Feb. 14, 1933. J. H. McILVAINE 1,897,318

APPARATUS FOR BURNING LIQUID FUEL

Filed Dec. 8, 1923 3 Sheets-Sheet 1

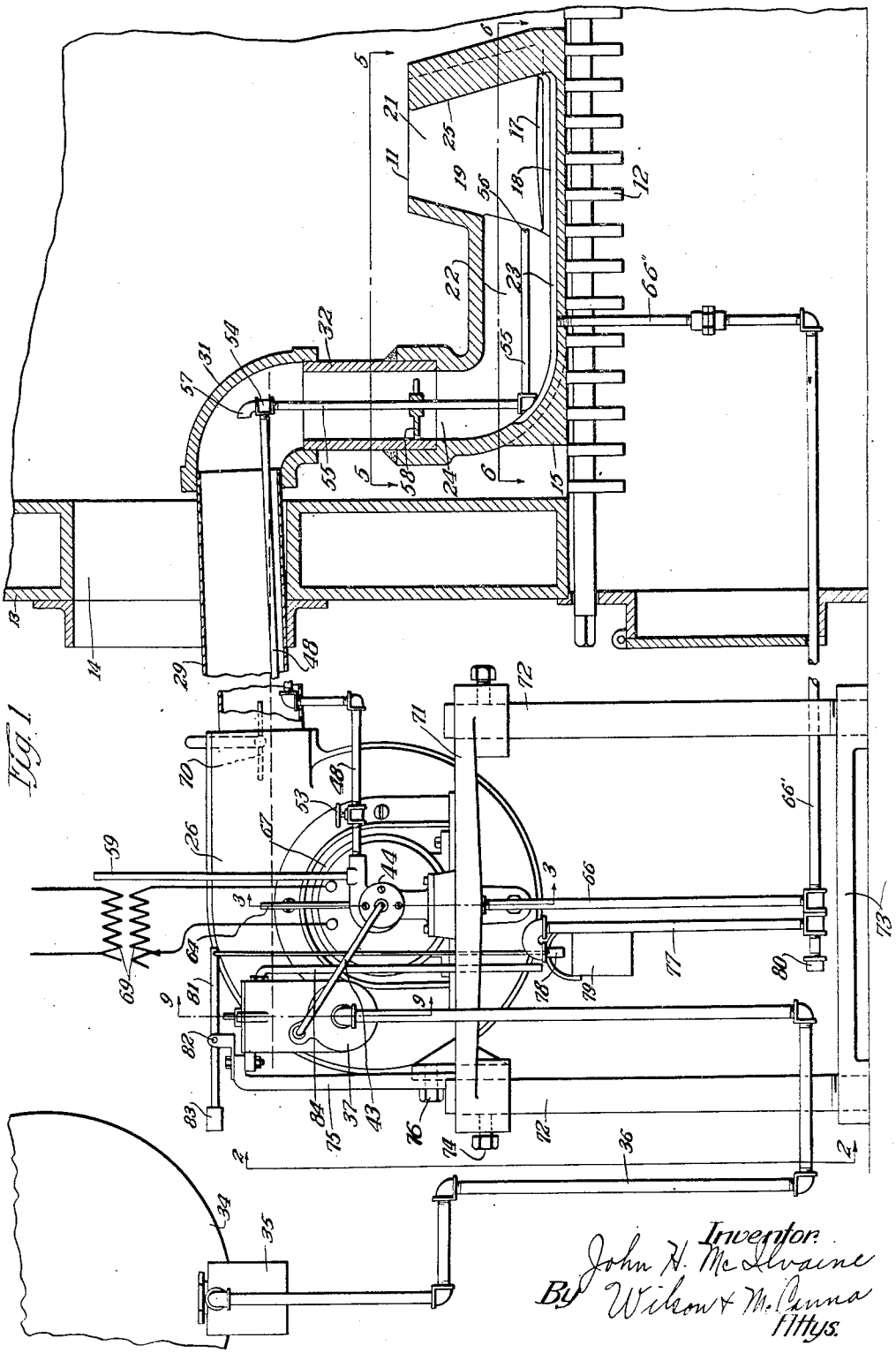

Fig. 1

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Fig. 2.

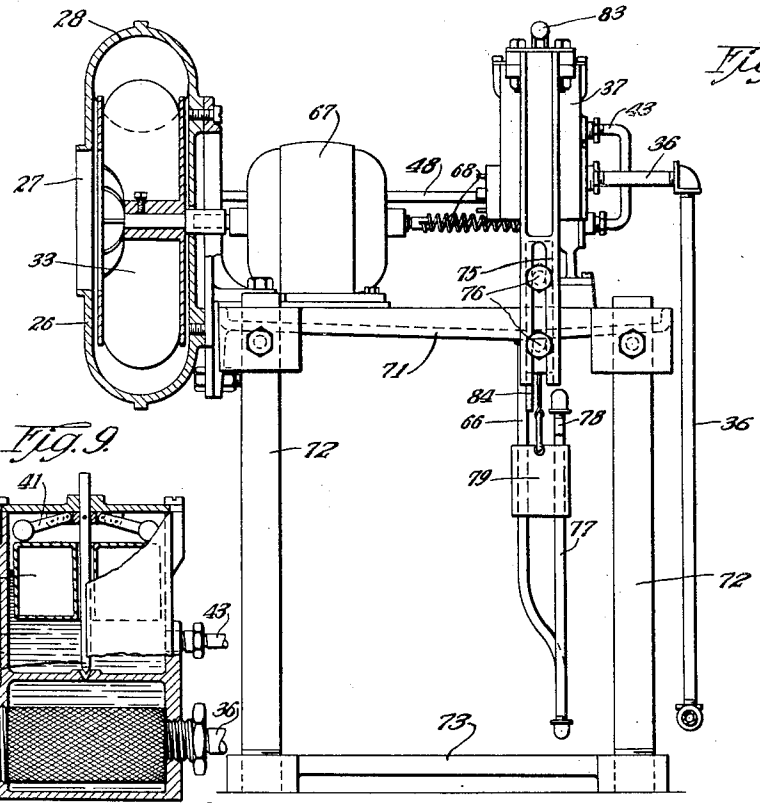

Fig. 9.

Fig. 3.

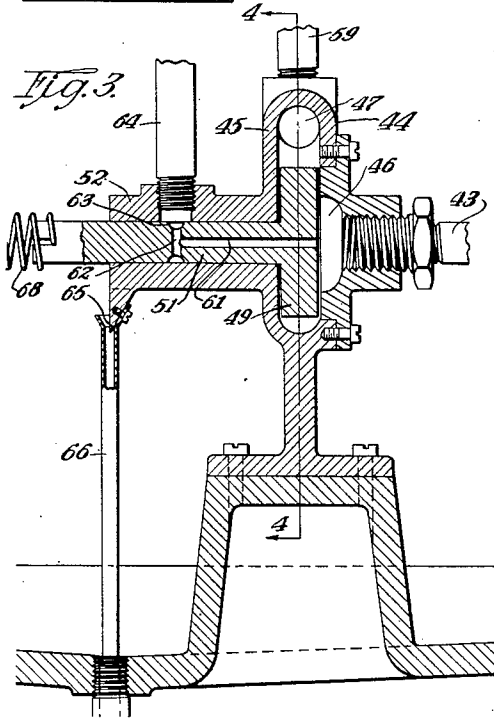

Fig. 4.

