Oct. 4, 1927. 1,644,372

J. H. GRAY

BURNER FOR LIQUID FUEL

Filed April 21, 1922 2 Sheets-Sheet 1

Fig. 3.

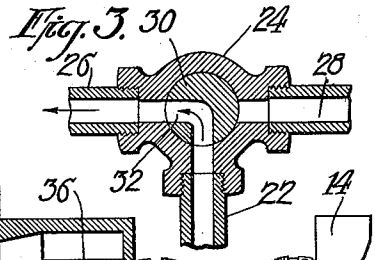


Fig. 1.

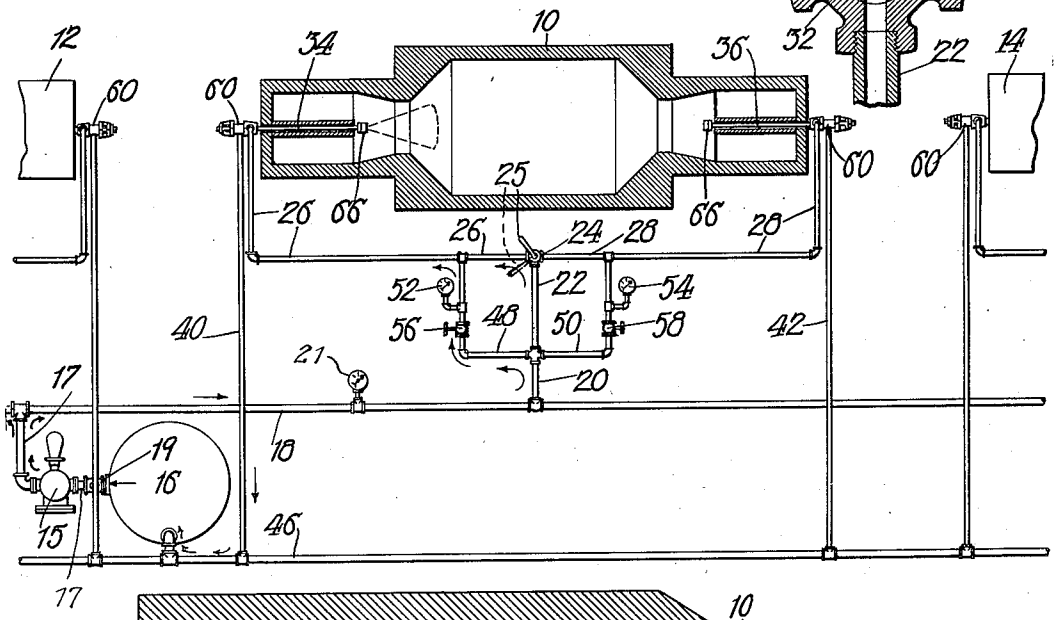
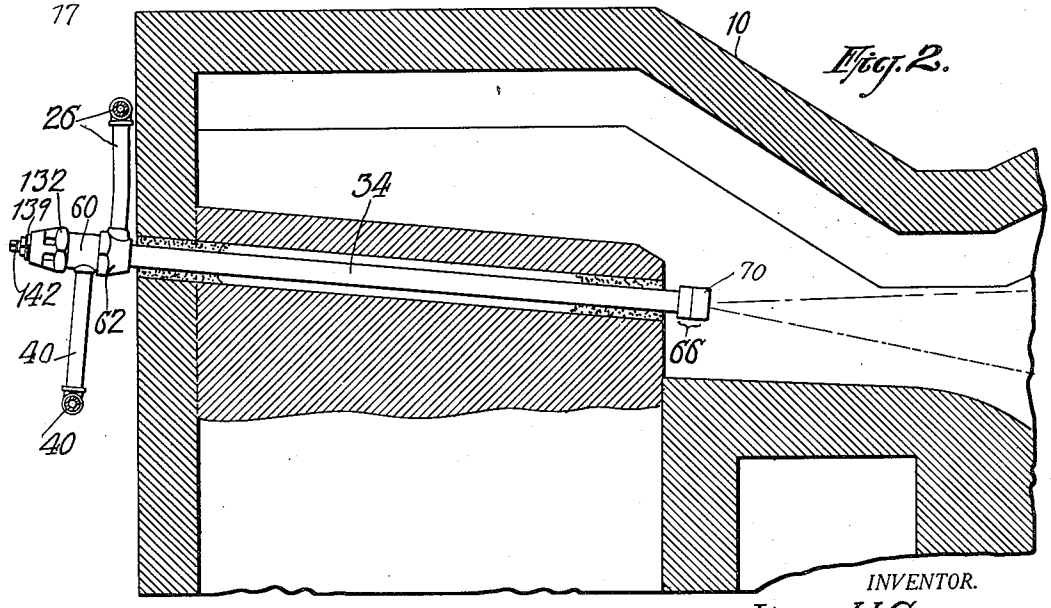


