March 20, 1928.

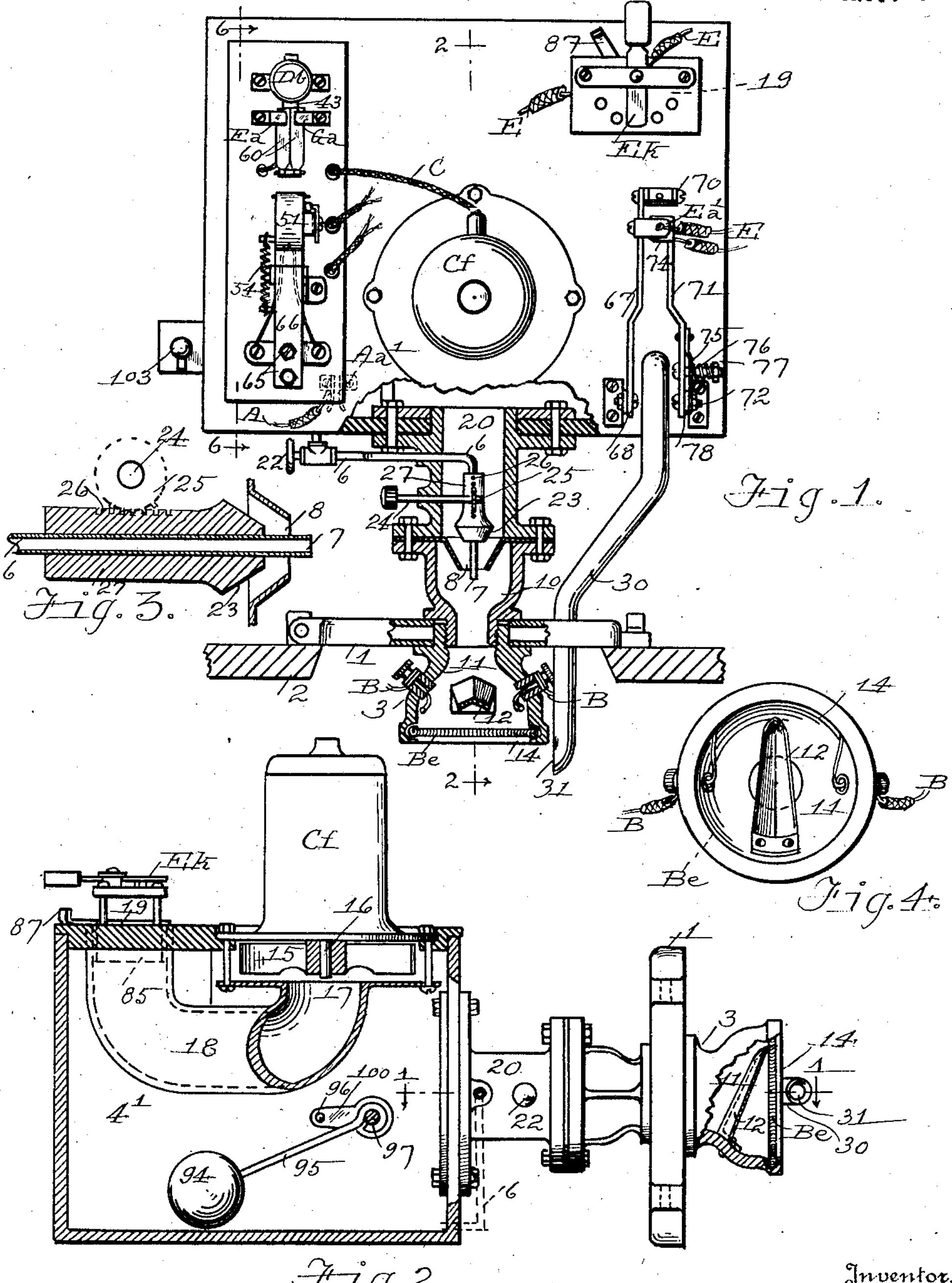
1,663,442

G. K. CULP, JR., ET AL

LIQUID FUEL BURNING HEATER

Filed Nov. 26, 1924

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

Fig. 5.