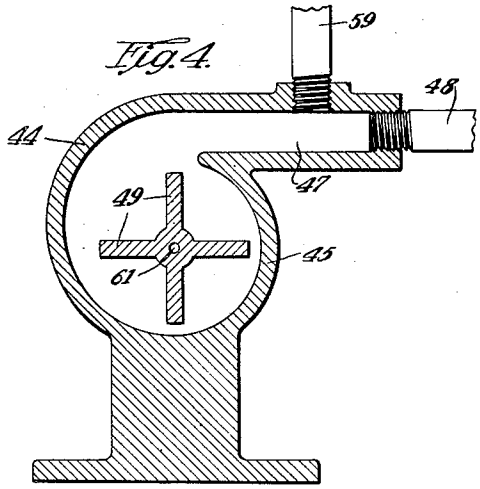

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Fig. 5.

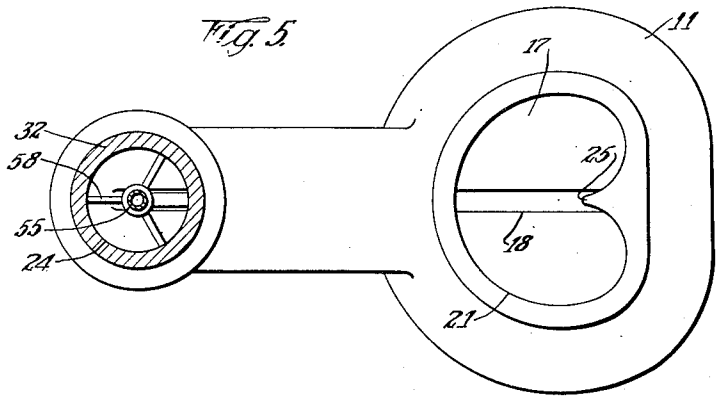


Fig. 6.

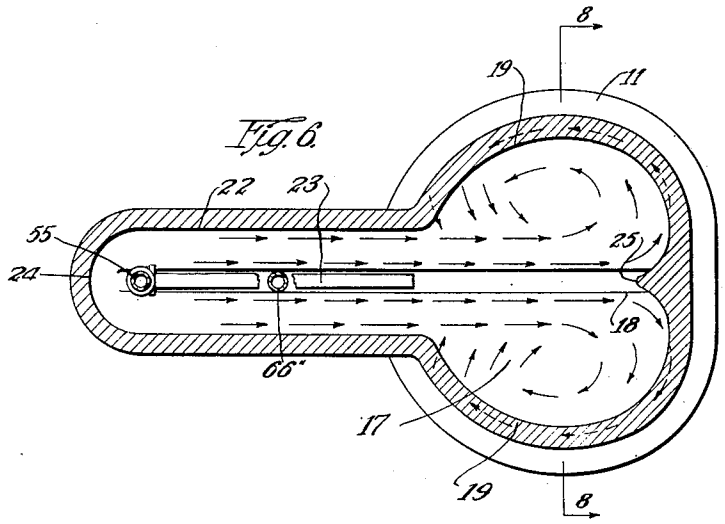


Fig. 7.

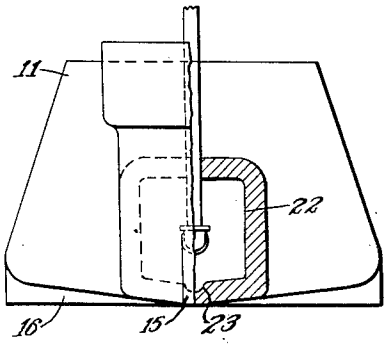
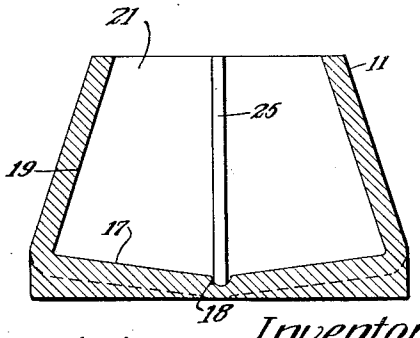


Fig. 8.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR BURNING LIQUID FUEL

Application filed December 8, 1923. Serial No. 679,467.

This invention pertains in general to apparatus for burning liquid fuel, and more particularly to oil burners so called, for heating, and power plants adapted for both industrial and domestic purposes.

My invention as herein illustrated is, however, particularly designed for house heating, as for example, by installation in connection with a furnace, hot water heater, or boiler.

The primary object of the present invention is to provide simplified and improved apparatus of this character, which may be produced and installed at a comparatively low cost and will have a low operating and maintenance cost and will be efficient and economical in its fuel consumption.

In furtherance of this general object, my invention contemplates the provision of apparatus embodying new principles of construction and operation, briefly described as follows:

I have provided a burner that is operated continuously as distinguished from those types which operate intermittently or periodically. That is, certain types of oil burners are designed to operate only at such times and duration under the thermostatic control, as is necessary to maintain a given heat. During these periods of operation the fuel consumption is at a comparatively high rate. Furthermore, the repeated starting and stopping necessitates the provision of ignition means and an automatic control therefor. This intermittent operation with its sudden and extreme change of temperature in the fire pot and consequent expansion and contraction thereof, sooner or later, invariably causes the fire pot to crack, requiring replacement; and when such apparatus is used for heating a boiler, the latter is subjected to severe strains by the high temperature and sudden changes. Also in most instances where the apparatus is intermittently operated, the liquid fuel is atomized, thus necessitating high fuel pressures, additional equipment and more power to operate the same. It follows that this periodic operation involves the provision of special mechanism of a more or less complicated nature for controlling the fuel and air supply and the ignition means and for starting and stopping the apparatus. On the other hand, in a system such as I have devised, the apparatus operates continuously, producing such heat as is needed. For example, in the fall and spring when only a small amount of heat is required, the fuel and air delivery will be regulated so that a comparatively small flame will be burned continuously. When greater heat is required, the fuel and air will be increased accordingly; such delivery being increased or diminished at will by manual operation or automatically as by means of a gradual thermostatic control, so that only the necessary heat is produced. However, an important consideration is that I am able to burn a much lower flame and consume considerably less current for operation than is possible with apparatus of the kind which operates intermittently. One of the reasons for this is the novel method of and means for feeding the liquid fuel and air to the combustion chamber and of controlling the feed. My invention contemplates supplying fuel to the in-take of a centrifugal pump under a constant head as by gravity from a supply chamber in which the fuel is maintained at a predetermined level, raising the fuel by means of the pump to a head higher than the in-take of said pump, delivering the fuel from the outlet of said pump to an overflow point, the elevation of which is but slightly greater than the level of fuel in said chamber, and permitting the fuel to feed by gravity from said overflow point to a discharge point in proximity to the combustion chamber and in the presence of the air which is simultaneously delivered to the combustion chamber at a predetermined velocity. The fuel will be vaporized by contact with the fire pot or by any suitable means and mixed with the air, providing a combustible mixture. As a result, the fuel feed is positively controlled and but little power is required, as will be explained more fully hereinafter; and in the event that the pump stops, the feed of the fuel to the combustion chamber will cease, as distinguished from some systems wherein the fuel continues to feed to the combustion chamber after some casualty interrupts the normal operation.