Fig. 2.



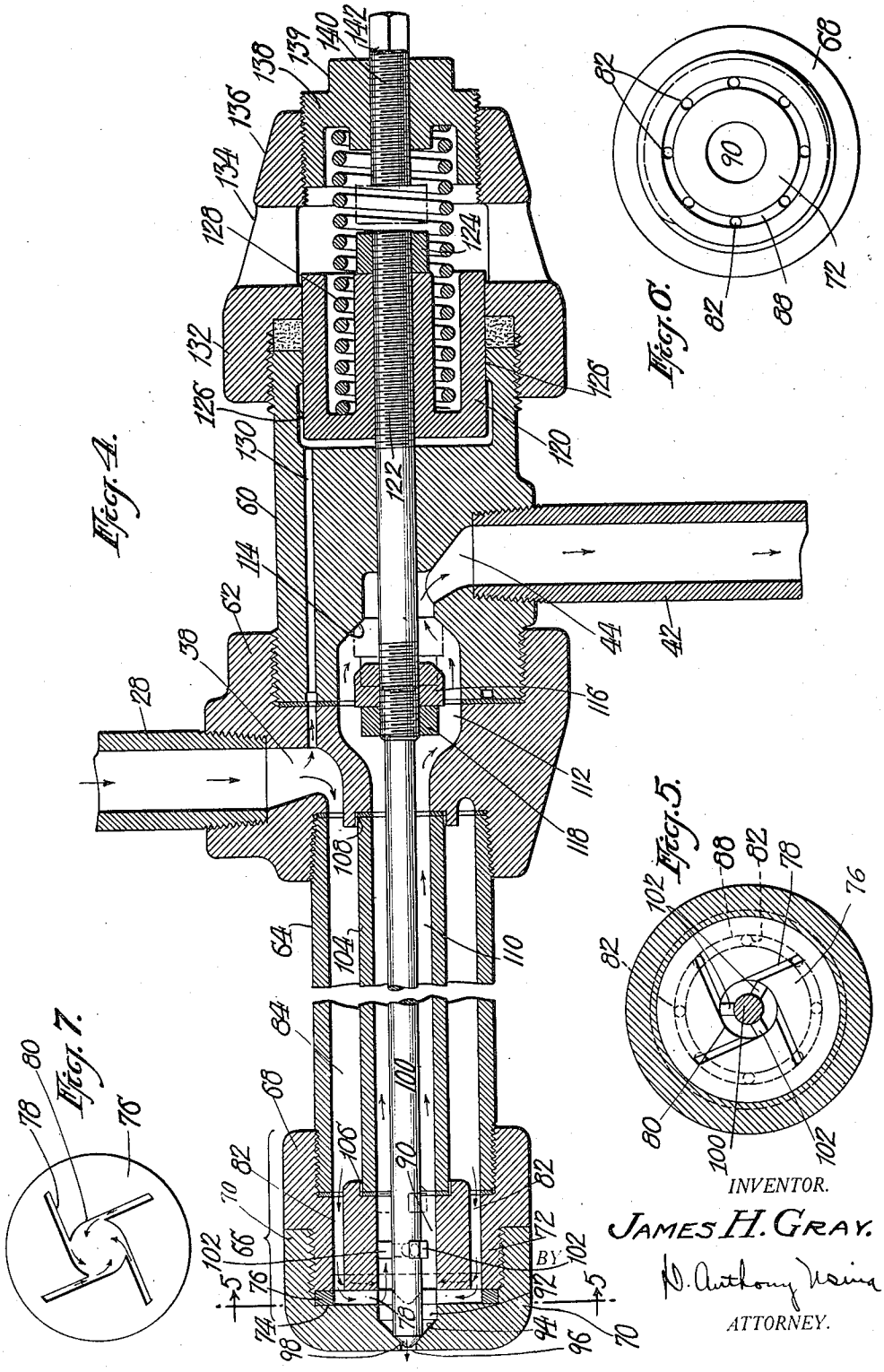
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UNITED STATES PATENT OFFICE.

