

Nov. 19, 1929.

G. D. SUNDSTRAND
AUTOMATIC OIL BURNER

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Original Filed Dec. 2, 1925 8 Sheets-Sheet 2

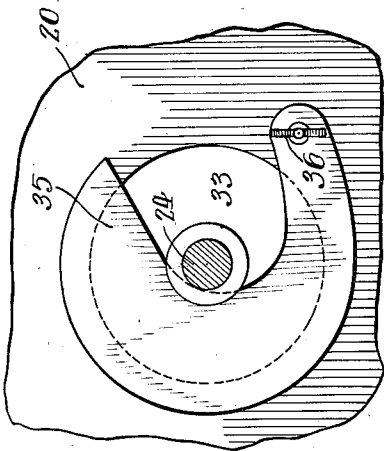
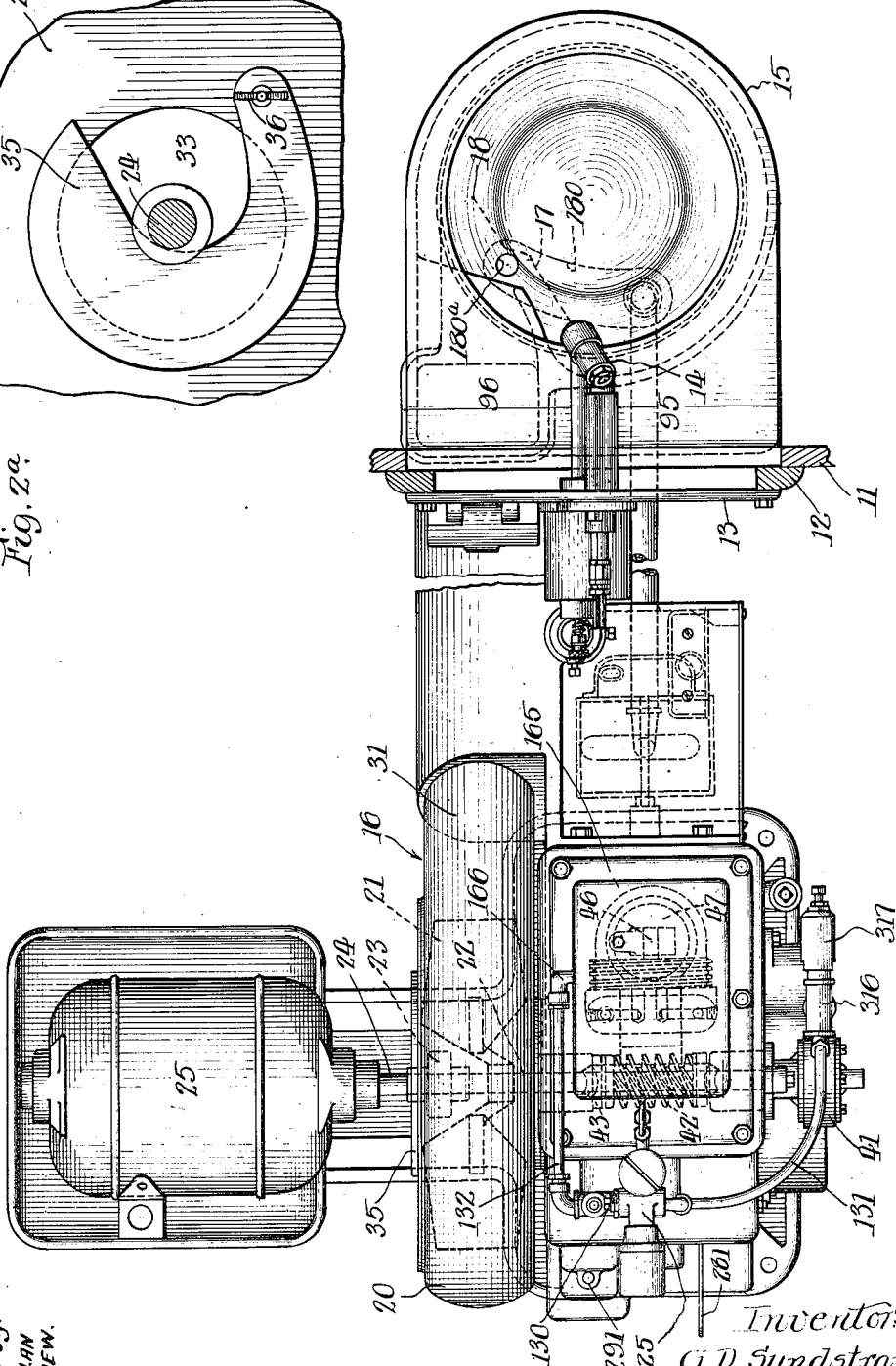


Fig. 2a.

Fig. 2.
PLAN
VIEW.



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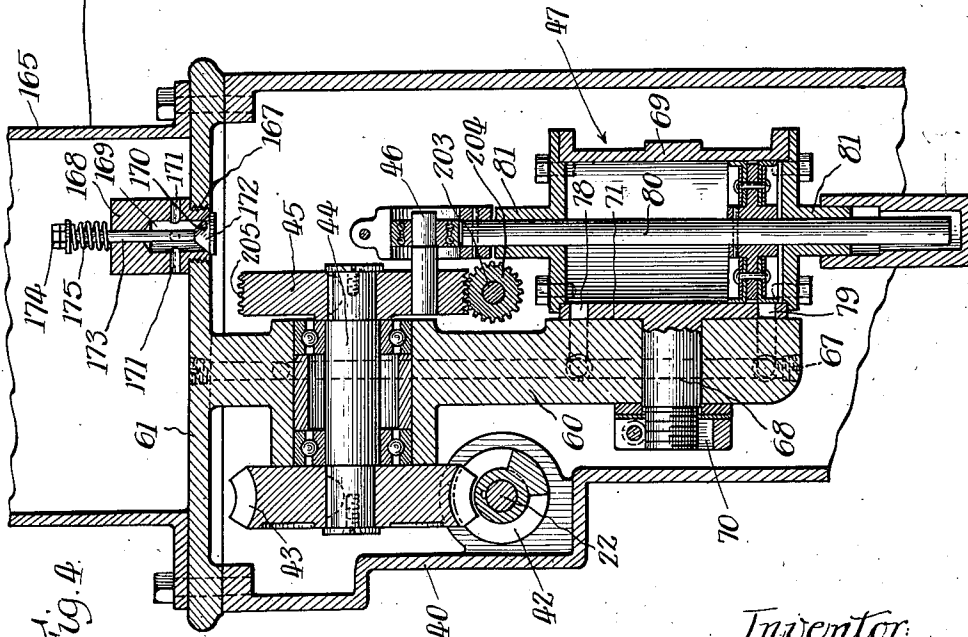
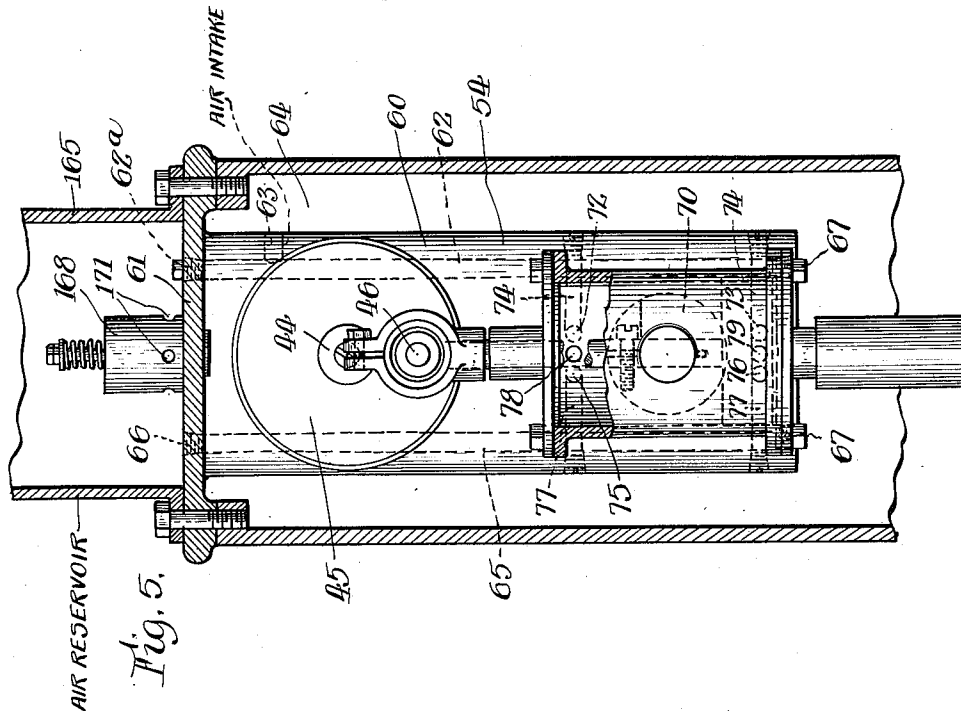
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AUTOMATIC OIL BURNER