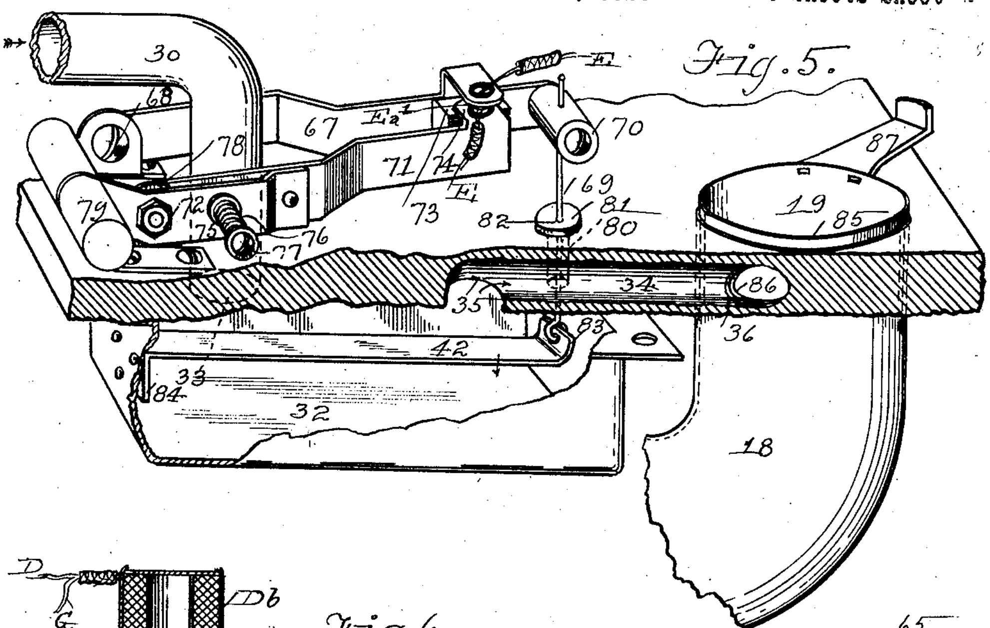

Fig. 6.

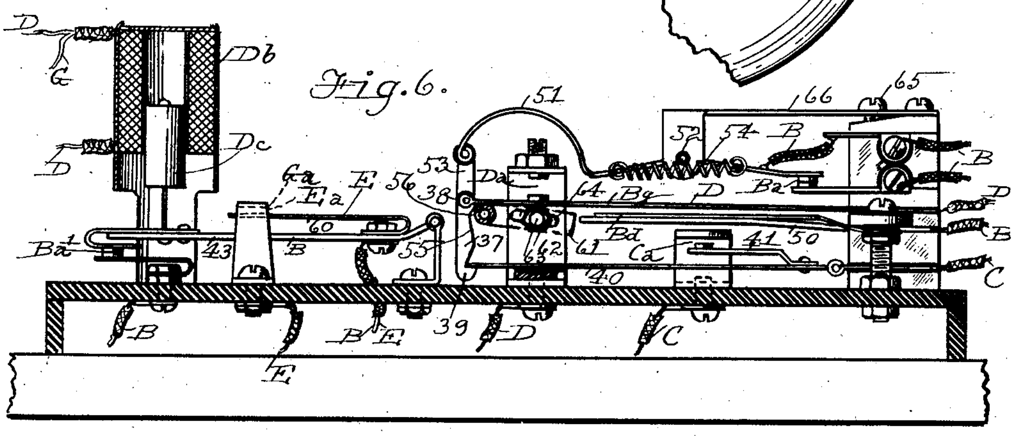

Fig. 7.

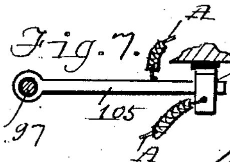

Fig. 8.