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BURNER FOR LIQUID FUEL.

Application filed April 21, 1922. Serial No. 555,803.

This invention relates to improvements in burners particularly adapted to supplying liquid fuel to metallurgical furnaces. In the operation of certain types of furnaces and particularly furnaces of the open hearth type, it is customary to periodically reverse the furnace. That is to say, for one period the fuel and the air to support combustion are supplied at one end of the furnace, then after the lapse of about fifteen minutes fuel and air is cut off at that end and supplied to the opposite end of the furnace. The products of combustion or waste gases on the outgoing end of the furnace are used to heat regenerative chambers which are subsequently used to pre-heat the air on the incoming end of the furnace.

Oil and tar are both desirable fuels and they can be introduced singly or may be mixed with gas such as by-product coke oven gas. Tar and fuel oils such as are usually used in metallurgical practice are so viscous at ordinary temperatures that it is necessary to pre-heat them in order to circulate these fuels through pipes and inject them into the furnace through burners. For this reason it has been necessary heretofore to store the tar or oil in tanks heated by means of steam coils or the like. In order to properly atomize the fuel it has been necessary, heretofore, to resort to the use of a blast of steam or compressed air.

In reversing furnaces at one time it was the practice to withdraw the burner from the outgoing end of the furnace to prevent its destruction by the excessive heat and to mount it at the incoming end of the furnace at each reversing period. This proved to be a laborious and costly operation. Later the burners were left in place at both ends of the furnace and to prevent their destruction by the excessive heat water cooling devices were used.

The use of steam or air for atomizing the fuel and the use of water for cooling the burner added greatly to the cost of operation of burners heretofore proposed. In fact in some installations this cost is as high as one-quarter of the value of the fuel used.

My improved burner eliminates the necessity of providing steam or air pressure to atomize the fuel and also eliminates the use of water for cooling the burner, as well as the necessary apparatus to control the steam or air each time the furnace is reversed and also relieves the operator of the work of going in between the hot furnaces to adjust the flow of the air or steam heretofore used for atomizing the fuel.

In my improved burner the fuel is atomized mechanically without the use of steam or air and the burner itself is cooled by circulating the fuel continuously through the burners at both ends of the furnace.

The invention is illustrated in the accompanying drawings in which

Fig. 1 shows diagrammatically a plurality of metallurgical furnaces embodying my invention;

Fig. 2 is a longitudinal section through one end of a furnace equipped with the improved type of burner;

Fig. 3 is a detail of a valve shown in Fig. 1;

Fig. 4 is an enlarged longitudinal section showing a burner embodying my invention;

Fig. 5 is a section through the spray nozzle of the burner on line 5—5 of Fig. 4;

Fig. 6 is an end view of a member shown in Fig. 4;

Fig. 7 is a detail of a portion of the spray nozzle as viewed from line 5—5 of Fig. 4.