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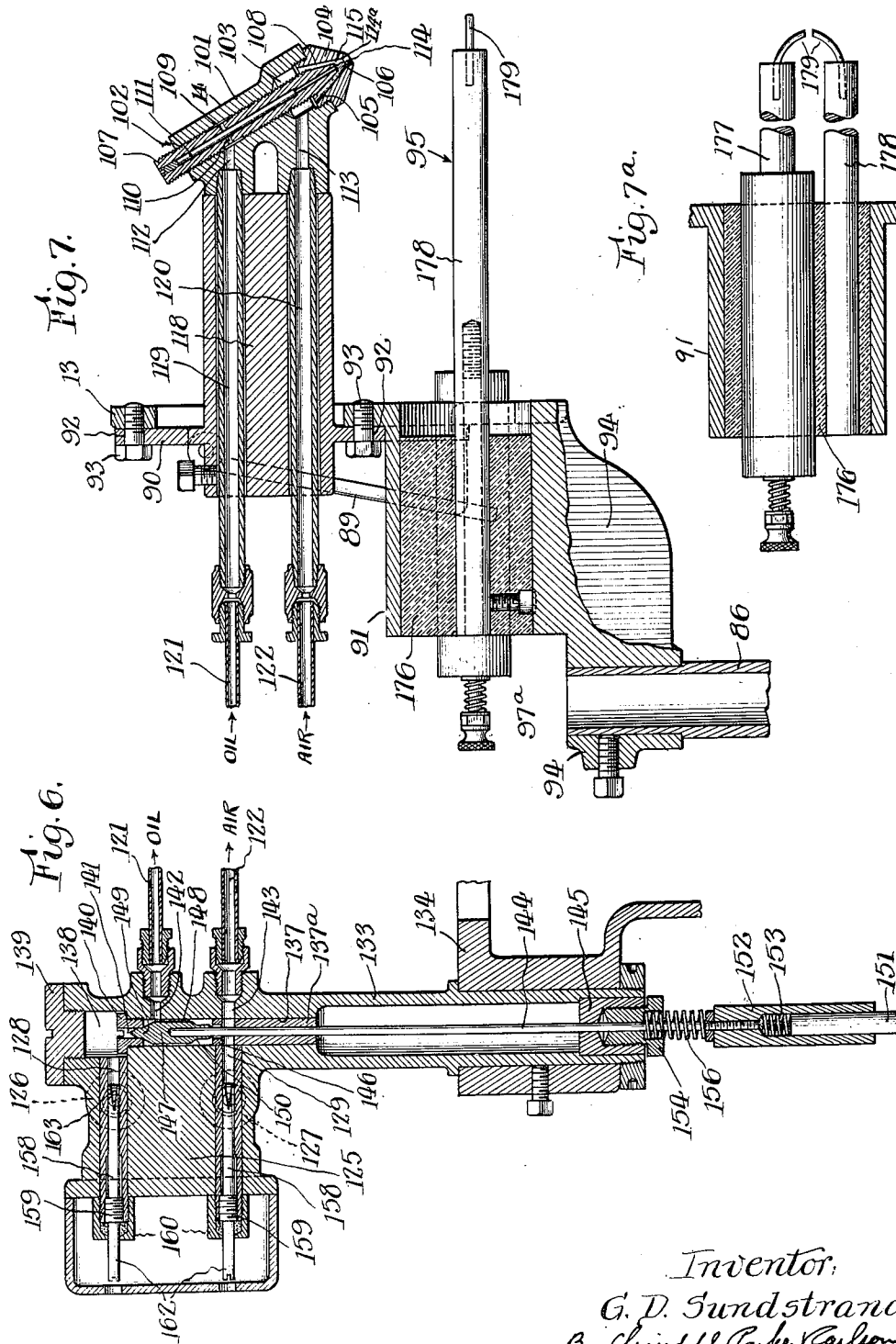
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AUTOMATIC OIL BURNER

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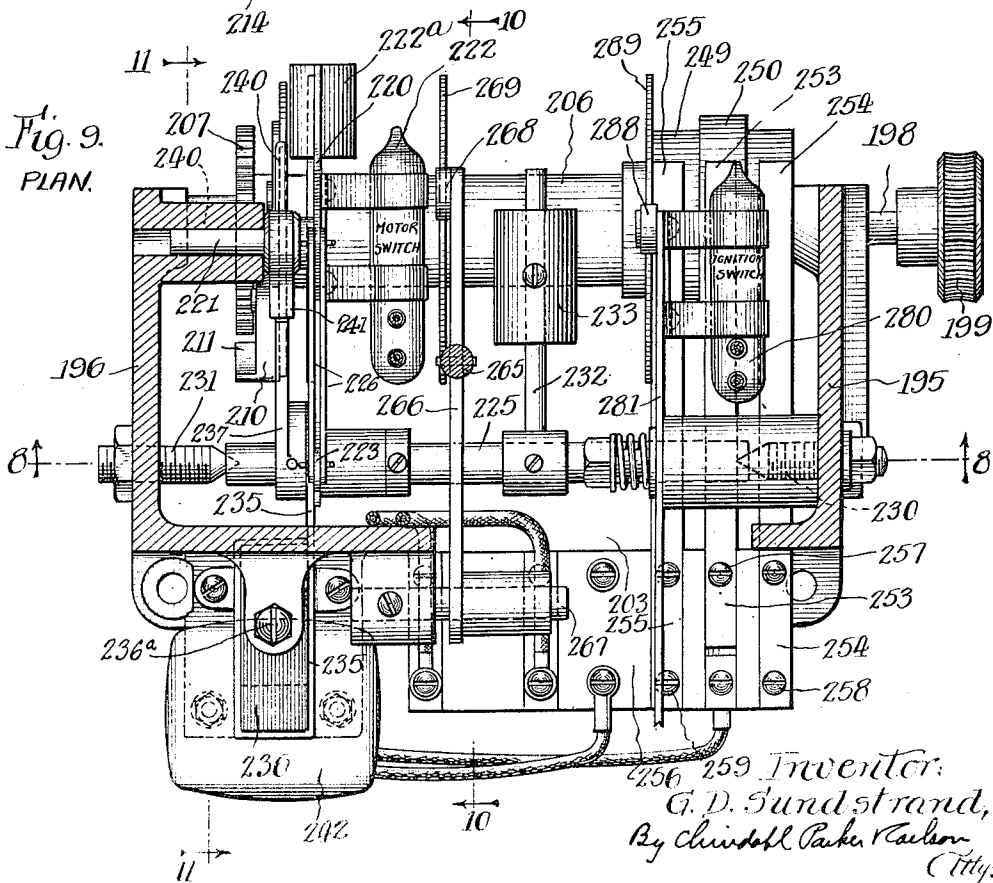
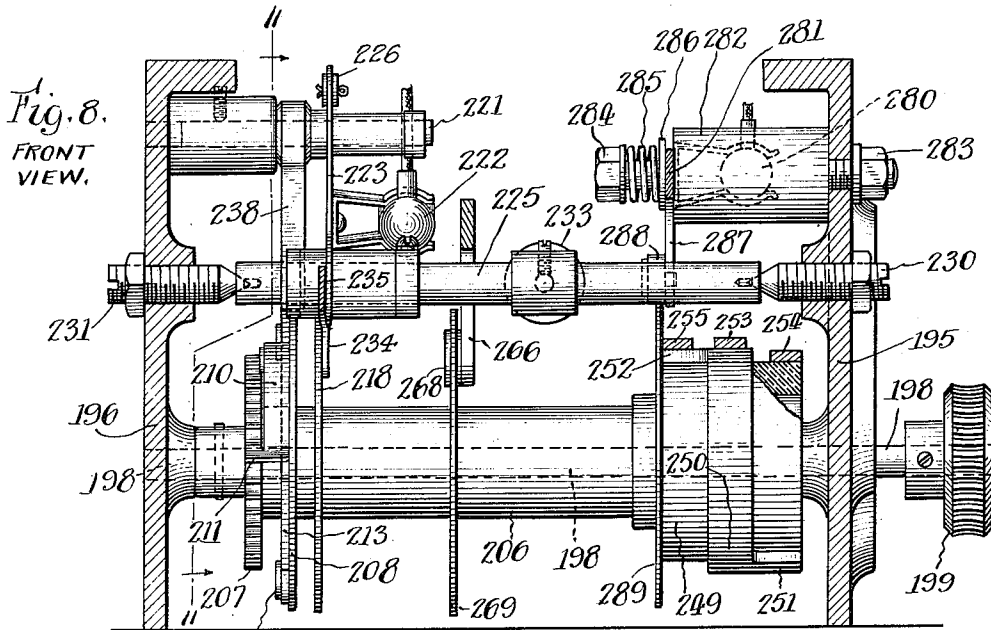
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AUTOMATIC OIL BURNER

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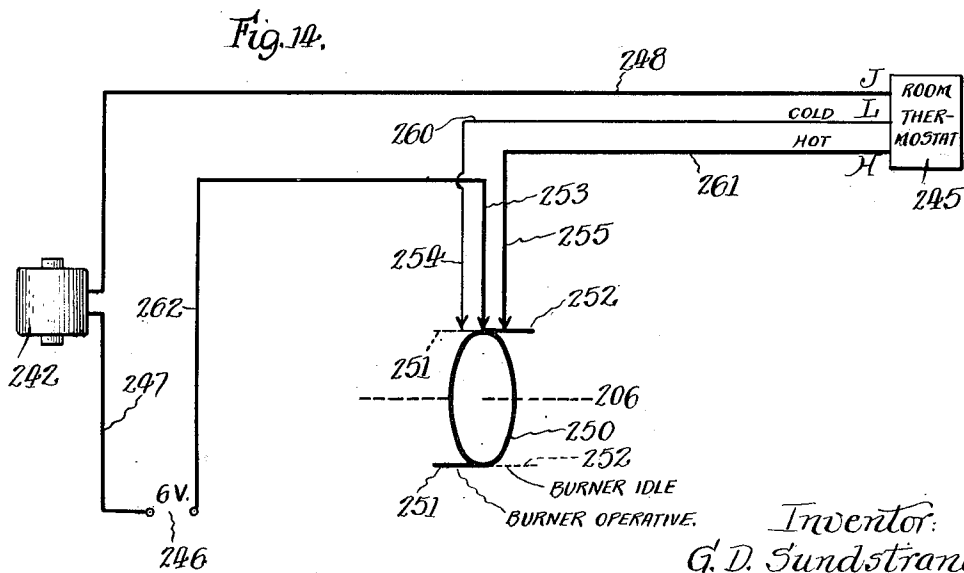
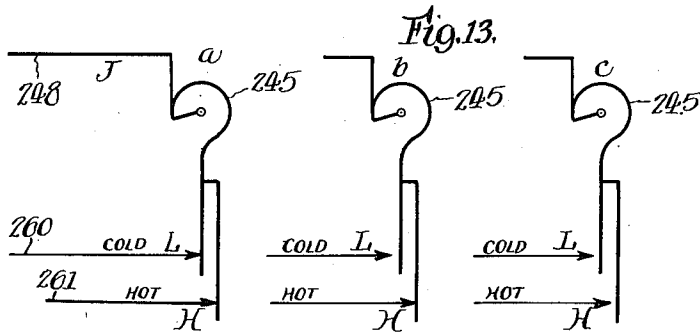
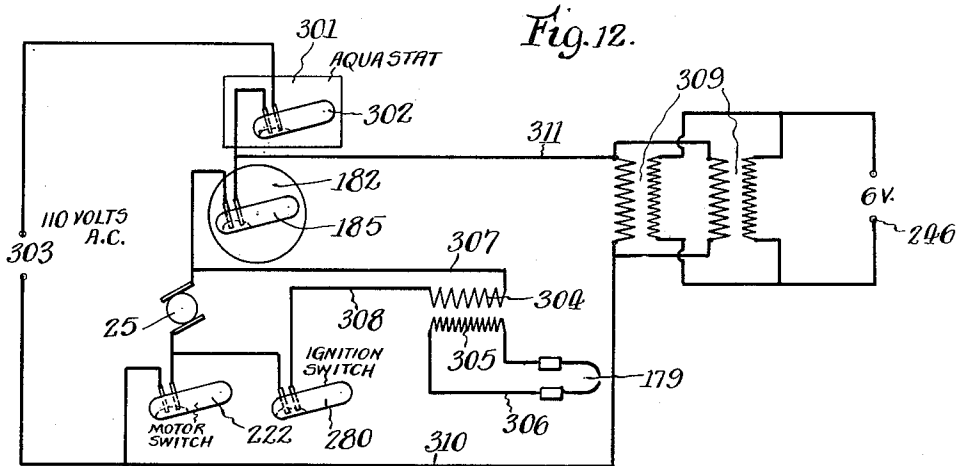
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UNITED STATES PATENT OFFICE

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AUTOMATIC OIL BURNER

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The present invention relates generally to oil burners and especially to the type of burner which is usually associated with automatic controlling mechanism. The invention relates more specially to that type of self-controlled burner which is adapted to maintain a predetermined degree of heat within a very narrow range of temperature without the intervention of an attendant, unless some emergency defect arises, in which instance the burner is adapted to become inoperative and non-responsive to the starting control.