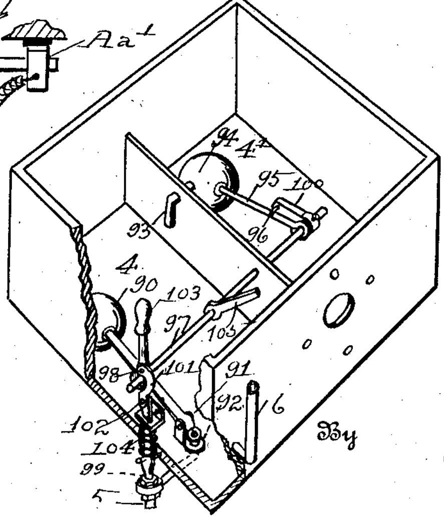

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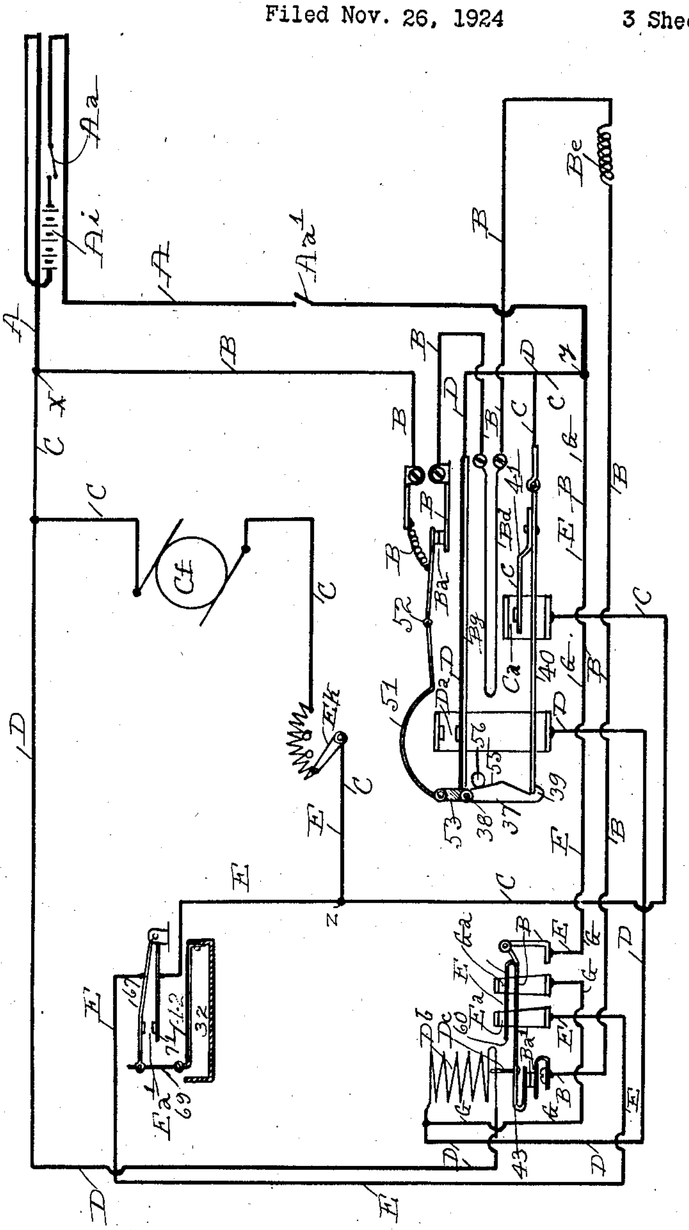
Fig. 9.



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UNITED STATES PATENT OFFICE.

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LIQUID-FUEL-BURNING HEATER.

Application filed November 26, 1924. Serial No. 752,429.

The present invention relates to liquid fuel-burning heaters; and its object is, generally to provide heating apparatus of that character improved in various respects hereinafter appearing; and, more particularly, to provide such apparatus having improved means for projecting a stream of air and liquid fuel to the igniting means therefor; and further, to provide improved means for properly conditioning such stream of fuel and air preparatory to igniting the same; and further, to provide improved means for igniting such fuel; and further, to provide improved operating and controlling means for such apparatus; and further, to provide improved electrical devices and connections for operating, and controlling the operation of, said means.

These and any other objects hereinafter appearing are attained by, and the invention finds preferable embodiment in, the apparatus and devices, mechanical and electric, hereinafter particularly described in the body of this specification and illustrated by the accompanying drawings, in which:

Figure 1 is a top plan view of oil-burning heating apparatus, partially sectioned horizontally on line 1—1 of Figure 2;

Figure 2 is a side view thereof, partially sectioned vertically on line 2—2 of Figure 1;

Figure 3 is a vertical longitudinal sectional view of certain parts, taken on the same line;

Figure 4 is an outer end view of the nozzle of the apparatus;

Figure 5 is a side view of portions of said apparatus, certain parts being broken away;

Figure 6 is a side view of certain of the operating and controlling means of the apparatus, the solenoid shown therein being centrally longitudinally sectioned and the electrically-insulating mounting base for said means being shown in vertical section taken on line 6—6 of Figure 1;

Figure 7 is a detail view of an electric switch;

Figure 8 is a view in perspective of the fuel containing tank of the apparatus, a wall thereof being broken away to show parts in the interior thereof; and

Figure 9 is a diagrammatic representation of electric connections and devices therein, for operating and controlling the apparatus.

Throughout this specification the structural and mechanical parts are, as a rule, identified by numerals, and the electric connections and instruments therein by letters.