In modern steel plants the open hearth furnaces are usually arranged in batteries of from ten to twenty furnaces each, all drawing fuel from a common supply tank. Fig. 1 illustrates diagrammatically one complete furnace 10 of such a battery and portions of two other furnaces 12 and 14 adjacent thereto. Fuel is supplied to all of the furnaces from a tank 16 through a supply main 18 which has a branch 20 leading to each furnace. A pump 15 is connected by a branch 17 with the tank 16 and the supply main 18 is adapted to maintain a pressure of approximately 80 pounds in said main and to circulate the fuel in the direction of the arrows. A check valve 19 is located in the branch 17 between the pump and the tank, and a gauge 21 is provided in the main 18 to indicate the pressure. The pipe 20 connects with a pipe 22 leading to a three-way control valve 24 from which extends branches 26 and 28. The three-way valve is provided with a plug 30 having a port 32 therein adapted to establish communication from the pipe 22 to either of the pipes 26 or 28 as desired. Pipes 26 and 28 connect the burners 34 and 36 respectively at opposite ends of the furnace with an inlet port 38 (Fig. 4) formed in each burner. Pipes 40 and 42 connect an outlet

port 44 of each burner with a return fuel main 46. By-pass branches 48 and 50 are connected around the three-way valve so that fuel may be supplied to the pipes 26 and 28 regardless of the position of the three-way valve. These by-pass pipes are provided with pressure gauges 52 and 54 and throttle valves 56 and 58.

The burners are so constructed that the fuel is continuously circulated through the burners 34 and 36 at the opposite ends of the furnace regardless of the position of the three-way valve so that the fuel is utilized to cool the burners and prevent their destruction. This also keeps the fuel in such liquid condition that it can readily be circulated through the piping system and atomized without the utilization of steam or compressed air.

The arrangement is such that when the plug 30 of the three-way valve 24 is in one position, the fuel will be injected into one end of the furnace from burner 34 and a certain amount of fuel will circulate through the other burner 36 without being injected into the furnace. When the three-way valve is shifted to its other position, the fuel will be injected from the burner 36 at the opposite end of the furnace and at such time there will be a circulation of fuel through the opposite burner 34. This operation is made possible by use of the improved burner I am now about to describe.

The burners 34 and 36 are duplicates, and therefore, a description of one will suffice for both. Each burner comprises a body portion 60 having a head 62 secured thereto which is formed with an inlet port 38. The body portion 60 is formed with an outlet port 44, these ports being connected with the pipes 28 and 42 as shown in Figs. 1 and 4. Threaded or otherwise secured to the forward end of the head 62 is an elongated outer tubular casing 64 which carries at its forward end a spray nozzle indicated as a whole by the numeral 66. The spray nozzle shown in Fig. 4 comprises a member 68 in screw threaded engagement with the casing 64 and a nozzle tip 70 which is secured to an externally threaded shank 72 of the member 68 which is secured to the end of the casing 64. Between the end of the shank 72 and the inner wall 74 of the nozzle tip is secured a disc 76 having a plurality of slots 78 (Figs. 5 and 7) formed therein which extend tangentially outward from a central circular opening 80 formed in the disc. The member 68 of the nozzle is formed with a series of ports 82 which establish communication between a chamber 84 formed by the casing 64 and an annular groove 88 formed in the front face of the shank 72 of the nozzle. The member 68 is formed with an axial cylindrical chamber 90 which aligns with the opening 80 in the disc 76 and also with a chamber 92 formed in the nozzle tip 70. The forward end of the chamber 92 is of conical formation as indicated at 94 and an outlet orifice 96 is formed in the tip 70 through which the fuel is discharged. Liquid fuel flows from the port 38 through the chamber 84 and ports 82 through the tangential slots 78 and has a whirling motion imparted thereto and is discharged from the outlet orifice 96, in a spray of conical formation.

A rod 100 forms a needle valve and is provided with a bevelled end 98 adapted to co-act with the surface 94 to control the passage of fuel through the outlet orifice 96. This rod or needle valve 100 is provided with a plurality of lugs 102 which slidingly engage the walls of the chamber 90, and serve to keep the rod centered. The liquid fuel flows rearwardly past the lugs through the chamber 90 when the needle valve is in the closed position shown in full lines in Fig. 4.

Located concentrically within the casing 64 is an inner tubular member 104 which is held in suitable seats 106 and 108 formed respectively in the member 68 and the burner head 62, suitable gaskets being provided as shown. The tubular member 104 forms a conduit 110 through which the fuel can flow to a chamber 112 formed by suitable cavities in the valve head 62 and the valve body 60. The rear portion of the chamber 112 is tapered to form a valve seat 114. A valve 116 is carried by a threaded portion of the rod 100 and a jam nut 118 is provided to securely hold the valve in place on the rod. The valve 116 is adapted to be seated against the seat 114 to either prevent communication between the chamber 110 and the outlet port 44 or else control the volume of fuel passing therebetween.