The general object of the invention is to provide a noiseless and efficient combustion, and a suitable mechanism for furnishing oil and air for combustion, together with an automatic controlling system providing perfect control over the burner in normal and in emergency conditions.

Another object is to provide an oil-burning apparatus which is capable of burning relatively heavy fuel oil, as, for example, oil of 18° to 24° Baumé gravity.

Still another object of the invention is the provision of a fuel control and delivery system which ensures that no oil remains in the nozzle on shutting off the supply thereto, thereby preventing the nozzle from accumulating residues therein by the action of heat upon oil which otherwise would be retained within the nozzle.

A further object is the provision of a mechanical control device operated directly from the moving burner parts and disengageable therefrom by a thermostatically controlled clutch mechanism.

It is another object of the invention to provide a device which will recycle the burner through stopping and starting actions when its normal operation during combustion is prevented by an interruption in the line power.

A further object is to provide a control device responsive to a type of thermostat which requires a small current through the thermostat during burner operation, the control device being arranged so that a defect in the thermostat circuit is effective to shut off the burner.

Still another object of the invention is to

provide, in combination with a normally continuously acting ignition means, a device capable of cutting out the ignition at will at a time only when it is not absolutely necessary, which device is operative automatically to place the ignition means again into operation when its function is required.

Various other objects and advantages of the invention will be apparent after an understanding of the invention as hereinafter explained fully and in detail, with reference to a preferred embodiment of the invention shown in the accompanying drawings primarily for the purpose of explanation.

The preferred embodiment of the invention comprises a nozzle, a burner bowl, an ignition means, a motor, a blower, an air pump, means for supplying oil under pressure, a control mechanism, and a controlled clutch connection between the control mechanism and the driving power, a thermostat for starting and stopping the burner through the control mechanism, and certain safety devices and constructions which avoid the usual and the emergency hazards of burner operation. The various safety units include a shut-off mechanism operated by an accumulation of unconsumed oil, a heater control which stops operation of the burner when excessive heat is produced regardless of the temperature of the normal controlling thermostat, a recycling device which causes the burner to pass through the igniting and starting actions in case there is an interruption in the line power during the operation of the burner, and a cut-out device which operates to stop the burner when there is a defective circuit to the controlling thermostat or in any other circuits essential to the proper control of the burner.

Although the foregoing enumeration of the parts of the burner refers to certain devices, mechanisms or constructions having different functions, it is to be understood that these parts are not independent parts assembled together into an operative unit, but they are rather individually active constructions having many parts in common which have overlapping and dual functions. This results from the provision of simple structural

forms embodying the principles of the various functional units coordinated with a proper arrangement of the electrical circuits and electrically operated devices.

Although the various functional units may overlap in construction in the combinations used, it is to be understood that the following description of an exemplary or preferred embodiment of the invention as illustrated in the accompanying drawings is not to be construed as a limitation of the invention to the form herein disclosed and hereinafter described. One familiar with the art will readily conceive of other arrangements and alternative constructions of the functional units. Therefore the following description is to be taken merely as explanatory of the invention, the scope of which is determined by the appended claims.

In the accompanying drawings, Figure 1 is a front elevation of an apparatus embodying the features of my invention.

Fig. 1^a illustrates an alternative arrangement for forcing oil to the nozzle.

Fig. 2 is a plan view of the form of apparatus shown in Fig. 1, parts being broken away to shorten the view.

Fig. 2^a is a fragmental view illustrating an adjustable air intake for the blower.

Fig. 3 is a side elevation of the apparatus shown in Fig. 2, parts being broken away to shorten the view.

Fig. 3^a is a detail view of a safety device operated by the weight of unconsumed oil.

Fig. 3^b is a section on line *b-b* of Fig. 3^a.

Figs. 4 and 5 are sectional views illustrating the air pump and related parts.

Fig. 6 is a vertical sectional view of a valve mechanism for controlling the flow of oil and air to the nozzle.

Fig. 7 is a sectional view illustrating the nozzle and the igniter.

Fig. 7^a is a horizontal sectional view of the igniter.

Fig. 8 is a front view of the control mechanism, the view being taken approximately in the plane of line 8-8 of Fig. 9 and line 8-8 of Fig. 10. The parts are in position shown in Fig. 11.

Fig. 9 is a plan view of the control mechanism.

Fig. 10 is a vertical sectional view of the control mechanism taken approximately in the plane of line 10-10 of Fig. 9.

Fig. 10^a is a detail view of a certain detent.

Fig. 10^b is a fragmental detail view of the ignition switch and the lever on which it is mounted.

Fig. 11 is a vertical sectional view of the control mechanism taken approximately in the plane of line 11-11 of Figs. 8 and 9.

Fig. 11^a is a detail view of one of the elements of the clutch through which the control mechanism is driven.

Fig. 11^b is a detail view of a certain bell

crank member comprised in the control mechanism.

Fig. 12 is a diagram of the motor circuit and the ignition circuit, showing also the transformers that supply current to the room thermostat circuits.

Fig. 13 illustrates diagrammatically three different positions of the room thermostat.

Fig. 14 is a diagram of the room thermostat circuits.

Referring first to Figs. 1, 2 and 3 there is shown a burner unit mounted on a base 10 and adapted to be placed before a boiler or other heater shown in part and designated 11. The upper or combustion chamber door 12 of the heater has an opening therethrough which is covered by a plate 13 on which certain of the burner parts are mounted. The general arrangement of the burner parts in the heater is such as to spray a mixture of oil and air from a nozzle 14 located high in the combustion chamber down into a bowl 15 herein shown as circular, into which a tangential stream of air is forced by a blower 16, the arrangement being such that the oil spray follows generally the path indicated by the dotted line 17 (shown offset in Fig. 3), in order that the oil spray may impinge on the entering stream of air in the bowl in the vicinity of the point 18 (Fig. 2). Of course, it is to be understood that the spray spreads outwardly from the nozzle and is carried or dragged away from a true conical path by the whirling air and gases.

The blower 16 comprises, in the present instance, a casing 20 enclosing a fan 21 (Fig. 2) carried on a shaft 22. A coupling 23 is provided for connecting the shaft 22 to a motor shaft 24. Any type of motor such as that indicated at 25 may thus be used. As shown in Fig. 1, a suitable adjustable motor-mounting platform is provided. This comprises a vertically adjustable leg 26 fitting in a socket 27 on the base 10 and held by a set screw 28. The leg 26 carries a platform or shelf 30 upon which the motor 25 is bolted. The fan casing has a tangential outlet 31 (Fig. 3) leading into a suitable conduit 32 which enters at the bottom of the heater 11 for connection to the bowl 15. The inlet to the fan is through a central opening 33 (Fig. 2^a) about the motor shaft 24, and it is partially closed by an adjustable crescent shaped damper 35 movable about its pivotal clamping screw 36. The casing 20 is supported for limited rotary adjustment on the axis of the fan shaft. This facilitates locating the burner with reference to any heater by permitting the outlet 31 to be moved circumferentially of the fan and to permit its being telescoped, if desired, into the conduit 32. Adjacent the blower casing 20 and on the base 10 is a framework comprised of various housings or casings and generally designated by the numeral 40. The main shaft 22 ex-

tends through the framework and serves to provide power for operating pumping means for air and oil, or for air alone, and for driving a control mechanism associated with the electrical control features or safety devices above alluded to. On the extreme end of the main shaft 22 outside of the framework there is shown a centrifugal oil pump 41 which may be used for supplying oil to the burner, the details of the pump, however, forming no part of this invention. This position makes the oil pump readily removable and it can thus easily be attached or dispensed with when not desired without mechanical difficulty.

The air pump involves parts moving relatively slowly compared to the speed of the motor 25. The first speed reduction is obtained from a worm 42 (Fig. 4) on the main shaft 22 meshing with a worm wheel 43 on a transverse countershaft 44 within the housing. The other end of the shaft 44 carries a disk 45 carrying a crank-pin 46 operatively connected to an air pump 47.

Because of the extensive use of oil burners of this general type for domestic purposes, it is desirable to use an air pump construction which minimizes the danger of break-down or of failure of the pump. Such failures would leave the house without heat awaiting the return of the householder or the arrival of a service man to remedy the defect. Hence, the likelihood of such interruption of the burner should be minimized. The reciprocatory oscillating air pump of the type herein described is preferred because of its simplicity of construction, its durability, and its minimum number of moving or wearing parts, and also because of its slower action compared to the usual rotary pump. Heretofore rotary air pumps which have been used employ sliding vanes and the vanes are subject to great wear. By the provision of a reciprocating piston, these parts are eliminated and by the provision of an oscillatory pump valve mechanism is also eliminated whereby to simplify the construction.