In the embodiment of the invention chosen for illustration by the drawings and for detailed description in the body of this specification, the apparatus may, if desired and as indicated in Figure 1, be mounted on the outside of the swinging door 1 of a furnace 2 which may be of the solid-fuel-burning type, the nozzle 3 of the apparatus extending through said door and into the combustion chamber of the furnace. The illustrated apparatus comprises a tank 4 containing the oil which is introduced thereinto in any suitable manner as through the pipe 5 leading from a source of supply, not shown. The oil is slowly driven from this tank through a conduit 6 by pressure exerted within the tank, instead of being drawn through the conduit by other methods such as the creating of a vacuum adjacent the conduit's discharge vent. It will be seen that, by the method used in this invention for driving the oil from the tank, a conduit may be employed having a discharge vent 7 of so large an internal cross-sectional area that an oil may be used so heavy or impure as might choke or clog any pipe's discharge vent whose cross-sectional area is small enough to be completely filled by the oil stream passing therethrough, such complete-filling being necessary in other apparatus wherein the oil is drawn through a pipe by means of a vacuum created adjacent its discharge vent. Furthermore: In other apparatus wherein the oil is driven from behind through a discharge vent in a stream moving very rapidly, such vent must be much smaller cross-sectionally and thus much more liable to choking or clogging (where a heavy or impure oil is used) than in the illustrated apparatus of the present invention wherein the oil moves very slowly.

The oil stream thus discharged from the conduit's vent 7 is minutely divided by, and intimately commingled with, an air stream rapidly discharged through an outwardly-tapering discharge vent 8 surrounding the oil conduit 6 adjacent its vent 7;

and the air and oil in such intimately commingled condition are driven through the nozzle 3 of the apparatus. This nozzle 3 first contracts gradually beyond the vents 7 and 8, as shown at 10, such shaping of this portion of the nozzle thus serving to more intimately commingle the oil and air. The stream of oil and air, thus properly conditioned, now passes through the expanded outer portion 11 of the nozzle and is deflected by a baffle 12 located centrally of said expanded portion, the velocity of the stream being thus lessened to a degree wherein it is readily ignited by the igniting element, the electric coil Be, axially circular or arcuate as shown and located adjacent the mouth of the nozzle 3, said coil becoming incandescent when electrically energized to fire the stream as it issues from the mouth of the nozzle and is projected into the furnace's interior.

It will be seen that the oil alone and before becoming finely divided and thoroughly commingled in proper portions with the air stream is not ignited; but that the stream of oil and air thus properly conditioned is ignited by the coil Be as it issues from the mouth of the nozzle 3. Both the oil and the air are forced through the vents 7 and 8 respectively and are commingled as aforesaid by means of a rotary air pump or fan 15 inside the tank 4 and carried by the shaft 16 of an electric motor indicated at Cf. This fan draws air through a pipe 18 having the inlet 19 from the outside atmosphere and an outlet 17 adjacent the axis of the fan, and discharges the air through a pipe 20 leading from the tank above the level of the oil therein and having the tapering discharge vent 8 aforesaid. The air pressure in the tank created by operating this fan thus not only drives the air rapidly through said vent 8, but also, acting on the surface of the oil, drives the same slowly through the conduit 6, leading from near the bottom of the tank, and through said conduit's vent 7. The volume of oil passing through the apparatus and the velocity thereof may be controlled by the adjustable valve indicated at 22 in the oil conduit 6; and the volume of air passing through the apparatus and the velocity thereof may be controlled by the conical valve 23 surrounding and slidably movable along the conduit 6, and thus adjustable relatively to the inner surface of the tapering vent 8 by turning the shaft 24 carrying a small gear 25 meshing with a rack 26 on the stem 27 of said valve.

A circuitous movement of gases heated by the burning stream issuing from the nozzle 3 is provided (as and for the purpose hereinafter explained) through the following continuous air passages: A pipe 30 closely adjacent the mouth 14 of the nozzle 3 and having an intake port 31; a chamber 32 receiving the heated gases from the discharge vent 33 of pipe 30; a conduit 34 receiving the gases at its intake 35 from said chamber; and the main air pipe 18 receiving the gases from said conduit's vent 36 and returning them, now more or less cooled, to the fan, which forces such gases with air from the outside atmosphere through the vent 8.

The illustrated apparatus is operated, and various hereinafter explained controlling devices thereof function, by the following means and in the following manner and sequence, reference being had to the views showing structural and mechanical parts, and particularly to Figure 9 showing diagrammatically the operating electric circuits and electrically-energized instruments therein.