Another feature of my invention is that in a system of the character described, I am enabled to employ a comparatively small electric motor for driving the blower and pump, with a commensurate low current consumption, this being due mainly to the fact that the air and oil are delivered at low pressures and the pump friction is reduced to a minimum, as hereinafter described. And because there are no static heads to overcome in either the air or fuel lines, but only frictional resistances, it follows that the amounts of air and oil delivered by this apparatus, and consequently the resultant heat, are proportional to the speed of rotation of the motor. Control of the motor speed, therefore, by any suitable means governs the operation of the apparatus and gives a variable heat which may be easily and accurately controlled. However, it should be understood that my invention is not limited to the use of a variable speed motor, as the motor speed might be constant and the fuel and air be varied as will be explained hereinafter.

Other features covered in a divisional application Serial No. 70,754, filed November 23, 1925, are found in the construction of the centrifugal fuel pump and the method of supplying fuel thereto and of delivering it to the combustion chamber, the omission of a pump stuffing box and the method of burning fuel leakage therefrom, as well as the provision of safety devices for shutting off the fuel supply in the event that the flame should for any reason be extinguished, and the provision of a novel structure for adjustably supporting the several devices.

Other objects and attendant advantages will be appreciated by those skilled in this art as the invention becomes better understood by reference to the following description when considered in connection with the accompanying drawings, in which—

Figure 1 is a side elevation partly in section, of a liquid fuel burner embodying my invention;

Fig. 2 is a vertical section taken substantially on the line 2—2 of Fig. 1, with the blower also in vertical section;

Fig. 3 is an enlarged fragmentary section through the centrifugal fuel pump taken substantially on the line 3—3 of Fig. 1;

Fig. 4 is a vertical section through the centrifugal pump taken substantially on the line 4—4 of Fig. 3;

Fig. 5 is an enlarged top view of the fire pot;

Fig. 6 is a horizontal section through the fire pot on the same enlarged scale, taken substantially on the line 6—6 of Fig. 1;

Fig. 7 is an end view of the fire pot;

Fig. 8 is a vertical sectional view of the fire pot taken on the line 8—8 of Fig. 6; and

Fig. 9 is a vertical sectional view through the float valve taken substantially on the line 9—9 of Fig. 1.

The following description is for purpose of clearness, under subject titles, viz: combustion chamber, air delivery means, fuel delivery means, operating means, frame structure, safety provisions and general operation; this in no way limiting the scope of the invention.

Combustion chamber

The combustion chamber or fire pot designated generally by 11, may be supported by any suitable means and in co-operative relation with any apparatus to be heated. In the present illustration of my invention, the fire pot is supported on the grate bars 12 of a furnace 13, such as is used for house heating. In this instance, the fire pot is of such size that it may be in inserted through the fire door opening 14 and simply placed on the grate bars, the fire pot having ribs 15 and 16 on its bottom for maintaining it in a level position. The fire pot is characterized by a bottom wall 17, which inclines downwardly at both sides to a trough 18 located at the center and parallel with the plane in which the air and fuel is delivered to the combustion chamber. The sides of the combustion chamber are defined or bounded by an arcuate wall 19 at each side of said center, these walls converging upwardly from the bottom wall 17 and providing a constricted open top 21. Liquid fuel and air are delivered into the combustion chamber, as will be explained more fully hereinafter through a throat 22, the bottom of which is substantially co-planar with the bottom wall of the fire pot and which has a fuel channel or trough 23 along its center, this being a continuation of the trough 18 above referred to. In this instance, said throat has an upstanding elbow providing an inlet opening 24 for connection with an air delivery pipe which will be later described. The side walls of the fire pot are shaped to provide an inwardly reaching ridge 25 disposed diametrically opposite from the throat 22, reaching from top to bottom of the combustion chamber and following the vertical inclination of its side walls. It will be here noted that each side wall 19 is substantially involute, the curvature of which is greatest at the ridge 25.

The functioning of the fire pot is briefly as follows: Air will be delivered at a predetermined velocity through the inlet opening 24 and the throat 22 into the combustion chamber by means described hereinafter, and liquid fuel will be delivered by gravity into the trough 18 at the entrance to the combustion chamber, as also will be described hereinafter. The liquid fuel flows along said trough 18 and is confined thereby to a definite channel so as to insure equal distribution of

vapor on both sides of the combustion chamber. Assuming that the fire pot is heated, the liquid fuel will be vaporized by contact with the heated bottom thereof, the vaporization occurring in the presence of the incoming air and providing a combustible mixture. Combustion occurs practically instantaneously, and the burning mixture impinges on the ridge 25 and is divided thereby into opposite currents or flames which follow the wall 19 and are caused thereby to whirl or rotate in the combustion chamber as indicated by the arrows in Fig. 6. The inclined side walls of the combustion chamber cause the flames to be directed downwardly so as to hug the bottom as long as possible and to be thrown together as they reach the throat opening. These flames by reason of the curvature of the side walls 19 and of being thrown together against the incoming current delivered through the throat will be caused to rotate as above mentioned. The horizontal cross-section of the combustion chamber and the cross section of the throat are so proportioned that the air currents produced thereby and resulting in two oppositely whirling or rotating flames will burn with a bright clean flame and will leave no dead spaces in the combustion chamber for the formation of unburned carbon caused by incomplete combustion. These proportions also insure the maintenance of a low flame when operating at a low speed as will be explained hereinafter, without the flame blowing out. It should be understood that the apparatus of this invention is not limited to use with this special fire pot nor any other open top pot but is adapted for use with other types of fire pots open at the side, front or otherwise.