Within the housing 40 there is a depending web or supporting wall 60 in which there are two vertical passages formed which extend through the top 61 of the housing. The right hand passage 62 (Fig. 5) is closed by a plug 62^a screwed into the top 61 and has a laterally communicating hole or port 63 opening into the space 64 within the housing beneath the top 61. Port 63 is an air inlet port for the pump. The left hand passage 65 (Fig. 5) opens through the top 61 and is screw-threaded as shown at 66. This opening is the outlet for the air pump 47. Both passages 62 and 65 are closed at the bottom end as shown at 67. The above described counter-shaft 44 is journaled in the upper portion of the web 60, while the lower

end of the wall serves as a bearing for a trunnion 68 having at one end a pump cylinder 69 and at the other a nut 70. The cylinder and the lower right face (Fig. 4) of the web 60 have finished superimposed plane bearing surfaces indicated at 71. Inlet and outlet ports connect the interior of the cylinder and the passages 62 and 65, there being in the cylinder a shifting port to register alternately with the inlet and outlet ports in the wall 60. The inlet ports in the web 60 are designated as 72 and 73 and are connected to the inlet passage 62 by suitable passages 74 in the interior of said web. The outlet ports 75 and 76 are connected by passages 77 to the outlet passage 65. The inlet port 72 and the outlet port 75 are arranged to communicate alternatively with a port 78 in the cylinder. Similarly the inlet port 73 and the discharge port 76 communicate alternatively with a port 79 in the pump cylinder. A piston rod 80 slides in long bearings 81 at each end of the cylinder. The upper end of the piston rod is connected to the crank pin 46.

Situated on the rear part of the oil burner framework is an adjustable standard 86 (Fig. 3) held in a socket 87 by a screw 88. The upper end of the standard carries a nozzle structure and ignition means which project through the door 12 of the heater. In the plate 13 on the door 12 is an observation hole provided with a hinged closure 89 (Fig. 1). On the plate 13 is a nozzle-carrying plate 90 which is so mounted as to swing angularly for the purpose of adjusting the angular direction of the spray to cause it to impinge at the proper point in the bowl 15. The plate 90 swings about the axis of a sleeve 91 and is provided with arcuate slots 92 and clamping screws 93. The sleeve 91 is integral with the plate 13 and a bracket 94 (Figs. 3 and 7) secured to the standard 86.

The nozzle structure comprises a suitable means arranged to receive a supply of air and a supply of oil, the air being used to spray the oil. Ordinarily nozzles of this type spray by aspiration, that is, the differential pressure between the atmosphere and the oil is in effect increased by the aspirating effect of the escaping air. In the present nozzle, however, the reverse is true, the pressure of the air serving to repress the flow of oil under its own applied pressure.

The nozzle construction in the present instance comprises a cast head 101 (Fig. 7) having an axial threaded bore 102 enlarged at its lower end to form a chamber 103 and there screw threaded to receive a nozzle tip 104. The latter has a conical recess 105 formed from the inner face thereof and a short narrow cylindrical delivery hole 106. A threaded plug 107 screws into the upper portion of the bore 102 and is provided with

a tapered or conical end 108 narrower than the taper 105. The plug 107 is provided with an annular channel 109 and passages 110 which extend from the channel to the axial bore 111 of the plug, the passage 111 opening at the tapered end 108. The head 101 has an oil inlet 112 and an air inlet 113 communicating respectively with the oil channel 109 and the air chamber 103. Both conical parts are provided with right frustal bases which are in the present instance of the same diameter as indicated at 114 and 114^a. Thus, the plug 107 may be screwed tightly against the nozzle cap and when withdrawn therefrom it terminates at successively greater cross sectional areas of the conical recess 105 and may therefore be subjected to different pressures according to its position. There will, of course, be one point where the annular space 115 at the base 114 between the two tapered surfaces will be equal in area to the opening 106. This is referred to as the transitional position. By moving the plug forward from this position this annular space becomes the issuing orifice for the air and by moving it rearwardly the opening 106 becomes the issuing orifice. In the latter case the tip of the plug will be subject to the air pressure within the space 115 and this air pressure will repress the oil. When the opening 106 is the air orifice adjustment of the plug 107 will not vary the pressure on the oil exerted by the air. However, when the plug is in a position forward of the transitional position the annular space 115 becomes the issuing orifice, and the pressure will be less than the applied air pressure, thus permitting more oil to flow as the plug is moved forwardly. It should be remembered, however, that the exact conditions above described are in practice varied, because a portion of the orifice 106 is occupied by the stream of oil thus reducing its cross sectional area available for air delivery. The construction therefore provides for an adjustment of the position of the plug 107 to vary the air pressure bucking the oil pressure and yet the differential pressure under which oil is emitted will be small. This enables the maintenance of a high oil pressure in the system without the necessity of emitting oil under a high pressure into the fire box. It further permits adjustment of the differential oil pressure at the nozzle without adjusting the pressure-producing mechanism.

The nozzle 14 is mounted on an extension 118 of the plate 90. Oil and air pipes 119 and 120 coupled to conduits 121 and 122, respectively, extend through the portion 118.

The flow of air and oil to the nozzle is controlled by a valve structure which has a novel arrangement particularly related to the nozzle just described. The whole oil burning system herein described is of a type adapted to be frequently shut off and turned on to maintain an even temperature. Upon shutting

off the supply of oil to the nozzle as is ordinarily done in other burners, there will remain in the nozzle a certain quantity of oil. Although the combustion in the fire box will cease at the same time, there is a high degree of heat in the fire box which soon heats up the nozzle. Ordinarily the flow of oil and air through the nozzle keeps it relatively cool, but when the oil and air are shut off it is immediately subjected to heating action without a cooling action and will become hotter than when it is in use with combustion in the fire box. The effect of increased heat on the nozzle would ordinarily serve to evaporate the fuel remaining therein leaving tar or residues in the nozzle which may carbonize therein. This would soon choke the nozzle, making it ineffective and requiring that it be cleaned frequently. To avoid this I provide a means for blowing out the residual oil in the nozzle upon shutting off the oil supply. This is preferably done by blowing out also the oil line leading to the nozzle so that there is no creeping of oil therefrom into the nozzle.

In Fig. 6 a construction is disclosed which is in effect a two-way valve connecting the nozzle oil line 121 either with the oil supply or with an air supply. The valve structure comprises a casting 125 into which the oil and air conduits 121 and 122 are connected. Oil and air entry ports 126 and 127 are also provided, there being in the present instance two opposing ports 126 for oil and one port 127 for air on the sides of the valve structure. But one of the opposing ports need be used according to the desired connections made in the apparatus. The ports open respectively into an oil passage 128 and an air passage 129. In Figs. 1 and 2 it will be observed that one oil port is closed by a plug 130, while the other oil port is connected to an oil conduit 131 extending from the oil pump 41. An air supply pipe 132 (Fig. 3) is connected into the air port 127. The valve casing 125 has a tubular stem 133 by which it is mounted in the part 134 on the housing 40. The valve casing 125 is bored at 137 in continuation of the bore of the stem 133. In the lower portion of the bore 137 is fixed a bushing 137^a. The upper end of the bore 137 is enlarged at 138, and screw-threaded plugs 139 and 140 are provided for the ends of the two portions of different diameters. The plug 139 closes the passage at the outside of the casing, while the plug 140 serves as a valve seat, being provided with an opening 141 therethrough so that oil may pass. The oil passage 128 leads into the chamber 138, and a port 142 leads from the bore 137 to the oil conduit 121. A constantly open duct 143 connects the passage 129 to the air conduit 122. A valve means is provided which is operable to shut off the oil to the oil conduit and to permit the entry of air thereto to blow

out the oil. A valve stem 144 slides in the bushing 145. The stem extends through a port 146 communicating with the duct 143. The oil port 142 leading to the nozzle is between the oil supply port 141 and the air supply port 146. On said valve stem is a valve head 147 which is slightly smaller than the bore in order to leave an air space 148 about the head from end to end. The head 147 has a tapered seat-and-plug end 149 which closes the oil passage 141 in the uppermost position of the valve stem; and it has a similar end 150 which closes the air port 146 in the lowermost position of the valve stem.

To operate the valve a movable plunger 151 acts on the valve stem 144 through an impositive connection including spring means. A socket member 152 is fixed on the end of the valve stem 144, and in its socket an expansible spring 153 is placed. Plunger 151 operates to move the stem by compression through the spring 153. The valve stem 144 is suitably packed and guided in the bottom of the extension 133 as indicated at 154. Between the stuffing box 154 and the socket member 152 is a second and lighter spring 156 which normally tends to compel the socket member 152 to follow the plunger 151 when the latter is withdrawn, whereby to open the oil valve.

To regulate the supply of oil and air to the nozzle 101, needle valves are dispensed with and an adjustable valve member is provided for each of the oil and air passages 128 and 129. Each comprises a plug 158 longitudinally adjustable in the passages by means of their screw-threaded relation at 159 with the casing. The plug extends through a stuffing box 160 and has an outer slotted end 162 for engagement by a screw-driver. The inner end of the plug terminates adjacent to the entry port and is notched as shown at 163. Varying the longitudinal position of the notch in front of the port 126 or 127 will vary the inlet opening. This construction is very advantageous, because as the plug is turned the edge of the notch serves to scrape the interior of the passage and to free it from collected dirt of any kind. Likewise, a half turn on the screw plug will reverse the notch, compelling the oil or air to clean out any obstruction which may have lodged in the notch.

Referring to the air supply leading to the nozzle 101, it has been set forth that the oil line and the nozzle are cleared of oil on shutting off the oil, by letting air blow there-through. For this reason there is provided in the system a sufficient reservoir of air under compression to supply the necessary air for clearing out the oil line after the air pump has stopped. The reservoir for air is also provided for the purpose of eliminating pulsations of the reciprocating pump

above described, which might otherwise be undesirably effective at the nozzle. Referring now to Figs. 3, 4 and 5, an air reservoir 165 is preferably mounted on the top plate 61 of the housing 40 directly over the air pump 47. Thus the pump outlet 66 discharges directly into the chamber 165 to which the pipe 132 is connected as shown at 166 (Figs. 2 and 3).

The housing 40 contains sufficient lubricating oil to submerge the pump 47, gears 42 and 43, etc. This arrangement and the pump construction makes it likely that the air pump will suck a slight amount of oil and deliver it with the air to the chamber 165. A constant air pressure is desired in the air chamber in order to prevent a change in the differential oil regulating pressure at the nozzle. For this reason a relief valve is arranged to permit the escape of excess air, thereby keeping the pressure constant. Because of the likelihood of oil gathering in the bottom of the reservoir the air relief valve is arranged to blow from the bottom of the chamber to carry off the accumulated oil. The valve is so arranged as to blow off into the housing 40 to return the oil thereto.