The main electric line A containing a suitable source of electric energy Ai may be closed and opened by a switch Aa, either manually or thermically operated. When line A is closed, its branch or extension circuit B (joining said main line at x and y) conducts the electric current through the closed switch Ba to and through the heating element (the filament Bd supported on a shelf 50) and the igniting coil Be, and through the closed swith Ba^1 and lever arm 43 to the main line A again. The hot element Bd now flexes the thermostat Bg upwardly, and by means of the link 37, pivotally mounted thereon at 38, whose hooked lower end 39 engages beneath a movable member, the lever arm 40, raises said arm carrying the spring switch arm 41 and thus closes the open switch Ca and the temporarily energized motor-containing circuit C branching from the main line A at x and y and containing the fan-operating electric motor Cf. The motor being now (and temporarily as hereinafter explained) energized, the oil and air stream is forced past the igniting coil Be (already heated to incandescence) and is thereby ignited; and the flaming stream issuing from the mouth of the nozzle 3 heats the gases adjacent the mouth 14 of the nozzle and the intake port 31 of the pipe 30 to such a degree that when such gases are drawn by the fan circuitously through the pipe 30 and chamber 32, the thermostat 42 in said chamber is thereby flexed downwardly, thus closing the switch Ea^1 in the circuit E containing the motor and energizing the same in its regular operation, this circuit E joining the main line A at y and the circuit C at z. Although the intake 31 of the pipe 30 is desirably closely adjacent the mouth 14 of the nozzle 3 (as shown by the drawings) to thus more certainly insure the heating of the gases sufficiently to flex the thermostat 42 to close the switch Ea^1, it will be understood that it is only necessary to heat the circulating gases in some manner by the burning fuel to a sufficient degree to thus flex said thermostat. This circuit E, now closed at the switch Ea^1, is still open at its other switch E*a*, and the motor C*f* continues in operation by means of the circuit C remaining closed by the switch C*a*. When and not until the circuitous movement of heated gases has continued long enough to insure the maintaining of the switch Ea^1 in closed position, the thermostat B*g* further flexes upwardly sufficiently to suddenly open the switch B*a* by means of a lever arm 51 pivotally mounted at 52 and connected to said thermostat by a link 53, a contractile spring 54 connected to said arm and switch suddenly throwing this switch open when the upward movement of said arm carries this spring above said pivotal mounting 52, the arm 51 closing said switch when its downward movement carries this spring below said pivotal mounting. The opening of the switch B*a* opens the circuit B and thus deenergizes the heating element B*d* and the igniting element B*e*.

The same upward movement of the thermostat B*g* which thus opens the switch B*a* also closes the switch D*a* in the circuit D branching from the main line A at *x* and *y* and including said thermostat B*g* and an electromagnet, the solenoid D*b*, and temporarily energizing this solenoid, whose armature D*c* is connected to the lever arm 43, and thereby raises said arm to close by its spring switch arm 60 the switch E*a* in the branch circuit E including said spring arm 60 and the motor and thus energizing the motor in its regular operation. Inasmuch as the switch B*a* in circuit B is now closed, the same movement of the lever arm 43 which closes the switch E*a* also opens the switch Ba^1 in circuit B which includes the heating element B*d* and the igniting element B*e*, so that said elements may remain deenergized during the regular operation of the apparatus.

As the thermostat B*g* flexes upwardly to open the switch B*a* and to close the switch D*a*, the link 37 is swung, by the sliding contact of its inclined surface 55 on the tripping member 56, outwardly far enough to disengage its hook 39 from the lever arm 40, which arm thereupon falls to its initial position and thus opens the switch C*a;* and the cooling of the thermostat B*g* causes it to flex downwardly to its initial position in which its hook 39 automatically again engages beneath the lever arm 40 in readiness for a subsequent initiating of the operation of the apparatus.

Inasmuch as the opening of the switch D*a* by the downward flexing of the thermostat B*g* opens the circuit D which has temporarily energized the solenoid D*b* to close the switch E*a* and thus the circuit E energizing the motor in its regular operation, the circuit G, joining the main line A at *x* and *y* and including the spring arm 60 and said solenoid is closed by closing the switch G*a* by the same movement of the lever arm 43 which closes the switch E*a*, so that the solenoid continues energized to maintain the lever arm 43 in raised position (in which it closes the circuit E) during the regular operation of the motor.