Air delivery means

Air is delivered by suitable means to the inlet opening 24 of the throat 22 for mixture in predetermined proportions with the liquid fuel for providing the desired combustible mixture in the fire pot. I prefer to deliver this air by means of a centrifugal blower or fan, designated generally by 26 having an air inlet opening 27 and a delivery opening 28, the latter of which is connected by a slightly inclined pipe section 29, an elbow 31, and a vertical pipe section 32, with the inlet opening 24 of the fire pot structure above described. It will be manifest that by varying the speed of the impeller 33, the amount of air, that is, the cubic feet per hour delivered to the combustion chamber may be varied. While in the present instance the air delivery pipe passes through the fire door opening 14, it should be understood that this condition in the design is imposed by reason of the application of my improvements to a furnace changed over to oil burning, and that where the conditions and requirements differ from the present, the air delivery pipe or line may be otherwise suitably arranged between the blower and the fire pot.

Fuel delivery means

This apparatus is designed to burn oil of a low grade, the present embodiment being intended to burn oil having a specific gravity not higher than 30 degrees Baumé, commercially known as gas oil. A suitable oil supply tank 34 is supported at such height from the floor that the oil will flow by gravity to the fire pot. My invention contemplates, however, interposing in the oil supply line, devices for delivering a predetermined and uniform quantity of oil to the burner per hour, and means whereby this feed of oil may be varied and regulated so as to burn a steady low flame, or to increase the feed gradually to the maximum for correspondingly increasing the flame and heat production.

To this end I employ a small centrifugal pump to which oil is fed to the intake side at a uniform low pressure by gravity from a chamber in which a predetermined level is maintained by a float controlled valve, in turn fed by gravity from the service tank 34. As shown in Fig. 1, the oil flows from said tank through a suitable strainer 35 and pipe line 36 to the float valve designated generally by 37. This valve may be of any suitable or preferred construction, and at present I have shown one of conventional design for maintaining the oil at a constant level at all loads. This comprises a float 38 in the chamber 39 adapted to actuate through connections 41, a needle valve 42 for maintainng the oil in the chamber 39 at a predetermined level, said chamber being fed through the pipe connection 36, and such feed being controlled by the needle valve 42 as will be obvious. Oil from the chamber 39 flows through a pipe connection 43 to the inlet side of a centrifugal pump designated generally by 44, the float valve being supported above the pump so as to insure the desired constant flow thereto.

The centrifugal pump, best shown in Figs. 3 and 4, comprises a casing 45 having an inlet side 46 to which the pipe 43 connects, and an outlet opening 47 connected to a delivery pipe line, designated generally by 48, and a blade impeller 49 carried by a shaft 51 journaled in the bearing portion 52 of the casing. The impeller shaft will be constantly driven in a clockwise direction viewing Fig. 4, by means described hereinafter, thereby raising the pressure of the oil to a comparatively low pressure head in proportion to the square of the speed. The oil escapes from the outlet side of the pump through an adjusting valve 53 in the oil delivery line 48 to an overflow point 54, the elevation of which is from one-eighth to one-fourth of an inch above the constant level of the oil in the float chamber 39. The escape of oil through the valve 53 is pro-

portional to the square root of the head at the outlet or discharge side of the pump, and consequently proportional to the pump speed. The oil overflows at the point 54 into a pipe 55 and flows by gravity to a discharge point 56 approximately at the juncture of the throat 22 and the combustion chamber. It will be observed that the oil delivery line at the point 54 is open to the air pressure in the air delivery pipe 29 through means of an upstanding L 57 or the equivalent facing into the air stream so as to scoop air into the vertical pipe 55. This air pressure prevents the oil from overflowing and running down on the outside of the pipe 55 and insures a constant feed of oil through said pipe as well as minimizing danger of oil adhering to the inside walls of the pipe 55 and possibly clogging the same. If the oil delivery pipe line were closed as at the point 54, a siphon action would result which would destroy the proper proportion of the fuel and air delivery sought. In order to insure against vaporization of oil in the pipe 55 it is supported in the center of the air pipe 32 and the throat 22 by means of a spider bracket 58, so as to be substantially out of contact with the heated walls of said pipe and the fire pot throat.

The foregoing apparatus gives a positively controlled delivery of oil to the combustion chamber, the feed being proportional to the speed of the impeller.

It will be further observed that by maintaining a low head of oil by means of the centrifugal pump from which head the oil feeds through a restricted regulating orifice to an overflow point and thence by gravity to the combustion chamber, the feed will be continuous and uniform in amount rather than intermittent or in gulps and will cease when the motor stops.

In order to further insure a uniform feed of oil, I have provided the standpipe 59, in which the oil is arranged to rise in proportion to the speed of operation of the pump, a substantially uniform head of oil being ordinarily maintained in said pipe so that the oil is delivered in a steady stream into the fire pot. I also guard against a condition which would tend to prevent the uniform feeding of oil, by providing means for preventing any air from being delivered by the pump. In experimenting, I have found that the churning of oil by the rapid revolution of the impeller causes the formation of small bubbles of air or gas, some of which will escape through the pump's outlet and rise in the standpipe 59 which is open to the atmosphere. Also some of the bubbles gather at the center of the impeller casing; and to remove the latter bubbles the shaft 51 is drilled axially as at 61, to a point intermediate the end of the bearing 52, at which point this axial hole is intersected by a diametrical hole 62, and the latter by a groove 63 turned in the periphery of the shaft. Air accumulating at the center of the impeller casing will pass through such holes and escape through a standpipe 64 which is in communication with the peripheral groove 63.

Inasmuch as I have aimed in this invention to reduce pressures and resistances to a minimum in order to reduce the electric current consumption required for operating the centrifugal pump, without however, impairing accuracy and reliability of control and regulation, I have also reduced the pump shaft friction to a minimum by making the pump without a stuffing box. The impeller shaft is fitted in its bearings with a small clearance which allows only a few drops of oil leakage per minute. This leaking oil may be conveyed to any receptacle, but I prefer to conduct it to the bottom of the charging throat of the fire pot so that it may be mixed with the main oil supply and be vaporized and burned therewith. As shown in Figs. 1, 2 and 3, this leaking oil is conveyed through a drain pipe 66 having a horizontal portion 66′ leading to a point beneath the fire pot, and a riser portion 66″ entering the bottom of the throat 22.

Operating means

The centrifugal blower and centrifugal oil pump are both preferably driven by a single electric motor 67. As shown in Fig. 2, this motor is interposed between and directly connected to the blower and pump. For convenience in assembling and so as not to require extreme accuracy in aligning these devices, I fix the blower shaft directly to the motor and provide a flexible connection, through means of a coil compression spring 68, to the impeller shaft 51. It will thus be seen that inasmuch as the blower and pump are directly connected by the motor and there are no static heads or resistances in the oil and air lines than frictional to overcome, the amounts of air and oil delivered to the fire pot will be proportional to the speed of rotation of the motor.

The motor speed may be regulated in any suitable manner, as for example, by a speed regulator in the form either of a rheostat or an adjustable transformer, the latter being diagrammatically shown in the present instance, and indicated by 69. This speed regulator in turn may be controlled either by hand or automatically as by means of a thermostatic control, well known in this art.