Any desired structure may be used for the relief valve, but the following is preferred. A hole 167 (Fig. 4) is tapped in the top 61 into which a valve casing 168 is threaded, the valve being contained within the reservoir 165. A chamber 169 having a seat 170 is formed upwardly into the valve casing. Passages 171 communicate from the air reservoir 165 to the chamber 169. The passages 171 are arranged close to the level of the top 61 so that the liquid gathering in the chamber may flow into the valve. A valve head 172 and stem 173 are provided, the latter extending through the valve casing and having a nut 174 and spring 175 for yieldably holding the valve seated. The position of nut 174 of course determines the blow-off pressure of the valve. Since it is desirable that this be fixed for proper operation of the burner, the adjusting nut is located inside of the air reservoir. This insures that it will not be tampered with during operation of the burner, and further because of its inaccessibility it in effect compels competent service to make an adjustment. This is an important feature in domestic oil burners.

The ignition means is shown in Figs. 7 and 7a. Within the sleeve 91 is insulating material 176 which supports two conductors 177 and 178 having sparking points 179. The sparking points are located in the path of the oil spray issuing from the nozzle 101.

A safety device is provided for assuring that the burner will be rendered inoperative to supply oil to the combustion chamber when there is a failure of combustion. Such means is operative through an accumulation of un-

consumed oil collected in a basin or covered chamber 180 (Fig. 3) in the bottom of the bowl 15, the oil entering through a hole 180^a. Into the basin 180 there is tapped a pipe 181 leading to an axially tiltable drum 182 (Figs. 1, 2, 3^a and 3^b). The drum has a partition 183 therein so that oil may collect in but one side of the drum behind the partition in order to overbalance the same to tilt it. An elongated slot 184 at the top of the drum into which the pipe 181 projects both permits and limits the tilting of the drum. A mercury switch 185 carried by the drum is suitably connected into a circuit, later to be described, for the purpose of stopping the operation of the burner.

Other well known safety devices and appliances may be used in connection with the foregoing as will appear more fully hereinafter in the diagrammatic representation of the controlling circuits and mechanisms.

Control mechanism

The control mechanism is herein shown as arranged to be driven by the burner motor, and preferably under the control of the main motor switch. An intermediate controlling means is employed between the control mechanism and this source of motive power. The motive power preferably used for the control mechanism is derived directly from the motor. In the present instance, the control mechanism is operated by a continuously rotating shaft, the shaft having rotation only during the operative period of the burner. The parts are so arranged that the burner motor is started and stopped by said control mechanism, the latter being driven by the motor, and being made responsive to a thermostatically controlled current.

The mechanical control is preferably made as a unit having a frame comprising the two opposing plates 195 and 196 (Figs. 8 to 11) connected by a web-plate 197 at the forward side. At the rear of the unit there is a shaft 198 carrying a worm wheel 199. The gear 199 meshes with a worm 200 (Fig. 3) on a shaft 201. Said shaft is connected by miter gears 202 to a shaft 203 (Fig. 4). The latter is driven from the shaft 44 through a worm wheel 204 meshing with a worm 205 formed on the periphery of the crank disk 45.

The shaft 198 drives the controlling cam shaft 206 which makes a half-revolution to initiate combustion and a half-revolution to stop combustion. The shaft 206 is preferably made tubular and surrounds the shaft 198, being rotatably supported thereon. The shaft 198 is arranged to drive the shaft 206 through clutch means which is preferably of the positive type and comprises a ratchet wheel 207 fixed to the main power shaft 198 of the control unit. The tubular shaft 206 carries rigidly therewith a disk 208, upon which there is a pin 209 (Fig. 11) carrying a dog

210 which is provided with a tooth-engaging part 211 designed to be caught by the ratchet wheel to turn the disk. A tension spring 212 tends to swing the dog into engagement with the ratchet wheel. The parts are shown in engaging relation in Fig. 10. Releasing means is provided for the dog and wheel by the employment of a member carried by the disk 208 and movable with relation thereto to swing the dog away from the ratchet wheel. The movable member in the present instance comprises a plate 213 (Figs. 11 and 11^a) pivoted loosely about the shaft 198 and connected to the disk 208 by headed pins 214 which pass through arcuate slots 215 in the plate to permit a limited rotational movement between the disk and the plate. The spring 212 is connected to both the dog 210 and the plate 213 and tends to hold the plate 213 in a position which may be described as advanced in the direction of normal rotation of the disk. The plate 213 carries a lug 216 projecting beyond the periphery of the disk 208 so that during rotation of the disk a stop means, later to be described, may move the plate 213 from its advanced position (Fig. 10) to its rear position (Fig. 11) relative to its carrying disk 208, this motion being effective to move the dog 210 out of engagement with the ratchet wheel, whereby to stop the rotation of disk 208. The present means for moving the dog includes a cam projection 217 on the plate 213, which cam is moved into a position wherein it operates to raise the dog against the tension of its spring 212 into a position free from engagement with the teeth of the ratchet wheel.

On the shaft 206 adjacent the disk 208 there is fixed a cam 218 (Fig. 8) having a circular periphery containing a recess 219 (Fig. 11) which is positioned on the periphery at a point opposite to the stopping lug 216. An electric switch is incorporated into the device and so arranged as to be closed in all positions of the cam 218 except one, at which position a movable part enters into the recess 219 to permit opening of the switch. Thus, when said movable part is permitted by the remainder of the mechanism to enter the recess, the switch is opened and the motor stopped. Various constructions for mounting the switch may be employed but the preferable form comprises a plate 220 (Fig. 9) swinging on a fixed pin 221 carried by the side plate 196. The plate 220 carries a mercury switch 222 which is arranged in such a manner that it effects stopping of the main control shaft 198, in the present instance, it being connected into the motor circuit. The plate 220 carries a counterweight 222^a tending normally to swing the plate to open the motor switch 222 as shown in Fig. 10. A linkage is connected to the plate to tilt it mechanically against the counterweight, said linkage being arranged to be operated by the cam 218. The

linkage comprises a right angular bell crank member (Figs. 10, 11 and 11^b) having arms 223 and 224 pivoted loosely on a shaft 225 extending between the side plates. The arm 223 is connected by a link 226 to a part of the plate 220 which lies above its pivot point 221, and the arm 224 carries a cam roller 227 which rides the cam 218 and which is adapted to fall into the recess 219 of the cam under the gravity influence of the weight 222^a. The bell crank 223—224 also has a projecting heel 228 upon which pressure may be placed to raise the cam roller 227 out of the recess 219 thereby to close the switch 222, closing the motor circuit and turning the cam disk 218 through the dog and ratchet device (which is thrown in as indicated in Fig. 10). The cam 218 therefore revolves and moves its recess 219 out from under the roller 227. The motor switch cannot be opened until the cam disk has made at least a complete revolution to return the recess 219 into a position to receive the roller 227.

The shaft 225 is a rock shaft held between the cone bearings 230 and 231, (Fig. 9) located respectively in the side plates 195 and 196. To the rock shaft is fixed a plurality of arms including an arm 232 (Fig. 9) having an adjustable counterweight 233, a downwardly projecting heel 234 arranged to press on the heel 228 of the bell crank lever 223—224, a forwardly projecting arm 235 which carries an armature 236, and a rearwardly extending stop arm 237. The tilting of the rock shaft 225 is limited in one direction by the armature striking a screw 236^a adjustably fixed in the frame.

The stop means heretofore alluded to and employed as an obstruction in the path of the advancedly positioned lug 216 of the pawl and ratchet mechanism is a detent 238 (Fig. 10^a) depending loosely from the pivot pin 221 (Fig. 11) and drawn rearwardly by a light spring 239 secured to a pin 240 (Fig. 11) on the side plate 196, the pin being right angular to provide a rear stop for the detent. The detent has a forwardly projecting lug 241 which terminates near the end of the stop arm 237 on the rock shaft 225. When the rock shaft 225 is normally tilted by its counterweight 233 the arm 237 is lowered from its position in Fig. 11 to its position in Fig. 10, and it is then out of the path through which the lug 241 may swing about pivot 221. Thus the arm 237 may serve to lock the detent 238 in fixed position. In its locked position (full lines Fig. 11) it is a fixed stop means to cause throwing out of the dog 210, whereas in its unlocked position (dotted lines Fig. 10) it yields to permit the lug 216 to pass without throwing out the dog 210, the detent 238 swinging into the position as shown in dotted lines 238^a and 241^a in Fig. 11.

Also upon release of the detent 238 through

the lowering of the stop arm 237, the dog 210 is automatically swung into engagement with the ratchet wheel through the effect of its spring 212, the lug 216 and the plate 213 advance rotatively relatively to the plate 208 through the action of the spring 212, and the plate 208 again rotates with the main control shaft 198. In the initial advance of the lug 216 to its dotted line position 216^a in Fig. 11, the detent 238 is swung ahead of it into the dotted-line position indicated in Fig. 11 at 238^a and 241^a. It will thus be observed that in this position the lug 241 is above the end of the arm 237 which may nevertheless be in its normal locking position. The detent 238 cannot return to its effective stopping position (full lines in Fig. 11) from this abnormal position (dotted lines Fig. 11) while the arm 237 is raised even though the lug 216 has passed and thus permits its return.

From the foregoing it will be seen that there are certain positions of the arm 237 requisite for proper operation of the device. For a variety of reasons this is preferably controlled by an electromagnet 242 (Figs. 9, 10 and 11) acting on the armature 236 carried by the rock shaft 225. Current to the magnet is in part controlled by a switch device carried on the cam shaft 206 and in part by thermostatic means to which the burner is made responsive.

Assuming the motor 25 to be stopped and the burner idle, the counter-weight 222^a holds the parts in the position shown in Fig. 10 with the cam roller 227 in the cam recess 219. Energizing the magnet 242 will cause the heel 234 to act on the heel 228 and thereby to close the motor switch 222 and thus start the shaft 198 as heretofore described. The dog 210 being in engagement with the ratchet wheel as shown in Fig. 10, and the lug 216 being located at the lower side of its orbit, the cam shaft 216 will rotate half a revolution until the lug 216 meets its detent 238. During this period any program of operations requisite to initiate combustion is carried out, the several operations being performed in proper sequence through the action of the rotating cam shaft 206. In order to stop the cam shaft the arm 237 must be in locking position as regards the detent 238 at the time when the lug 216 meets said detent; and said arm 237 must be maintained in its raised locking position during the time in which the clutch is to be kept thrown out, that is while the burner is operating. The mere dropping of the arm 237 out of locking position allows the clutch to be thrown in automatically and the cam shaft again rotates half a revolution, during which suitable stopping operations of the burner parts may be effected in proper sequence by the rotation of the cam shaft. When the recess 219 of the motor switch cam 218 comes around to the cam roller 227, the switch will open by the dropping of the roller

into the recess, provided the arm 237 is down and the heel 234 thereby withdrawn from the heel 228. This action requires that the magnet be deenergized at this point.