A plunger 120 is secured to a threaded portion 122 at the rear end of the valve rod 100, a lock nut 124 being provided to prevent relative movement between the plunger and the rod. The plunger 120 operates in a cylindrical chamber 126 formed in the rear end of the burner body 60 and a spring 128 is adapted to hold the plunger and valve rod 100 in the position shown so that the bevelled end 98 of the needle valve, under certain conditions to be hereinafter described, will prevent fuel from escaping through the outlet orifice 96.

A port 130 connects the inlet 38 with the chamber 126 so that when the fuel is fed at a pressure great enough to compress the spring 128 the valve rod 100 will be retracted and permit fuel to be discharged through the orifice 96.

A head 132 is secured by suitable screw threads to the rear end of the burner body 60. This head carries rearwardly extending arms 134 which support a hub 136 in which

is seated a block 138 which forms an adjustable seat for the spring 128. This block is provided with a hexagonal head 139 by which the block may be turned to vary the tension of the spring. Extending axially through the hub 138 is a screw 140 having a squared end 142 which is adapted to be turned so as to limit the backward movement of the valve rod 100. By means of this adjustment, if desired, the valve 116 may be prevented from closing tight upon its seat 114.

The burners as above constructed provide means whereby the fuel is continuously circulated through the burners at the opposite ends of the furnace regardless of which burner is supplying the fuel and the control is such that when one burner is injecting the fuel into the furnace at one end, the injection of the fuel is automatically cut off at the opposite end of the furnace. This operation is made possible by the use of the movable plunger 120 and the valves 100 and 116 actuated thereby.

It will be readily appreciated that the spring 128 and plunger 120 can impart either a closing or opening movement to the needle valve 100. The valve 116 is carried by and therefore is moved simultaneously with the needle valve 100 and the parts are so arranged that when the needle valve moves in the direction to open the outlet orifice in the end of the nozzle, the valve 116 receives a closing movement. It will be further appreciated that the pressure exerted on the plunger by the fuel supplied each burner can be alternately varied by manipulation of the three-way valve shown in Fig. 3. By adjusting the screw 140 the movement of the needle valve 100 can be varied to control the volume of fuel discharged through the outlet orifice of the nozzle.

In operation assuming that the three-way valve 24 is in the position shown in Fig. 3, fuel under a pressure, for example of 80 pounds, will be pumped from the tank 16 through pipes 18, 20 and 22 to the pipe 26. The fuel enters the inlet port 38 of the burner 34 and passes through the chamber 84 to the forward part thereof. Part of the fuel passes through port 130 and exerts sufficient pressure on the plunger 120 to cause the needle valve 100 to be retracted from its seat 94. The fuel then escaping through the tangential slots 78 in the plate 76 has a whirling motion imparted thereto and is ejected in a fine spray from the outlet orifice 96 of the nozzle. When the maximum quantity of fuel is to be injected into the furnace from the nozzle, the adjusting screw 140 will be turned to such position that plunger 120 will cause the needle valve to be fully retracted from its seat 94 and the valve 116 will close communication between the chamber 110 and the return fuel pipe 40 of the burner 34. If desired the screw 140 can be set to prevent the valve 116 from entirely cutting off communication between the outlet port 44 and the chamber 110 when the needle valve is retracted so that a certain amount of fuel will continuously circulate back to the return pipe 46.