A constant speed motor may be used in place of a variable speed motor, and in this event, a suitable means such as a butterfly valve 70 will be employed for regulating the air delivery. In such case, both the valves 53 and 70 would have to be adjusted in proportion when increasing or decreasing the fuel feed.

In view of the little power required to operate the blower and pump continuously, a comparatively small electric motor may be used and the electric current consumption will be correspondingly small.

Frame structure

I prefer to mount the blower, motor, pump and float valve in co-operative relation on a frame 71 in turn supported on a plurality of legs or posts 72 with capacity for vertical adjustment thereon, so that the pump and blower may be positioned at the desired elevation. At present the posts 72 are fixed to a base 73, and set screws 74 are used for adjustably securing the frame 71 on the posts. Suitable pads are provided on the frame 71 for supporting the blower, motor and pump in substantially co-axial relation. The float valve is attached to a bracket 75 vertically adjustable upon and with respect to the frame 71, set screws 76 serving to secure the bracket 75 in any adjusted position.

The purpose of the foregoing adjustments is obviously to position the pump at the desired level below the overflow point 54 of the oil feed and to position the float valve so that its constant level is about one-eighth of an inch or more below said overflow point and sufficiently above the pump inlet as to insure gravity feed thereto.

Safety provisions

Means is provided for automatically stopping the delivery of oil to the centrifugal pump 44 in the event that the flame in the combustion chamber should, for any reason be extinguished, and in such event the fire pot will obviously be cooled rapidly by the delivery of air and oil until vaporization ceases. The oil delivered to the fire pot will then rise therein, and this rising level will overflow into a receptacle, which will be actuated by the weight of the fuel to shut off the oil supply at the float valve. At present, this overflow is obtained through a pipe 77, which rises from the pipe 66′ to a level above the bottom of the fire pot and has a downturned overflow end 78 adapted to discharge into a suitable receptacle or bucket 79. This bucket is suspended from one end of a lever 81 pivotally mounted at 82 on the upper end of the bracket 75, the lever being positioned over the upper end of the needle valve 42 as shown in Figs. 1 and 9, and normally held in this inoperative position by a counter-balancing weight 83. When the level of the oil rises in the fire pot and overflows through the overflow pipe 77—78, the bucket 79 will be filled sufficiently to overcome the weight 83 and depress the lever 81, thereby closing the needle valve and stopping delivery of oil to the chamber 39, and consequently to the centrifugal pump. Should the float 38 for any reason sink in its chamber, or fail to properly function in maintaining the desired level therein, the oil level would rise in said chamber and overflow through the pipe 84 to the bucket 79, thereby shutting off the oil supply in the manner just described. After the burner has been stopped by the trip bucket due to the oil level rising in the combustion chamber, the standing oil in said chamber may be drained by removing a plug 80 before starting the burner. It is not necessary, however, to do this before starting, as the oil in the combustion chamber will be burned but with a longer flame and not as efficiently as with only the regulated feed of oil.

General operation

When starting the burner, the fire pot will be preheated by any suitable means, so that when the oil feed is started by opening the valve 53, it will be vaporized by contact with the heated pot as described above, and will be ignited by such heating means. In a burner such as disclosed herein, especially adapted for house heating, I operate the motor at variable speeds between what I term a "low load" at 300 R. P. M. and "high load" at between 2300 and 2400 R. P. M. Under the low load the centrifugal pump will deliver approximately one-fourth of a gallon of oil per hour and at the high load two gallons per hour. The blower delivers approximately 330 and 2640 cubic feet of air per hour at the low and high loads, respectively. These figures are, of course, merely illustrative of one practical example of the operation of my invention and show relatively the economies in fuel consumption. In the event that a thermostatic control is used for stepping the speeds of the motor up or down accordingly as a greater or less heat is required to maintain a given temperature in the room or rooms to be heated, the motor will never be stopped but its speed will be gradually increased or diminished, as may be done with standard controls of this kind on the market.

When starting the burner the valve 53 will be adjusted until the oil delivery is in the proper proportion to the air delivery and produces the desired combustible mixture. After once setting the valve the amounts of air and oil delivered are proportional to the speed of the motor as described above.

In an emergency such as caused by complete failure of the electric power or inability to secure oil the apparatus herein described may be easily removed from the furnace; and due to the fact that the grate bars have not been removed when installing the burner, the furnace is ready for immediate use with the usual fuels.

It is believed that the foregoing conveys a clear understanding of the objects and principles of my invention, and it should be understood that when putting these into

practice, various changes might be made in the construction and arrangement of the necessary parts and devices without departing from the spirit and scope of the invention as expressed in the appended claims, in which—

I claim:

1. Apparatus for burning liquid fuel comprising in combination with a furnace, an open combustion chamber positioned in the fire box of the furnace and having an air inlet, an air delivery pipe passing through the fire door opening of the furnace and having a downturned end delivering into said inlet, and a liquid fuel delivery pipe for delivering fuel under pressure, said pipe having an overflow point therein and, extending from this point, having a gravity feed portion within said downturned portion of the air pipe, the last mentioned portion of said fuel pipe being open to the air pressure therein at the overflow point at its upper end and discharging at its lower end into the combustion chamber.

2. Apparatus for burning liquid fuel comprising in combination with a furnace, a fire pot adapted to be positioned in the fire box of the furnace, a blower having an air delivery pipe extending through the furnace fire door opening and delivering into the fire pot, a fuel supply tank, a float valve, the float chamber of which is fed by fuel from said tank, a pump fed by fuel from said chamber and adapted for delivering fuel to the fire pot, an electric motor for driving the blower and pump, and a vertically adjustable frame carrying the blower, pump, motor and float valve, and means for adjusting the float valve bodily upon and with respect to said frame.

3. Apparatus for burning liquid fuel comprising in combination with a furnace, a fire pot adapted for positioning in the fire box of the furnace at a certain elevation, a supporting frame for liquid fuel burning apparatus, a standard therefor on which said frame is vertically adjustable, a liquid fuel pump supported on said frame arranged to deliver fuel to the fire pot at a predetermined pressure head, and a float chamber supported on said frame at a predetermined elevation above said pump for delivering fuel to the latter, and means for adjusting said float chamber bodily upon and with respect to said frame.

4. Apparatus for burning liquid fuel comprising in combination with a furnace, a fire pot adapted for positioning in the fire box of the furnace at a certain elevation, a supporting frame for liquid fuel burning apparatus, a standard therefor on which said frame is vertically adjustable, a liquid fuel pump supported on said frame, a fuel delivery line extending from said pump to said fire pot having an intermediate overflow portion at a predetermined elevation with respect to said pump whereby to deliver fuel to said fire pot by gravity at a predetermined pressure head, a float chamber for delivering fuel to said pump disposed above the level of said pump, and means for adjusting said float chamber vertically with respect to said frame and relative to said pump to maintain a certain elevation of said float chamber relative to the level of the overflow portion in said fuel delivery line.