Various electrical arrangements may be used to meet these conditions, the electromagnet 242 being suitably energized to control the position of the rock shaft 225, the electromagnet being so arranged that it is energized when heat is demanded and deenergized when no heat is demanded. In the present instance there is employed a room thermostat of the well known type wherein one circuit is closed when the room becomes too cold and another circuit is opened when the room becomes too hot. Thus, above a maximum temperature no circuit is closed in the thermostat; between the desired upper and lower limits of temperature control one circuit is closed in the thermostat; and below the minimum desired temperature, both circuits are closed in the thermostat. Such a thermostat is indicated diagrammatically in Fig. 13 in which L and H represent adjustably fixed contact points corresponding to the lower and higher temperature limits desired, and to which independent circuits are connected identified respectively as "cold" and "hot". A common wire J is connected to a thermal expansive element 245 which is electrically common to both circuits. The element is in effect split at the movable end forming two branches which make successive contact with the contact points L and H as the temperature varies. The three conditions are respectively indicated in (a), (b) and (c) in Fig. 13 corresponding to the room being (a) too cold, (b) properly tempered between the desired limits, and (c) too hot.

In the diagram Fig. 14, the thermostat is generally designated 245, it being understood that it partakes of the character of the thermostat described with reference to Fig. 13 and having three possible internal conditions. There is provided a low voltage electrical source indicated at 246, which in the present instance is a six volt source, connected from one terminal by wire 247 to one side of the electromagnet 242. Wire 248 leads from the magnet to the J or common wire of the thermostat. On the cam shaft 206 (Figs. 8 and 9) there is an insulating drum 249 around which is a continuous metallic band 250. The band has alternate and diametrically opposite lateral projections 251 and 252 arranged so that one of them, 251, is on top when the recess 219 of the motor switch cam is on top. In the diagram (Fig. 14) the dotted line position of the ring lugs indicates the position of the ring after a half revolution of the drum. Three spring contacts 253, 254, and 255 respectively engage with the ring 250 and the lugs 251 and 252, these being securely fastened to an insulating strip 256 (Fig. 9) on the front connecting frame

plate 197. Screws 257, 258 and 259 are used respectively to make connections to the bars 253, 254 and 255. A wire 260 connects the contact bar 254 to the "cold" circuit L of the thermostat; a wire 261 connects the "hot" circuit H of the thermostat and the contact bar 255; and a wire 262 connects the source 246 and the middle contact bar 253.

Diagram Fig. 14 represents in full lines the control device in the running position of the burner (Fig. 11), the electromagnet 242 being energized because contact H in the thermostat is closed and the circuit therethrough is completed by wire 262, contact bar 253, ring 250, lug 252, bar 255, wire 261, thermostat contact H, common wire 248, electromagnet 242, wire 247, source 246. When the room temperature goes over the upper temperature limit, contact H opens whereupon the magnet 242 is deenergized, the arm 237 drops through the dropping of the counter-weight 233, and the clutch automatically throws itself into engaging position to turn the cam shaft 206 including the drum 249 which carries the contacts 251 and 252. The ring and lugs on drum 249 move to the dotted line position of Fig. 14. Just prior to the recess 219 arriving at the cam roller 227 the contact bar 254 wipes the lug contact 251 but no circuit is completed through the magnet because contact L in the thermostat is open. Therefore the arm 237 remains down and the cam roller drops into the recess 219 to open the motor switch 222 and thus stop the entire apparatus. This condition continues until the lower limit of room temperature is reached. Thereupon closure of the contact L energizes the magnet 242 and rocks the shaft 225, to close the motor switch, raising the roller 227 out of its recess 219 as an incident to the operation. This starts the motor and thus sets the cam shaft 206 in rotation, said cam shaft again causing the required starting operations to be performed according to the mechanisms associated with the cam shaft. After a slight rotation from the starting position the lug 251 recedes from the bar 254 and the magnet 242 is de-energized, but this does not take place until the recess in cam 218 has moved away from the raised roller so that the cam periphery holds the roller up and maintains the switch in closed position. As rotation continues the clutch lug 216 approaches the detent 238. The magnet being de-energized, the arm 237 is not in a position to lock the detent. However, the lug 252 is arranged to make contact with the bar 255 prior to the time the clutch lug 216 reaches the detent 238, and circuit H being closed in the thermostat, the arm 237 is raised by the magnet to lock the detent, whereupon the clutch is thrown out, leaving the control mechanism idle and the burner in operation.

In addition to stopping and starting the motor 25, the control mechanism also operates

the oil valve. Referring to Fig. 6, the part therein designated 151 for urging the oil valve stem upwardly may be considered as an extension of a rod 265 (Fig. 10) carried by an arm 266 pivoted in the frame of the control device at 267. The arm 266 carries at its outer end a cam roller 268 which rides on a cam 269 rigid with the cam shaft 206. One portion 270 of the cam surface is substantially radial, which permits the cam roller 268 to drop and the oil valve to open suddenly. The cam surface 270 is placed so that the oil valve opens just prior to the disengagement of the clutch. The cam 269 has an inner concentric cam surface or dwell 271 which permits the cam shaft to turn approximately one-eighth of a revolution in its burner-stopping operation without affecting the valve, after which a rise in the cam surface at 272 raises the roller to close the valve. The closing action of the valve is completed in about one-eighth of a revolution, after which the cam turns for approximately one-fourth of a revolution before the power is shut off through the motor switch 222. Thus the air pump continues in operation after the oil has been shut off and assures the blowing out of the oil line and nozzle, as heretofore described.

The supply of current to the sparking points 179 is primarily controlled by the motor switch 222, as indicated in Fig. 12, the supply of current to the igniter being cut off when the motor switch is opened. However, since the character of spark ordinarily employed is such as to interfere with the use of a radio receiver, means is provided for cutting out the spark when it is not necessary and for automatically connecting it when it is required for proper operation of the burner.

The ignition circuit includes a mercury switch 280 (Fig. 9) which is carried by a lever 281 (Figs. 8, 9, 10^b and 11) pivotally mounted on a boss 282 secured to the side wall 195. A screw 284 forms the pivot, and a spring 285 acting on a washer 286 places frictional pressure on the lever 281. The lever 281 extends forwardly and projects through the casing so that one may raise said end of the lever to open the switch. Friction holds the lever in raised position to maintain the switch open. On the rear end of the lever 281 is a downwardly extending arm 287 carrying a cam roller 288 arranged to be moved by a cam 289 on the cam shaft 206. The cam 289 is similar to the cam 218 having one cam recess 290 (Fig. 11) arranged to lie at the top in the operating position of the burner, and hence diametrically opposite the recess 219 of the motor switch cam 218, which lies at the top in the idle position of the burner. Thus while the burner is in operation the notch 290 is so positioned that the ignition switch 280 may be manually opened, that is, roller 288 may enter the recess 290

of cam 289. Subsequent rotation of the cam 289 when the burner is being stopped will close the switch so that the ignition system will be effective in a subsequent starting operation.

A spring pressed plunger 291 (Fig. 3) on the housing 40 is arranged for manual depression of the armature 236 when the magnet is not energized. This enables one to start the burner independently of the thermostat circuit which, of course, will control the further action of the burner after being so started.

The remaining electrical devices and circuits of the oil burner are indicated in Fig. 12. The boiler or heater with which the burner is used is preferably provided with a well known safety control device indicated generally at 301 which is effective upon excessive steam pressure or excessive water temperature to shut off the burner independently of the room thermostat. This device is represented as containing a mercury tube switch 302 adapted to open on excessive heat. The mercury tube switch 185 is also arranged to open on accumulation of oil in the drum 182. Both these switches, together with the motor 25 and the cam operated switch 222, are connected in series in the order named to a power source 303 which in the present instance is 110 volt alternating current. The spark ignition is obtained through an induction coil having the primary coil 304 and secondary coil 305 from which the wires 306 lead to the spark terminals 179. One side of the primary coil is connected by wire 307 to one side of the motor 25 and the other side is connected by wire 308 to the other side of the motor through the optionally cut-out and automatically cam-closed ignition switch 280. The low voltage source 246 of Fig. 14 of the thermostat circuit as above mentioned is a six volt circuit obtained from a transformer connected to the main A—C line. In the present instance two similar transformers 309 are used and are connected in parallel, this arrangement being chosen so that when a 220 volt source is available the two transformers may be connected in series. The transformers are connected by wire 310 to one side of the power source 303, and by the wire 311 to the other side at a point between the boiler control switch 302 and the oil control switch 185. This point is chosen for connection of the transformer circuits because in the instance when the heater becomes excessively hot while the room thermostat is still demanding heat, the boiler control switch 302 cuts out the motor and also the control current.

Assuming the parts to be in the position shown in Fig. 11, opening of the switch 302 cuts out the transformers, and thus deenergizes the magnet 242, so that the clutch lug 216 is released and the clutch thrown in.

However, the cam shaft 206 remains at rest, as the motor also is cut out. The motor switch 222 remains closed, because the roller 227 is on the high portion of the periphery of the disk 218. On cooling of the boiler sufficient to close the safety switch 302, the motor begins running and turns the cam shaft 206 through a half-revolution, thus bringing the recess 219 into register with the roller 227. If the room is still cold, there is a circuit through the magnet 242 as follows: Source 246 (the transformers), line 262, bar 253, ring 250, lug 251, bar 254, wire 260, contact L, wire 248, magnet 242, source 246. Hence the magnet will prevent the roller 227 from dropping into the recess 219, and the motor will continue running. The cam shaft 206 will therefore make another half-revolution to complete a cycle during which the starting operations are initiated. This is called "recycling." In the initial stage of the recycling, after the lug 216 has passed its unlocked detent 238, the electromagnet circuit is broken so that arm 238 may return to normal obstructing position. Just prior to the completion of the cycle of cam revolution a circuit is established through lug 252 and contact H in the thermostat to energize the magnet, to lock the detent, and thus to throw out the clutch.

The above operation has been described with reference to the operation of the boiler safety switch 302, but it is obvious that the same operation will also take place when the source of power 303 fails. The whole arrangement is thus sufficient to protect the burner from a hazardous condition on failure of power, because on return of power the burner, although stopped in the operative position by the failure, will be recycled through its starting stage to ensure that combustion is initiated.