It will be seen that, inasmuch as the igniting element B*e* becomes hot enough to ignite the fuel before the thermostat B*g* has been heated by the element B*d* sufficiently to raise the lever arm 40 far enough to close the switch C*a* and thereby the circuit C which temporarily energizes the motor, the fuel can not be projected from the nozzle 3 without being ignited. Furthermore, it will be seen that the burning fuel heats the gases adjacent the nozzle's mouth 14 and the intake 31 of the pipe 30 to such a degree that, when drawn through the chamber 32, the thermostat 42 is flexed thereby to close the switch Ea^1 in the circuit E (preparatory to energizing the motor in its regular operation) before the thermostat B*g* is hot enough to rise further to effect other operations; and that this safety switch Ea^1 remains closed so long as the fuel issuing from the nozzle 3 is burning. Should the stream of fuel issuing from the nozzle 3 cease for any cause to burn, the gases adjacent its mouth and the pipe 30 and passing therethrough will instantly, or almost so, cool sufficiently to permit the thermostat 42 to flex upwardly far enough to open the switch Ea^1 thus opening the circuit E which energizes the motor in its regular operation, so that the fuel will cease to flow.

Furthermore: When the motor has been thus deenergized, the draft through the furnace and up its chimney flue or other hot air vent will instantly draw cool air through the intake port 19 from the outside atmosphere through the chamber 32 and into the furnace, thus hastening the further cooling and upward flexing of the thermostat 42 to its initial position preparatory to the next initiating of the apparatus' operation.

It will be understood that said gases adjacent the mouth of the nozzle 3 and the pipe 30 are heated directly by the flaming fuel to the degree necessary to flex thermostat 42 sufficiently to close switch Ea^1; that is, the said gases are never hot enough to flex the thermostat 42 sufficiently to close the switch Ea^1 and maintain it closed, unless the fuel issuing from said nozzle is actually aflame; for the heated condition of the furnace generally, or of any other parts of the structure, is never great enough to thus operate said thermostat, properly adjusted, in the absence of the flaming condition of the fuel stream.

It will be seen that this thermostat is not positioned within the furnace or its chimney flue or other hot air vent, and therefore is not operatively subject to the caloric conditions prevailing generally therein; but said thermostat is remote from the furnace and its chimney flue or hot air vent, being located in a channel through which the heated gases pass immediately from such near proximity to the flaming fuel as to be heated to thermostat-operating degree only by the actual burning of the fuel; the thermostat's action being so completely independent of caloric conditions prevailing in the furnace that it will operate to govern the switch Ea^1 even though the nozzle 3 opens into the outside atmosphere, no furnace being included in the installation.

It will be seen that after the regular operation of the apparatus has once been initiated in the manner explained and by the means described, the thermostat Bg falls to its initial position, opening the switches Ca and Da and closing the switch Ba, so that should the switch Aa (or any switch in main line A) be opened manually or by thermical or other operation, the apparatus and its motor will cease to operate, and the switch Ba^1 will close by reason of the solenoid being deenergized, thus putting the apparatus in condition for a subsequent operation, which operation cannot be resumed otherwise than by initiating the same again in the manner above described.

It will be understood that, the interrelative proportions of oil and air being adjusted properly by the valves 22 and 23 respectively, the same may be driven in like proportions through the nozzle 3 in desired volume and with desired rapidity by adjusting the rheostat Ek in the circuit E. Various other parts shown by the drawings and more or less subsidiary to those already described, are the following:

The degree of the upward flexing movement of the thermostat Bg necessary to swing the link 37 outwardly to release the lever arm 40, and thus the timing of such release, may be governed by adjusting the bar 61, which carries the tripping member 56, by means of the nut 62 on the threaded post 63 supporting said bar and passing through its slot 64; and the degree of the swinging movement of the lever arm 51 necessary to open and close the switch Ba, and thus the timing of such opening and closing, may be governed by springing down, by the set screw 65, the spring arm 66 on which said lever arm is pivotally mounted at 52. The upper contact point of the switch Ea^1 is carried by a lever arm 67 pivotally mounted at 68 and connected to the thermostat 42 by a rod or link 69 pivoted at 70 on said arm. The lower contact point of said switch is carried by a lever arm 71 pivotally mounted at 72 and having a slight swinging movement at its contact point-carrying end relatively to the arm 67, such relative movement being limited by said upper contact point and by the stop or ledge 73 of the arm 67 underlying the lateral extension 74 of the arm 71, as shown in Figure 5. The swinging movement of the arm 71 is braked or frictionally resisted by its spring portion 75 pressed yieldingly, by the spring 76 whose tension is adjustable by the nut 77, against the post 78 on which this arm is pivoted at 72. It will be seen that as the lever arm 67 swings upwardly under the action of the cooling thermostat 42 the switch Ea^1 is opened and the lever arm 71 is thereupon swung upwardly by the stop 73 engaging its extension 74; but as the heated thermostat 42 swings the lever arm 67 downwardly, this switch is quickly closed in whatever swung position these lever arms may be at the time the downward movement of the arm 67 begins. The lever arm may be counterbalanced at 79 as shown in Figure 5.