5. Apparatus for burning liquid fuel comprising in combination with a furnace, a fire pot adapted for positioning in the fire box of the furnace, a liquid fuel pump for delivering fuel to the fire pot, a fuel delivery line extending from said pump to said fire pot having an intermediate overflow portion at a predetermined head with respect to the pump whereby to deliver fuel to said fire pot by gravity at a certain desired low pressure head, and a float chamber for delivering fuel to said pump by gravity at a certain desired head, said float chamber being vertically adjustable with respect to said pump to secure the desired gravity feed to the latter and to maintain a predetermined desired elevation below the level of the overflow portion of said fuel delivery line.

6. In an apparatus for burning liquid fuel comprising a combustion chamber having means for delivering air thereto, a constant level means for supplying fuel at a constant head, a fuel feed line supplied thereby and extending to the combustion chamber, said line having an overflow point above the aforesaid constant level, a pump between said means and said overflow point to be supplied with fuel by said means, and a stand-pipe between said pump and said overflow point, said pump being arranged to build up a pressure on the fuel in said line to a head in said stand-pipe above the level of the overflow point in order to feed fuel under pressure to the combustion chamber, the head of fuel supplied and the consequent rate of feeding of fuel being proportionate to the speed of operation of the pump.

7. An oil burner comprising a combustion chamber having an air inlet opening, said chamber having means for supplying liquid fuel along with the air delivered, the chamber being of elongated form with he air inlet at one end thereof and the flame outlet at the other end thereof, the latter being in the top of said chamber, an upright dividing ridge on the end wall of said chamber at the latter end thereof diametrically opposite the air inlet, and a fuel trough provided in the middle of the bottom of said chamber and reaching in a line from the air inlet to the dividing ridge, the ridge and the trough substantially dividing the chamber into half portions so as to insure equal distribution of the fuel vapors on both sides of the combustion chamber.

8. Apparatus for burning liquid fuel comprising an open combustion chamber ar-

ranged to be positioned in the bottom of a furnace fire box, the combustion chamber having a throat portion emanating from one side, a blower, a delivery pipe between the blower and the throat portion arranged to pass through the fire door opening of the furnace and having a vertically disposed portion delivering into the top of said throat, and a pipe line for delivering liquid fuel to the combustion chamber under variable pressure, said pipe line having an overflow point therein and beyond this point extending downwardly into said throat and discharging approximately at the junction of the throat and the combustion chamber.

9. Apparatus for burning liquid fuel comprising an open combustion chamber arranged to be positioned in the bottom of a furnace fire box, the combustion chamber having an air inlet opening, a blower, a delivery pipe between the blower and the inlet arranged to pass through the fire door opening of the furnace and having a vertically disposed portion delivering downwardly into said inlet, there being a pump to provide for variable pressures of fuel feeding, and a pipe line for delivering liquid fuel to the combustion chamber under variable pressure, said pipe line having an overflow point therein and beyond this point extending downwardly and discharging into the combustion chamber, and said pipe line having a stand pipe wherein a head of fuel is arranged to be built up above the level of the overflow point.

10. Apparatus for burning liquid fuel comprising an open combustion chamber arranged to be positioned in the bottom of a furnace fire box, the combustion chamber having an air inlet opening, a blower, a delivery pipe between the blower and the inlet arranged to pass through the fire door opening of the furnace and having a vertically disposed portion delivering downwardly into said inlet, there being a pump to provide for variable pressures of fuel feeding, and a pipe line for delivering liquid fuel to the combustion chamber under variable pressure, said pipe line having an overflow point therein and beyond this point extending downwardly and discharging into the combustion chamber, and said pipe line having a siphoning preventing opening therein at the aforesaid overflow point.

11. Apparatus for burning liquid fuel comprising a combustion chamber having means for delivering air thereto, a pump for delivering liquid fuel to said chamber for admixture with the air therein, said pump having a fuel delivery line extending therefrom to the combustion chamber, the pump shaft being without a packing, and a second fuel delivery line having its intake end at the unpacked pump shaft to receive any fuel leaking therefrom, the said second fuel line being extended from the pump for the discharge of the leakage fuel into the combustion chamber with the main fuel delivery thereto.

12. In an apparatus for burning liquid fuel comprising a combustion chamber having means for delivering air thereto, means for supplying fuel at a certain level, a fuel feed line supplied thereby and extending to the combustion chamber, said line having an overflow point just above the level last referred to, a pump between the overflow point and the fuel supply means to be supplied with fuel by the latter, and a stand-pipe between said pump and said overflow point, said pump having a rotary impeller arranged in the operation thereof to raise fuel in said stand-pipe by centrifugal action from the first mentioned level to a point above the level of the overflow point whereby to feed fuel under a predetermined head to the combustion chamber, the head of fuel supplied and the consequent rate of feed of fuel being proportionate to the speed of operation of the pump.

13. A liquid fuel burning apparatus comprising in combination with a furnace, a firepot disposed in the furnace, the same being open for the exposure of the burning combustible mixture and having an air inlet opening into the top thereof, a substantially horizontal air conduit having a downturned portion communicating with said air inlet, a constant level fuel delivery chamber, a fuel delivery pipe communicating therewith and extending in the air conduit up to the downturned portion, the same having a downwardly directed discharge portion in the downturned portion of the air conduit for the delivery of liquid fuel into the firepot, said fuel delivery pipe having an opening at the upper end of the discharge portion whereby to prevent siphoning of fuel from said fuel delivery pipe through said discharge portion, means for supplying air to the air conduit, and means for supplying liquid fuel to the fuel delivery pipe.

14. An apparatus as set forth in claim 13 wherein the fuel delivery pipe has an upwardly projecting portion in which the siphoning preventing opening is provided, said opening being in the direct line of air travel into the firepot.

15. An apparatus as set forth in claim 13 wherein the fuel delivery pipe has an elbow portion reaching upwardly therefrom from above the downwardly extending discharge portion, the elbow being open at the free end thereof to provide the siphoning preventing opening and being disposed with the opening in the direct line of air travel through the horizontal portion of the air conduit.

16. A liquid fuel burning apparatus, comprising in combination with a furnace, a firepot disposed in the furnace, the same being open for the exposure of burning combustible mixture and having an air inlet

opening into the top thereof, an air conduit extending from an air supply means outside the furnace substantially horizontally into the furnace and having a downturned portion communicating with the air inlet for delivering air into the firepot, a constant level fuel delivery chamber, a liquid fuel delivery pipe communicating therewith and extending from a fuel supply means outside the furnace and having a portion thereof extending within the horizontal portion of the air conduit to a discharge point above the air inlet of the firepot, the same being thereby arranged to deliver raw liquid fuel in a thin stream downwardly by gravity into the firepot, said fuel delivery pipe having the discharge point above the level of the rest of the substantially horizontal portion of said pipe, a downwardly directed pipe for conducting the stream of liquid fuel from the discharge point in a predetermined manner into the fire-pot, and an upwardly extending elbow communicating with the fuel delivery pipe at the discharge point and also communicating with the last mentioned downwardly directed pipe, said elbow being disposed with the open end thereof directed toward the horizontal portion of the air conduit.