The function of the control mechanism to cut off the burner when there is a break in the thermostat circuit should be clear from the foregoing description. Under such conditions the magnet cannot be energized, the clutch cannot be thrown out and the cam shaft will always rotate until the motor switch cam roller 227 drops into its cam recess 219 whereupon the motor will stop. Nothing can operate to start the motor except the energization of the magnet, or the manual depression of the plunger 291. In the latter instance the cam shaft will turn for one cycle and then stop automatically.

Although the motor control mechanism has been shown specifically as moved directly by the motor 25, it is to be understood that the arrangement is not limited to such a driving means. The motor is under control of the motor switch, hence the motive power for the control mechanism may be regarded as under the control of said switch. For this reason the driving shaft 198 is to be considered

broadly as a secondary source of power, or rather as a source of motive power for the control mechanism, and the clutch mechanism is to be considered broadly as a power cut-off between said source and the control mechanism, said power cut-off having a power-on and a power-off position corresponding respectively to throwing in and out the dog of the clutch.

The burner is adapted for two types of installation, one wherein the oil is pumped, and the other wherein air pressure is utilized to force oil from a tank. The oil-pumping system has been described only generally as including the oil pump 41, but it involves further an intake pipe 315 (Figs. 1 and 3), an outlet pipe 316 (Figs. 1, 2 and 3), and a constant pressure relief or by-pass valve 317 of well known construction, which delivers the excess oil supplied by the pump through a return flow pipe 318 back to the initial source. Oil under the pressure at which the valve 317 is set flows through the pipe 131 as heretofore described. The continuous flow of oil obtained by this arrangement prior to the opening of the oil line to the nozzle allows all air bubbles to be removed from the oil stream so that the nozzle line upon opening of the valve 125 can be tapped into a completely filled air-free oil-flow. This prevents delivery of a mixture of oil and air to the nozzle, which causes an undesirable sputtering and frequently an extinguishment of the flame within the heater.

When the oil pump is not to be used, the air chamber 165 on top of the burner housing may be dispensed with, if desired. Such a modified use of the apparatus is shown in Fig. 1^a wherein 61 represents the top of the housing, heretofore described with reference to Figs. 4 and 5. The air delivered from the pump outlet 66 is carried directly by a conduit 320 to an air chamber 321 on a fuel pressure tank 322. An oil line 323 runs from the bottom of the tank to the oil valve casing 125. An air line 324 runs from the chamber 321 to the valve structure 125. This construction prevents pulsations of the air pump from being felt at the nozzle and also allows any oil which may be pumped with the air to be discharged into the tank and mixed with the fuel oil. A relief valve 325 is also placed on the air reservoir 321 to maintain the air pressure therein constant in the same manner as desired when the air chamber 165 is employed.

The operation of the apparatus shown in all of the views except Fig. 1^a may be briefly summarized as follows, assuming that the burner is idle, the control mechanism being in the position shown in Fig. 10, and the ignition switch 280 being held closed by the cam 289: When the temperature in the room in which the thermostat 245 is located falls below a predetermined minimum, the electromagnet 242 is energized, thus closing the mo-

tor switch 222 and causing current to flow to the sparking points 179. The motor begins to operate; the oil pump 41 forces oil to the oil supply port 141 (Fig. 6), excess oil returning to the oil tank (not shown) through the relief or by-pass valve 317; the air pump begins to build up air pressure in the reservoir 165 (air flowing through the air line 122, and a negligible quantity of air escaping through the oil line); and the cam shaft 206 begins to turn. By the time the cam shaft has nearly completed a half revolution, the air pump has built up sufficient pressure in the reservoir 165, and the roller 268 (Fig. 10) drops onto the dwell 271 of the oil valve cam 269, thereby opening the oil supply port 141, whereupon oil flows to the nozzle, where it is ignited by the arc between the points 179. As the cam shaft 206 completes a half revolution the clutch is thrown out, thus leaving the control mechanism in the position shown in Fig. 11. By reference to Fig. 11, it will be seen that the dog 210 lies on the projection 217 and that the tension of the spring 212 (which is stretched between the dog 210 and the plate 213) holds the lug 216 on said plate pressed against the detent 238. When the temperature in the room containing the thermostat 245 rises to the predetermined maximum, the electromagnet 242 is deenergized, whereupon the counterweight 233 lifts the armature 236 and swings the stop arm 237 down below the arm 241 of the detent 238, whereupon the spring 212 is permitted to turn the plate 213 clockwise (as viewed in Fig. 11) to withdraw the lug 217 from beneath the dog 210, the detent 238 yielding to the right to allow of such movement of the plate 213. Shortly after the cam shaft 206 has commenced to turn by reason of the throwing in of the dog 210, the cam surface 272 of the cam 269 closes the oil supply port 141 and allows air to flow through the port 146, the air passage 148 and the air port 142 to the oil line until the pressure in the reservoir 165 is reduced to atmospheric pressure, thus blowing out all the oil in the oil line 121 and the nozzle. As the cam shaft 206 completes a half revolution the recess 219 arrives under the roller 227, whereupon the weight 222^a places said roller in said recess and tilts the motor switch 222 into the open-circuit position, whereupon the motor stops, leaving parts in the position shown in Fig. 10.

With the form of oil supply means shown in Fig. 1^a, the operation is substantially the same as that just described. Whether one or the other form of oil supply means is used, the opening of the oil valve 149 (Fig. 6) is timed to occur when sufficient air pressure has been built up in the reservoir 165 or 321, as the case may be.

It will be seen that the control mechanism herein disclosed is of such character that the necessary program of operations required in

starting or stopping the apparatus is carried through in proper order and time relation.

The arrangement herein shown of the fuel discharge means, the combustion bowl and the air supply means is claimed in a divisional application Serial No. 90,452, filed February 25, 1926.

I claim as my invention:

1. A control device adapted for operation by a motor operated oil burner for the purpose of controlling said burner comprising, in combination, a power shaft arranged to be operated directly by the burner motor, a control shaft, a clutch connecting said two shafts, means under electrical control and positioned to throw out said clutch, means positioned on said control shaft to cause said first means to disengage the clutch at a predetermined position of said control shaft, a switch to control the motor of the burner, means on said control shaft permitting free operation of said switch in one position of the shaft and compelling closing of said switch in other positions of the shaft, said opened position of the switch occurring while the control shaft is operatively connected to the burner through said clutch, means tending normally to open said switch whereby it opens automatically when permitted for the purpose of stopping the motor and the control shaft, a room thermostat, and means operatively arranged to close the switch from said thermostat when heat is required, whereby the control shaft rotates to a position to throw out the clutch, the switch meanwhile being held in closed position, said electric clutch-controlling means being operatively associated with the thermostat to permit engagement of said clutch when heat is not required whereby the control shaft rotates to permit opening of the switch by the means tending normally to open the switch.

2. In combination, a motor operated oil burner, a thermostat, a mechanical motive device arranged to move for starting the burner into operation, said device being also arranged to move for stopping the burner, said device including self-stopping mechanism, a clutch connection from the burner to the motive device, said self-stopping mechanism being operative upon the clutch to disengage the same, said mechanism being affected by the thermostat to throw in said clutch to start the device on its burner stopping motive action, an electric switch controlling the burner motor and arranged to be operated by the motive device to stop the burner motor, said switch being arranged also to be closed by the thermostat to start the motor.

3. In combination, an oil burner motor, a thermostat to control the starting and stopping of the motor, a control mechanism operable to a predetermined extent in starting the motor and in stopping the motor, said mecha-

nism including a motor switch, the position of which is in part controlled by said mechanism, a power connection between the motor and the control mechanism, said thermostat being arranged to close the switch to start the motor and the control mechanism, and being further arranged to control the power connection for stopping and starting the control mechanism during operation of the motor.

4. In combination, an oil burner motor, a thermostat to control the starting and stopping of the motor; a control mechanism operable to a predetermined extent in starting the motor and in stopping the motor, said mechanism including a switch to control the motor, the position of said switch being controlled by the position of the control mechanism, a power connection between the motor and the mechanism, said thermostat being arranged to start the motor initially to move the control mechanism through said power connection, and being further arranged to control the power connection for stopping and starting the control mechanism during operation of the motor.

5. An automatically controlled oil burner comprising, in combination, an electrically operated burner, a mechanical controlling motive device for the burner, and a motive power source for said device under the direct control of the electrically operated burner so as to be on and off with said burner, said device including a control means for said source operative to cut in and out said source during operation of the burner, a thermostat responsive to the burner, and means responsive to said thermostat for controlling said power controlling means and also the electrically operated burner.

6. In combination, an oil burner motor, a switch to control said motor, a thermostat, a control mechanism operative upon the switch to control the motor and to institute starting and stopping operations of the burner, said motor being responsive to the thermostat for starting the motor, and a source of power for the control device, said source being dependent upon the power controlled by the main motor switch, and means actuated by the control mechanism responsive to said thermostat to control the transmission of power from said source to the mechanism.

7. A thermostatic control for a rotary control device movable in a cycle between two positions for starting and stopping an oil burner comprising, in combination, a three wire two circuit thermostat arranged to have both circuits closed below a minimum temperature, both circuits opened above a maximum temperature, and a certain circuit closed at the intervening temperatures, an electromagnet and an electrical source connected in series with the common wire of the thermostat circuits, a switch device operated by the ro-

tary device to shift the connection of the free terminal of the source to one or to the other of the thermostat circuits, the arrangement being such that upon the temperature decreasing to the minimum the magnet is energized, whereupon movement of the rotary device to its second position operates upon the switch means to shift the electromagnet to the other circuit, whereupon the magnet is again energized while the device occupies its second position and until the temperature reaches a maximum, whereupon de-energization of the magnet causes the parts to assume the initially described position.

8. In combination, a thermostat, an electromagnet energized by current passing through said thermostat when heat is required to raise the temperature of the thermostat to a predetermined degree, an oil burner motor arranged to be controlled by the thermostat, an electric switch for the motor, said switch being arranged to be closed on energization of the magnet, a control mechanism to institute starting and stopping operations of the burner including the opening of said motor switch during the period of de-energization of the magnet, said mechanism having means therein to hold said switch closed and to open it automatically at a predetermined position of the mechanism, a power transmitting clutch between the motor and said mechanism, and means operable during energization of said magnet to effect disengagement of the clutch at a second predetermined position of the control mechanism.