In order that the chamber 32 may confine the heated gases as completely as possible in their passage therethrough, the opening 80 through which the rod or link 69 extends is covered by a disk 81 lying on the upper surface of the apparatus and having an opening 82 through which the link 69 extends and in which it slidably fits. This disk is adapted to slide slightly on said surface in the lateral movement of the link 69 occasioned by the swinging of the lever arm 67 and the thermostat 42. In order that this link may be thus moved laterally as slightly as possible, the free end 83 of this rheostat extends upwardly, as shown, so that as the thermostat flexes and therefore shortens, its said free end may be inclined further outwardly, thus to maintain constant the distance between the thermostat's mounting point at 84 and the point at its free end 83 to which the link is connected. A valve is provided for the conduit 34 comprising a hollow cylinder 85 turnably mounted inside the air conduit 18 and having an opening 86, registering with the vent 36 of the conduit 34, so that the cylinder 85 may be turned by its handle 87 to close to the desired degree the passage from the conduit 34 to the conduit 18.

The oil-containing tank 4 is provided with a float 90 swingably mounted at 91 to open and close a valve indicated at 92 in the usual manner; and an auxiliary oil tank 4^1 is provided having an inlet port through a pipe 93 from the main tank 4, so that should the oil in the main tank 4 reach the level of this port 93 the auxiliary tank 4^1 begins to fill. When the tank 4^1 has filled to a determined level, the float 94 therein swings its carrying arm 95 upwardly into engagement with a lug 96 on an arm 100 of the rotatably mounted shaft 97 whose eccentrically positioned pin 98 forces the valve indicated at 99 downwardly, through the link 101 pivotally mounted on said pin and connected at 102 to the stem of said valve, and thus closes the oil-supplying pipe 5.

This valve 99 may be operated manually by the handle 103 turnable about the axis of the shaft 97 and adapted to open said valve against the pressure of a spring 104.

An electric switch indicated at Aa^1 in the main line A may be provided to open said circuit by the rising movement of the float 90, whenever the oil in tank 4 rises high enough to flow into the auxiliary tank 4^1. This switch comprises the arm 105 carried by the shaft 97 adapted to contact with the split member of the switch indicated in dotted lines in Figure 1.

As indicated in Figures 1 and 2, the body of the apparatus may be spaced outwardly from the furnace so as to provide a considerable air space therebetween to keep the apparatus and the oil therein cool.

It will be seen that the discharge vent 7 of the oil conduit extends outwardly beyond the discharge vent 8 of the air conduit, so that the flow of air through the air conduit's said vent will not create back pressure on the oil issuing from the oil conduit. The baffle 12 creates an eddying of the stream passing thereby and adjacent the igniting element, so that the stream at such eddying and adjacent the base of the baffle at its outer side is readily kindled.

The thermically-operated electric switch illustrated in Figure 5 is not claimed in this application but is made the subject of a separate application.

The invention being intended to be pointed out in the claims, is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings or hereinbefore described.

What is claimed is:

1. In apparatus of the character described: a combustion chamber; fuel-igniting means; means for propelling fuel to the igniting means and into the chamber; thermically-controlled means for maintaining the operation of the fuel-propelling means; a conduit adapted to convey to the thermically-controlled means gases heated directly by the flaming fuel to a degree sufficient to operate the thermically-controlled means to maintain the operation of the fuel-propelling means.

2. In apparatus of the character described: a combustion chamber; fuel-igniting means; means for propelling fuel to the igniting means and into the chamber; thermically-controlled means outside the chamber for maintaining the operation of the fuel-propelling means; a conduit adapted to convey to the thermically-controlled means gases heated directly by the flaming fuel to a degree sufficient to operate the thermically-controlled means to maintain the operation of the fuel-propelling means.

3. In apparatus of the character described: a combustion chamber; fuel-igniting means; means for propelling fuel to the igniting means and into the chamber; thermically-controlled means outside the chamber for maintaining the operation of the fuel-propelling means; a conduit adapted to convey to the thermically-controlled means gases heated directly in the chamber by the flaming fuel to a degree sufficient to operate the thermically-controlled means to maintain the operation of the fuel-propelling means.