17. Apparatus for burning liquid fuel, comprising in combination with a furnace, a firepot disposed in the furnace at a certain elevation, a liquid fuel pump having communication with a fuel supply and arranged to pump liquid fuel to a certain elevation above its outlet for a gravity flow to the fire-pot, the outlet of said pump being disposed normally at a certain elevation with respect to the firepot, and a support for said pump adjustable vertically whereby to increase or decrease the head of fuel relative to the firepot.

18. Apparatus for burning liquid fuel, comprising in combination with a furnace, a firepot disposed in the furnace at a certain elevation, a liquid fuel pump having communication with a fuel supply and arranged to pump liquid fuel to a certain elevation above its outlet for gravity flow to the fire-pot, the outlet of said pump being disposed normally at a certain elevation with respect to the firepot, a standpipe reaching upwardly from the outlet of the pump, the fuel being arranged to rise in said pipe in accordance with the speed of operation of the pump to afford different heads of fuel relative to the firepot, and a support for said pump together with its standpipe, the said support being vertically adjustable whereby to change the relationship in elevation of the standpipe relative to the firepot.

19. Apparatus for burning liquid fuel, comprising in combination with a furnace, a firepot disposed in the furnace, a liquid fuel receptacle at one elevation, a liquid fuel pump disposed with its inlet below the receptacle whereby to be supplied with fuel by gravity from the receptacle, said pump being of an impeller type whereby the outlet communicates with the inlet when the pump is not in operation, so that fuel would be capable of flowing through the pump when the same is not in operation, and a fuel delivery line extending from the outlet of the pump to an overflow point for discharge of raw liquid fuel downwardly by gravity into the firepot, said overflow point being disposed above the level of liquid fuel in the receptacle whereby to prevent leakage of oil from the receptacle at the overflow point when the pump is not in operation.

20. An apparatus as set forth in claim 19 including a support for the pump, said support being vertically adjustable whereby to change the elevation of the pump relative to the overflow point.

21. An apparatus as set forth in claim 19 including a standpipe communicating with the outlet of the pump and reaching to an elevation above the overflow point, the standpipe being arranged to have fuel rise therein to a level depending on the speed of operation of the pump, and a support for the pump together with its standpipe, said support being vertically adjustable whereby to change the relationship in elevation between the standpipe and overflow point.

22. An apparatus as set forth in claim 19 including a standpipe communicating with the casing of the pump for permitting the escape of air in the operation of the impeller, the said standpipe reaching to an elevation above the overflow point.

23. An apparatus as set forth in claim 19 including a single support for the pump and liquid fuel receptacle, said support being vertically adjustable whereby to change the elevation of the pump relative to the overflow point, and the liquid fuel receptacle being vertically adjustable relative to the pump on said support whereby to position the same below the level of the overflow point.

24. An apparatus as set forth in claim 19 including a standpipe communicating with the outlet of the pump and reaching to an elevation above the overflow point, the standpipe being arranged to have fuel rise therein to a level depending on the speed of operation of the pump, and a support for the pump together with its standpipe and the liquid fuel receptacle, said support being vertically adjustable whereby to change the relationship in elevation between the standpipe and overflow point, and the liquid fuel receptacle being vertically adjustable relative to the pump on said support whereby to position the same below the level of the overflow point.

25. In an apparatus for burning vaporized liquid fuel, the combination with a combustion chamber, of rotary air impeller means for delivering air to said chamber, means

for supplying fuel, a fuel feed line supplied thereby and extending to the combustion chamber, said line having a discharge point above the level of the supply means, a liquid fuel pump impeller casing in said line between said means and said discharge point, a rotary impeller in said casing arranged to build up a pressure on the fuel in said line to feed fuel under pressure to the combustion chamber, and an atmospheric chamber in said line between the pump and the discharge point wherein a fuel head is arranged to be built up above the level of the discharge point and from whence the fuel is arranged to flow to the discharge point by gravity, the head of fuel supplied and the consequent rate of feeding thereof being proportionate to the speed of operation of said impeller, and said fuel impeller and air impeller being mechanically connected for operation together to maintain a properly proportioned combustible mixture of fuel and air for a given speed of operation of the impellers.

26. In an apparatus for burning liquid fuel, the combination with a combustion chamber, of means for delivering air thereto, a source of fuel supply, a fuel feed line extending therefrom to the combustion chamber, said line having a drop off point for delivery of the fuel by gravity into said chamber, said drop off point being at a level above the source of fuel supply, a pump between the source of fuel supply and the drop off point communicating with the fuel source on one hand and with the fuel feed line on the other, the fuel feed line extending directly from the pump to the drop off point, and a stand-pipe in said fuel feed line between the pump and the drop off point wherein a fuel head is arranged to be built up above the level of the drop off point, the head of fuel supplied and the consequent rate of feeding of fuel being proportionate to the speed of operation of the pump.

27. An apparatus as set forth in claim 26 including a gravity feed pipe portion extending from the drop off point downwardly for discharge into the combustion chamber, and a siphoning preventing opening provided in said gravity feed pipe portion.

28. An apparatus as set forth in claim 26 including a variable restriction valve in the fuel feed line between the stand-pipe and the drop off point for control of the fuel delivery to the combustion chamber.

29. An apparatus as set forth in claim 25 including a gravity feed pipe portion extending from the discharge point downwardly for discharge of fuel into the combustion chamber, and a siphoning preventing opening provided in said gravity feed pipe portion.

30. A liquid fuel burning apparatus comprising in combination with a furnace, a fire-pot disposed in the furnace, the same being open for exposure of the burning combustible mixture and having an air inlet opening, an air conduit communicating with said air inlet for delivering air into the fire-pot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream into the fire-pot so as to be instantaneously split up and vaporized by coming in contact with the hot metal of the fire-pot in the presence of the air delivered into said fire-pot, whereby to form a combustible mixture directly in the fire-pot, a rotary air impeller for supplying air to the air conduit for discharge into the fire-pot, a rotary liquid fuel impeller for supplying liquid fuel to the fuel delivery pipe for discharge into the fire-pot, and a single motor for operating the two impellers together, whereby to provide a properly proportioned combustible mixture of fuel and air.