9. In combination, a thermostat, an electromagnet energized by current passing through said thermostat when heat is required to raise the temperature of the thermostat to a predetermined degree, an oil burner motor arranged to be controlled by the thermostat, an electric switch for the motor, said switch being arranged to be closed on energization of the magnet, a control mechanism to institute starting and stopping operations of the burner including the opening of said motor switch during the period of de-energization of the magnet, said mechanism having means therein to hold said switch closed and to open it automatically at a predetermined position of the mechanism, a power transmitting clutch between the motor and said mechanism, and means operable during energization of said magnet to effect disengagement of the clutch at a second predetermined position of the control mechanism, and means in the control device to break the circuit to the magnet for an interval during the movement of the mechanism from the second to the first predetermined position.

10. In combination, a thermostat, an electromagnet energized by current passing through said thermostat when heat is required to raise the temperature of the ther-

mostat to a predetermined degree, an oil burner motor arranged to be controlled by the thermostat, an electric switch for the motor, said switch being arranged to be closed on energization of the magnet, a control mechanism to institute starting and stopping operations of the burner including the opening of said motor switch during the period of deenergization of the magnet, said mechanism having means therein to hold said switch closed and to open it automatically at a predetermined position of the mechanism, a source providing motive power for said mechanism, said power source being controlled by the motor switch, and a second power control for said motive power source, said second power control being responsive to energization of the magnet to transmit motive power to said mechanism at a second predetermined position of said control mechanism.

11. In combination, a three wire two circuit thermostat, a power operated circuit shifting device for said thermostat, an oil burner motor arranged to be controlled by said thermostat, an electric switch for the motor, said switch being arranged to be closed by one of the circuits of the thermostat, a power transmitting clutch between the motor and the shifting device, means controlled by the other circuit of the thermostat to throw in and out said clutch, and means associated with the shifting device to open the switch automatically.

12. In combination, a three wire two circuit thermostat, a power operated circuit shifting device for said thermostat, an oil burner motor arranged to be controlled by said thermostat, an electric switch for the motor, said switch being arranged to be closed by one of the circuits of the thermostat, means providing motive power for the shifting device, said means being dependent for its power upon the power controlled by the motor switch, means controlled by the other circuit of the thermostat to turn on and off said motive power, and means associated with the shifting device to open the motor switch automatically.

13. In combination, a motor operated burner, a burner controlling motive device to start the burner and to stop the burner, said device including a room thermostat and mechanism responsive to said thermostat arranged to start and stop the motive device, said mechanism including a clutch means operatively engageable and disengageable with respect to the motor of the burner for starting and stopping said device during operation of the burner motor.

14. In an automatically controlled motor operated burner, a mechanical controlling motive device for the burner driven by the motor which operates the burner, said device having a power clutch between the burner

motor and the movable parts thereof, a thermostat affected by the burner, and means responsive to said thermostat for controlling the clutch and the main motor.

15. In an oil burner, in combination, a power shaft, a motor and a motor switch, a control shaft capable of intermittent operation and adapted in one revolution to permit stopping of the burner motor through said switch and to initiate starting and stopping operations of the burner, a clutch intermediate the controlling shaft and the power shaft to permit stopping of the control shaft for a period between the burner starting and stopping actions, automatic means to disengage said clutch to stop the control shaft, thermostatically controlled means permitting re-engagement of said clutch to effect the burner stopping operation of the control shaft, said thermostatically controlled means also being arranged to close the switch to start the motor.

16. In an oil burner, in combination, a power shaft, a motor and a motor switch, a control shaft capable of intermittent operation and adapted in one revolution to permit stopping of the burner motor through said switch and to initiate starting and stopping operations of the burner, a clutch intermediate the controlling shaft and the power shaft to permit stopping of the control shaft for a period between the burner starting and stopping actions, automatic means to disengage said clutch to stop the control shaft, and thermostatically controlled means permitting reengagement of said clutch to effect the burner stopping operation of the control shaft, and other means thermostatically controlled to close said motor switch.

17. An electrically operated self-controlled oil burner having, in combination, a motor to operate the burner, a switch for the motor, a mechanical controlling motive device operated by power from said motor, including a thermostatic control, a clutch means for connecting said device to the power of the motor, said device being adapted to institute starting and stopping operations of the burner, including the actuation of the motor switch and the engaging and disengaging of the mechanical control device by action on said clutch.

18. An oil burner motor-starting-and-stopping-mechanism comprising, in combination with a motor, a switch for the motor, a thermostat to which the motor is made responsive for supplying heat, a switch operating device movable into two positions constituting a cycle of operations for said device, the device in its first position serving to permit opening of the switch, means normally compelling opening of the switch while the device is in said first position, a power transmitting clutch between said motor and said device to move it into its two positions, automatic means to disengage the clutch when

the device moves into its second position, and means controlled by the thermostat in starting the motor to close the switch against its normally acting opening means, and in stopping the motor to permit said clutch to reengage.

19. An oil burner motor-starting-and-stopping mechanism comprising, in combination with a motor, a switch therefor, a thermostat to which the motor is made responsive for supplying heat, a switch operating device movable into two positions constituting a cycle of operations for said device, the device in its first position serving to permit opening of the switch, means normally compelling opening of the switch while the device is in said first position, a power connecting clutch between said motor and said device to move it into its two positions, automatic means to disengage the clutch when the device moves into its second position, and means controlled by the thermostat in starting the motor to close the switch against its normally acting opening means, and in stopping the motor to permit said clutch to reengage, and means holding said last mentioned thermostatically controlled means in a releasable condition by a current flowing through said thermostat during the desired period of burner operation, whereby a defect or break in the thermostat circuit causes the device to shut off the motor.

20. In combination, an oil burner motor, a switch for the motor, a thermostat to control the motor through said switch, a mechanical motive device for operating said switch, disengageable clutch means transmitting power from said motor to said motive device, means controlled by the thermostat to move said switch from open to closed position, said motive device serving to permit automatic opening of the switch, and means also controlled by the thermostat to control the engagement of the power clutch means.

21. In combination, a burner motor, a switch therefor, a thermostat responsive to the heat from the burner operated by the motor, a mechanical motive device arranged to stop the motor, a clutch connection between the motor and said device to transmit power to said device, means arranged so that said clutch may be operatively connected and disengaged under control of the thermostat whereby to move said device to open the motor switch, and other means also under control of the thermostat to close the switch to move said device into a position to disengage said clutch from the burner motor.

22. In combination, a motor adapted to operate a heating unit, a thermostat subjected to heat from said unit, said thermostat having two circuits therethrough, both of said circuits being closed in the thermostat when heat is demanded, both circuits being opened when no heat is demanded, and but

one of said circuits being closed within a given desired range of temperature, an electromagnet associated with said thermostat and arranged to be common to both circuits, a controlling mechanism for initiating the starting and stopping operations of the burner motor, said mechanism having two positions, the mechanism in one position permitting automatic stopping of the motor, a clutch connection from the motor to said device, said mechanism including means operable by current through the electromagnet to hold the clutch out of engagement in the other position of the mechanism, said means upon breaking the current serving to permit automatic reengagement of the clutch to move the mechanism again to the first position, and means operable by current through the other circuit of the thermostat to again start the motor.

23. In a motor-operated oil-burner control in combination, a motor switch for starting and stopping the burner, means tending normally to open said switch to stop the burner, a control cam movable by the motor into a predetermined position to permit said means to open the switch to stop the motor, said cam in other positions preventing the opening of the switch, and an electromagnet arranged when energized to close the switch whereby the motor moves the cam to maintain the switch closed against the means tending to open it.

24. In a motor-operated oil-burner control, in combination, a motor switch, means tending normally to open said switch, cam means movable into a predetermined position to permit said means to open the switch, said cam in other positions preventing the opening of the switch, an electromagnet, a member arranged to be moved by the magnet upon energization to close the switch, said cam being moved by the motor on closure of the switch, said member having an impositive mechanical connection with said switch whereby said member may return to its initial position on release by the magnet upon deenergization while the switch is held closed by said cam means.

25. In an oil burner, in combination, a control device movable into two stopped positions corresponding to the idle and the operative conditions of the oil burner, a nozzle, a pressure oil supply, a shut-off valve interposed between the oil supply and the nozzle, a cam included in the control device arranged to open the oil valve just prior to the stopping of the control device in the operative condition of the burner, and further arranged to close the oil valve soon after the beginning of the transitional movement of the control device to its other stopped position corresponding to the idle condition of the burner.

26. In combination, a burner motor, a

nozzle, means to feed oil to the nozzle, an electric igniter for the oil situated adjacent to the nozzle, said igniter being arranged for continuous operation during the feeding of fuel, a switch positioned in the igniter circuit to cut out the igniter at will during the operative period of the burner, and means associated with the burner motor for compelling closing of said switch except during the operative period of the burner whereby said switch is always closed upon starting the burner until opened at will during the operative period.

27. In an oil burner, in combination, an ignition switch arranged to be held frictionally in open or closed position, a cam means movable into a predetermined position during the operative period of the burner to permit opening of said switch at will, said cam means in all other positions serving to close said switch and being ineffective to open said switch, said cam means being moved out of said predetermined position during the inoperative period of the burner.

28. An automatically controlled oil burner having, in combination, a burner motor, a switch to control said motor, a thermostat, an electromagnet energized by said thermostat when heat is demanded, a movable device adapted to remain stopped in one of two positions corresponding to the idle and the operating periods of the burner, a secondary power means to move said device by power under control of the motor switch, a power cut-off for said secondary power means, said cut-off having a power-on and a power-off position, the movable device in the burner-idle position permitting automatic opening of the motor switch and compelling the secondary power cut-off to occupy its power-on position, the movable device being adapted on reaching its burner-operative position to permit said cut-off device to occupy automatically its power-off position and compelling and maintaining closure of the motor switch, and means arranged to be affected by said electromagnet when energized to close the motor switch if open whereby to start the burner, and when de-energized to move the cut-out device into its power-on position, whereby to move said device into its burner-idle position to effect automatic stopping of the burner motor.

29. A motor operated oil burner having, in combination, a motor to operate the burner, a thermostat, means controlled by said thermostat for starting and stopping said motor, an electric ignition device having an electric circuit and arranged normally to operate while said motor is running, and a switch in said circuit associated with said means so as to permit opening of said circuit by said switch while said motor is running and arranged invariably to be in closed position

when said means is operated to start said motor.

In testimony whereof, I have hereunto affixed my signature.

GUSTAF DAVID SUNDSTRAND.

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CERTIFICATE OF CORRECTION.

Patent No. 1,735,911.

Granted November 19, 1929, to

GUSTAF DAVID SUNDSTRAND.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, lines 83 and 86, for the word "alternatively" read "alternately"; page 8, line 28, for "indented" read "identified"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 31st day of December, A. D. 1929.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.