When fuel is being injected at one end of the furnace, for example, from the burner 34, Fig. 1, the spray from burner 36 will be cut off because its needle valve 100 will be in closed position as shown in Fig. 4, it being remembered that the three-way valve is not in position to supply high pressure fuel to the pipe 28, and the spring 128 is sufficient to hold the plunger 120 in the position shown in Fig. 4. The fuel which is fed from the pipe 20 through the by-pass 50 passes through a throttle valve 58 which is arranged so that fuel thus by-passed has a pressure of approximately 20 pounds. The spring 128 is of sufficient strength to withstand this pressure and, therefore, the outlet orifice 96 of the burner 36 is closed by its needle valve 100. The valve 116 of the burner 36 will be in the full line open position shown in Fig. 4, and thus permit the fuel to circulate continuously from the pipe 28 through inlet port 38, chamber 84, ports 82 and rearwardly through the chamber 110 past the valve 116 to the outlet port 44 and by way of pipe 42 to the return main 46. By this arrangement it is seen that the spray is cut off from the burner 36 at the outgoing end of the furnace and yet a circulation of fuel oil is maintained therethrough which is sufficient to adequately cool the burner and thus prevent its destruction by the hot gases coming from the furnace chamber on their way to the down-take ports. When the furnace is to be reversed the handle 25 of the three-way valve 24 is moved to the dotted line position shown in Fig. 1 which causes fuel oil under high pressure to flow through the pipe 28 so that the needle valve 100 in the burner 36 will be retracted and the spray will be injected at the corresponding end of the furnace. The high pressure fuel will then be cut off from the burner 34 and fuel at a lower pressure will circulate through this burner, the fuel being supplied from the pipe 20 through the by-pass 48.

My invention eliminates the necessity of providing water cooling means for the burner and also the expense of keeping such cooling arrangements in proper working order. Another advantage of my invention is that its use renders it unnecessary to provide special heating coils for bringing the tar, heavy oil or other fuel to a sufficiently fluid condition so that it will easily flow through pipes and so that it can be atomized mechanically. I eliminate the air or steam blast heretofore used for atmomizing the fuel. This makes it unnecessary for the operator to go between

the hot furnaces to regulate the air and steam used in former types of burners. There are several objections to the introduction of steam in open hearth furnaces one being a thermal loss due to the necessity of dissociating the steam into hydrogen and oxygen, and another being that the hydrogen attacks the white hot silica brickwork of the furnace and causes its premature destruction. Furthermore the presence of water vapor causes a lower flame temperature.

Though I have described with great particularity the details of the embodiment of the invention herein shown, it is not to be construed that I am limited thereto as changes in arrangement and substitution of equivalents may be made by those skilled in the art without departing from the invention as defined in the appended claims.

What I claim is:

1. In combination with a metallurgical furnace, burners for injecting liquid fuel at opposite ends of the furnace, means for continuously circulating the fuel through said burners and means including a manually operated valve for controlling the injection of the fuel whereby it is injected at one end of the furnace and cut off at the other end of the furnace.

2. In combination with a metallurgical furnace, burners located at opposite ends of the furnace, means for circulating the fuel in contact with said burners to cool the same, means actuated by the pressure of the fuel supplied to the burners for controlling the discharge of fuel into the furnace and means including a manually controlled valve whereby fuel of high and low pressure is alternately supplied to the burners at opposite ends of the furnace.

3. In combination with a metallurgical furnace, burners located at opposite ends of the furnace, a respective needle valve in each burner adapted to open or close the outlet orifice of a respective burner, a spring arranged to hold each needle valve in one position, a plunger adapted to move each needle valve to another position and means whereby fuel at respectively high and low pressure acts alternately on each plunger so that the fuel is alternately supplied and cut off at opposite ends of the furnace.

4. In combination with a metallurgical furnace, burners located at opposite ends of the furnace, means for alternately varying the pressure of the fuel supplied to the burners, and means carried by each burner arranged to be actuated by a variation in the pressure of fuel supplied thereto for controlling the injection of fuel into the furnace.

5. In combination with a metallurgical furnace, burners located at opposite ends of the furnace, means for alternately varying the pressure of the fuel supplied to the burners, fuel inlet and outlet pipes connected to said burners, means for providing a circulation of fuel through the burners to cool the same, and means carried by each burner arranged to be actuated by a variation of the pressure at which the fuel is supplied thereto for controlling communication between said fuel inlet and outlet pipes.