31. A liquid fuel burning apparatus comprising in combination with a furnace, a fire-pot disposed in the furnace, the same being open for exposure of the burning combustible mixture and having an air inlet opening, an air conduit communicating with said air inlet for delivering air into the fire-pot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream into the fire-pot so as to be instantaneously split up and vaporized by coming in contact with the hot metal of the fire-pot in the presence of the air delivered into said fire-pot, whereby to form a combustible mixture directly in the fire-pot, a rotary air impeller for continuously supplying air to the air conduit for discharge into the fire-pot, a rotary liquid fuel impeller for continuously supplying liquid fuel to the fuel delivery pipe for discharge into the fire-pot, and a single variable speed motor for operating the two impellers together, whereby to provide a properly proportioned combustible mixture of fuel and air at any speed of operation of the motor, the fuel and air continuously delivered serving to maintain a flame in the fire-pot and keep the same hot, whereby a low feed flame is arranged to be built up as the feeding of fuel and air is gradually increased and permit operation without the use of a pilot flame or igniter.

32. A liquid fuel burning apparatus, comprising in combination with a furnace, a fire-pot disposed in the furnace, the same being open for exposure of the burning combustible mixture and having an air inlet opening, an air conduit communicating with said air inlet for delivering air into the fire-pot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream into the fire-pot, the raw liquid fuel being arranged to be instantaneously split up and vaporized by coming in contact with the hot metal of the fire-pot whereby to form the combustible mixture with the air directly in the fire-pot, a fan for

supplying air to the air conduit for discharge into the fire-pot, a pump for supplying liquid fuel to the fuel delivery pipe for discharge into the fire-pot, and a single motor for operating the fan and pump together whereby to maintain a properly proportioned combustible mixture of fuel and air.

33. A liquid fuel burning apparatus, comprising in combination with a furnace, a fire-pot disposed in the furnace, the same being open for exposure of the burning combustible mixture and having an air inlet opening communicating therewith, an air conduit for delivering air into the fire-pot, a liquid fuel delivery pipe arranged so as to discharge raw liquid fuel in a thin stream into the fire-pot so as to be instantaneously split up and vaporized by coming in contact with the hot metal of the fire-pot, whereby to form a combustible mixture directly in the fire-pot, a fan for supplying air to the air conduit for discharge into the fire-pot, a pump for supplying liquid fuel to the fuel delivery pipe for discharge into the fire-pot, and a single variable speed motor for operating the fan and pump together whereby to insure a desired proportion of air and fuel at any speed of operation of the motor, the fuel and air delivered serving to maintain a flame in the fire-pot and keep the same hot, whereby a low feed flame is arranged to be built up as the feeding of fuel and air is gradually increased and permit operation without the use of a pilot flame or igniter.

34. A liquid fuel burning apparatus comprising in combination with a furnace, a fire-pot disposed in the furnace, the same being open for exposure of the burning combustible mixture and having an air inlet opening, an air conduit communicating with said air inlet for delivering air into the fire-pot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream into the fire-pot so as to be instantaneously split up and vaporized by coming in contact with the hot metal of the fire-pot in the presence of the air delivered into said fire-pot, whereby to form a combustible mixture directly in the fire-pot, a rotary air impeller for supplying air to the air conduit for discharge into the fire-pot, a rotary liquid fuel impeller for suplying liquid fuel to the fuel delivery pipe for discharge into the fire-pot, and a single variable speed motor for operating the two impellers together, whereby to provide a properly proportioned combustible mixture of fuel and air at any speed of operation of the motor, the fuel and air delivered serving to maintain a flame in the fire-pot and keep the same hot, whereby a low feed flame is arranged to be built up as the feeding of fuel and air is gradually increased and permit operation without the use of a pilot flame or igniter.

35. In a liquid fuel burning apparatus, the combination with a furnace, of an open fire-pot disposed therein for burning a combustible mixture of liquid fuel and air and having an air inlet opening, an air conduit communicating with the air inlet to deliver air into the firepot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream directly into the firepot, the raw liquid fuel being arranged to be instantaneously split up and vaporized by coming in contact with a hot wall in the firepot whereby to form a combustible mixture with the air wholly within the firepot, a centrifugal fan for continuously supplying air to the air conduit for discharge into the firepot, a centrifugal pump for continuously supplying liquid fuel to the fuel delivery pipe for discharge into the firepot in the manner stated, and a single, continuously operated, variable speed motor for operating the fan and pump together whereby to continuously maintain a properly proportioned but variable combustible mixture of fuel and air, and permit operation without the use of a pilot flame or igniter.

36. In a liquid fuel burning apparatus, the combination with a furnace, of an open fire-pot disposed therein for burning a combustible mixture of liquid fuel and air and having an air inlet opening, an air conduit communicating with the air inlet to deliver air into the fire-pot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream directly into the fire-pot so as to be instantaneously split up and vaporized by coming in contact with a hot wall in the fire-pot, in the presence of the air delivered into said fire-pot, whereby to form a combustible mixture directly in the fire-pot, a fan for continuously supplying air to the air conduit at a variable rate for discharge into the fire-pot, a motor for operating the fan, and means for continuously supplying liquid fuel to the fuel delivery pipe at a variable rate for discharge into the fire-pot, said means serving to deliver a variable amount of fuel in proportion to the air delivered, whereby to provide a properly proportioned combustible mixture of fuel and air, the fuel and air continuously delivered serving to maintain a flame in the fire-pot and keep the same hot for continuously vaporizing fuel, whereby a flame of any size desired is arranged to be built up from a low feed or pilot flame by increasing the feed of fuel and air, so as to operate without necessity for a separate pilot or igniter.

JOHN H. McILVAINE.

DISCLAIMER

1,897,318.—*John H. McIlvaine*, Lake Forest, Ill. APPARATUS FOR BURNING LIQUID FUEL. Patent dated February 14, 1933. Disclaimer filed May 6, 1940, by the assignee, *McIlvaine Burner Corporation*.

Hereby enters this disclaimer to that part of claim 36 which is in excess of the following—

In a liquid fuel burning apparatus, the combination with a furnace, of an open fire-pot disposed therein for burning a combustible mixture of liquid fuel and air and having an air inlet opening, an air conduit communicating with the air inlet to deliver air into the fire-pot, a liquid fuel delivery pipe arranged to discharge raw liquid fuel in a thin stream directly into the fire-pot so as to be instantaneously split up and vaporized by coming in contact with a hot wall in the fire-pot, in the presence of the air delivered into said fire-pot, whereby to form a combustible mixture directly in the fire-pot, a fan means for continuously supplying air to the air conduit at a variable rate for discharge into the fire-pot, a motor for operating the fan means, and means for continuously supplying liquid fuel to the fuel delivery pipe at a variable rate for discharge into the fire-pot, said liquid fuel and fan means interconnected to deliver a variable amount of fuel in proportion to the air delivered, whereby to provide a properly proportioned combustible mixture of fuel and air, the fuel and air continuously delivered serving to maintain a flame in the fire-pot and keep the same hot for continuously vaporizing fuel, whereby a flame of any size desired is arranged to be built up from a low feed or pilot flame by concurrently increasing the feed of fuel and air, so as to operate without necessity for a separate pilot or igniter.

[*Official Gazette May 28, 1940.*]