4. In a burner of the character described: fuel-igniting means; means for propelling fuel to the igniting means; thermically-controlled means for maintaining the operation of the fuel-propelling means; means for circulating through the operative field of the thermically-controlled means gases heated directly by the flaming fuel to a degree sufficient to operate the thermically-operated means to maintain the operation of the fuel-propelling means.

5. In a burner of the character described: fuel-igniting means; means for propelling fuel to the igniting means; thermically-controlled means for maintaining the operation of the fuel-propelling means; means for circulating, by the operation of the fuel-propelling means, through the operative field of the thermically-controlled means gases heated directly by the flaming fuel to a degree sufficient to operate the thermically-operated means to maintain the operation of the fuel-propelling means.

6. In a burner of the character described: fuel-igniting means; means for propelling fuel to the igniting means; thermically-controlled means for maintaining the operation of the fuel-propelling means; a conduit adapted to convey to the thermically-controlled means gases heated directly by the flaming fuel to a degree sufficient to operate the thermically-operated means to maintain the operation of the fuel-propelling means, said gases being propelled through the conduit by said fuel-propelling means.

7. In a burner of the character described: electric fuel-igniting means; a fuel conduit leading to a discharge vent adjacent said means; electric means for propelling the fuel through the conduit to said means; an electric circuit containing the igniting means and electric heating means and having a first switch and a second switch; a second electric circuit containing the fuel-propelling means and having a third switch; a movable member; a thermostat having means for automatically engaging said member and, when heated by the heating means, moving said member to close the third

switch; a third electric circuit having a fourth switch closed by the further movement in the same direction of the thermostat and containing an electromagnet operating to open the second switch; a fourth electric circuit containing the fuel-propelling means and having a fifth switch closed by the magnet and a sixth switch; a fifth electric circuit containing the magnet and having a seventh switch closed by the magnet; a second thermostat; a conduit conveying to the second thermostat gases heated by the flaming fuel sufficiently to operate the second thermostat to close the sixth switch; means for disengaging the first thermostat's said means from said member to open the third switch after the gases have heated the second thermostat to the sufficient degree aforesaid; the said further movement of the first thermostat opening the first switch and its return movement closing the same.

8. In a burner of the character described: electric fuel-igniting means; a fuel conduit leading to a discharge vent adjacent said means; electric means for propelling the fuel through the conduit to said means; an electric circuit containing the igniting means and electric heating means; an electric circuit containing the fuel-propelling means and having a switch; a thermostat having a movement, when heated by the heating means, to close the switch.

9. In a burner of the character described: electric fuel-igniting means; a fuel conduit leading to a discharge vent adjacent said means; electric means for propelling the fuel through the conduit to said means; an electric circuit containing the igniting means and electric heating means; an electric circuit containing the fuel-propelling means and having a switch and a second switch; a thermostat having a movement, when heated by said heating means, to close the first-mentioned switch; a second thermostat; a conduit conveying to the second thermostat gases heated by the flaming fuel sufficiently to operate the second thermostat to close the second-mentioned switch.

10. In apparatus of the character described; a combustion chamber; fuel-igniting means; means for propelling fuel through a nozzle to the igniting means and into the chamber; thermically-controlled means for maintaining the operation of the fuel-propelling means; a conduit having an intake adjacent the nozzle and adapted to convey to the thermically-controlled means gases heated directly by the flaming fuel to a degree sufficient to operate the thermically-controlled means to maintain the operation of the fuel-propelling means.

11. In apparatus of the character described: fuel-igniting means; means for propelling fuel through a nozzle to the igniting means; thermically-controlled means for maintaining the operation of the fuel-propelling means; the apparatus having a passage adapted to convey from adjacent the nozzle to the thermically-controlled means gases heated directly by the flaming fuel, and the thermically-controlled means being so adjusted as to maintain the operation of the fuel-propelling means only when said gases are heated by the flaming fuel sufficiently to operate the thermically-controlled means.

12. In electrical means for controlling the operation of oil burning apparatus, an oil burner, an electrical motor for delivering fuel to said burner, an electrical igniter, a thermostat, a switch controlled by said thermostat, an electrically heated expansion motor in circuit with said switch, a motor starting switch and a motor running switch in parallel relation for controlling the burner motor, said expansion motor being arranged to close both of said motor switches and to cause the opening of the motor starting switch after a predetermined length of time, and a thermostat subjected to the heat of combustion and arranged to render the motor running switch effective or ineffective.

In testimony whereof we have hereunto set our hands at Hamilton, Missouri, this 17th day of November, 1924.

GEORGE K. CULP, Jr.
GALEN D. BARKER.
WILLIAM J. STURGIS.