6. A burner for liquid fuel including a spray nozzle, means for imparting a whirling motion to the fuel to assist in atomizing the same, a needle valve for opening and closing the outlet orifice of said spray nozzle, inlet and outlet pipes connected to said burner, means for circulating the fuel through said nozzle from said inlet pipe to said outlet pipe to cool the burner and a valve movable with said needle valve for controlling communication between said fuel inlet and said fuel outlet.

7. A burner for liquid fuel including a spray nozzle, means for imparting a whirling motion to the fuel to assist in atomizing the same, a needle valve for opening and closing the outlet orifice of said spray nozzle, inlet and outlet pipes connected to said burner, means for circulating the fuel through said nozzle from said inlet pipe to said outlet pipe to cool the burner and means for simultaneously moving said needle valve and controlling the circulation of fuel from said inlet pipe to said outlet pipe.

8. A burner for liquid fuel including a nozzle having an outlet orifice, inlet and outlet ports, means for conveying fuel to said outlet orifice, a needle valve for controlling the discharge of fuel through said orifice, a valve for controlling the circulation of fuel from said inlet port to said outlet port, said valve being so arranged that when the needle valve is given an opening movement said control valve is given a closing movement and vice versa.

9. A burner for liquid fuel including a nozzle having an outlet orifice, inlet and outlet ports, means for conveying fuel to said outlet orifice, a needle valve for controlling the discharge of fuel through said orifice, a valve for controlling the circulation of fuel from said inlet port to said outlet port, said valve being so arranged that when the needle valve is given an opening movement said control volve is given a closing movement and vice versa, and means actuated by the pressure of fuel supplied for moving both of said valves.

10. A burner for liquid fuel including a nozzle having an outlet orifice, inlet and outlet ports, means for conveying fuel to said outlet orifice, a needle valve for controlling the discharge of fuel through said orifice, a valve for controlling the circulation of fuel from said inlet port to said outlet port, said control valve being so arranged that when the needle valve is given an opening movement said control valve is given a closing

movement and vice versa, a spring for holding both of said valves in one position, and means actuated by the pressure of the fuel supplied for moving both valves to their other position.

11. A burner including a spray nozzle provided with means for atomizing liquid fuel, an outer shell supporting the spray nozzle, a needle valve extending longitudinally through the said shell and adapted to open and close the outlet orifice of said spray nozzle, a fuel inlet connected with said shell, a body to which said shell is secured, said body having a chamber formed therein, a plunger movable in said chamber, an outlet for fuel communicating with said fuel inlet, and means actuated by said plunger for cutting off communication between said fuel inlet and outlet.

12. A burner having an inlet pipe and an outlet pipe connected thereto through which the fuel is adapted to continuously circulate, an elongated shell secured to said burner and having a spray nozzle secured to one end thereof, means for providing a circulation between said inlet pipe and said outlet pipe through said nozzle and said shell and automatic means controlled by the pressure of the fuel supplied to the burner for controlling the rate of the passage of fuel from the inlet pipe to the outlet pipe.

13. A burner comprising a body portion having an inlet pipe and an outlet pipe connected thereto, an elongated shell secured to said body and having a spray nozzle secured to one end thereof, means for providing a circulation between said inlet pipe and said outlet pipe, means for automatically controlling the rate of passage of fuel from the inlet pipe to the outlet pipe, and means movable with the last named means for controlling the fuel discharged from said spray nozzle.

14. A burner adapted to atomize tar or similar heavy fuels comprising an elongated body structure formed with inner and outer longitudinal chambers, a fuel inlet communicating with the outer chamber and a fuel outlet communicating with the inner chamber which provide means for continuously circulating the fuel in contact with the burner so as to heat the fuel and cool the burner and automatically actuated means for varying the rate at which said fuel flows through the burner.

15. In combination with an open hearth furnace, a plurality of burners having elongated bodies extending into the furnace, each burner having an inner and outer hollow shell-like body with a space between them, fuel inlet and outlet ducts connected with each burner providing means for circulating fuel through the burners to cool the same and an automatically actuated valve in each burner for controlling the rate of flow of fuel therethrough.

In witness whereof, I have hereunto signed my name.

JAMES H. GRAY.