlled valve.

8. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a pipe line extending from the pump to the burner, a pressure regulating valve interposed in said pipe line, an electrically controlled valve interposed in said pipe line between the pressure regulating valve and the burner, a branch pipe line extending from said pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, and an electric switch in the motor circuit and controlled by said piston so constructed and arranged that the motor circuit is maintained for a definite time period after the closing of the electrically controlled valve, said time period being determined by the return movement of the piston.

9. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a main pipe line extending from the pump to the burner, a pressure regulating valve interposed in said pipe line, an overflow pipe line extending from said pressure regulating valve, an electrically controlled valve interposed in the main pipe line between the pressure regulating valve and the burner, an electric switch, and means for actuating said switch controlled by the pressure in the pipe line between the electrically controlled valve and the burner, said switch being adapted to control the motor circuit, and the switch actuating means being timed whereby the motor circuit will be maintained for a definite time period after the closing of the electrically controlled valve.

10. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a main pipe line extending from the pump to the burner, a pressure regulating valve interposed in said pipe line, an overflow pipe line extending from said pressure regulating valve, an electrically controlled valve interposed in the main pipe line between the pressure regulating valve and the burner, a branch pipe line extending from the main pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, and an electric switch controlled by said piston so constructed and arranged that the motor circuit is maintained for a definite time period after the closing of the electrically controlled valve.

11. In a liquid fuel burner, an electric motor, an electric circuit for said motor, an air blower actuated by said motor, a liquid fuel pump also actuated by said motor, a burner, a main pipe line extending from the pump to the burner, a pressure regulating valve interposed in said pipe line, an overflow pipe line extending from said pressure regulating valve, an electrically controlled valve interposed in the main pipe line between the pressure regulating valve and the burner, a branch pipe line extending from the main pipe line between the electrically controlled valve and the burner, a flow regulator in said branch pipe line, a cylinder to which said branch pipe line extends, a piston slidably mounted in said cylinder responsive to pressure changes in the main pipe line, and an electric switch controlled by said piston so constructed and arranged that the motor circuit is maintained for a definite time period after the closing of the electrically controlled valve, said time period being determined by the return movement of the piston.

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