July 14, 1936. W. F. WILTSHIRE 2,047,570

FUEL BURNER

Filed Feb. 5, 1934 3 Sheets-Sheet 1

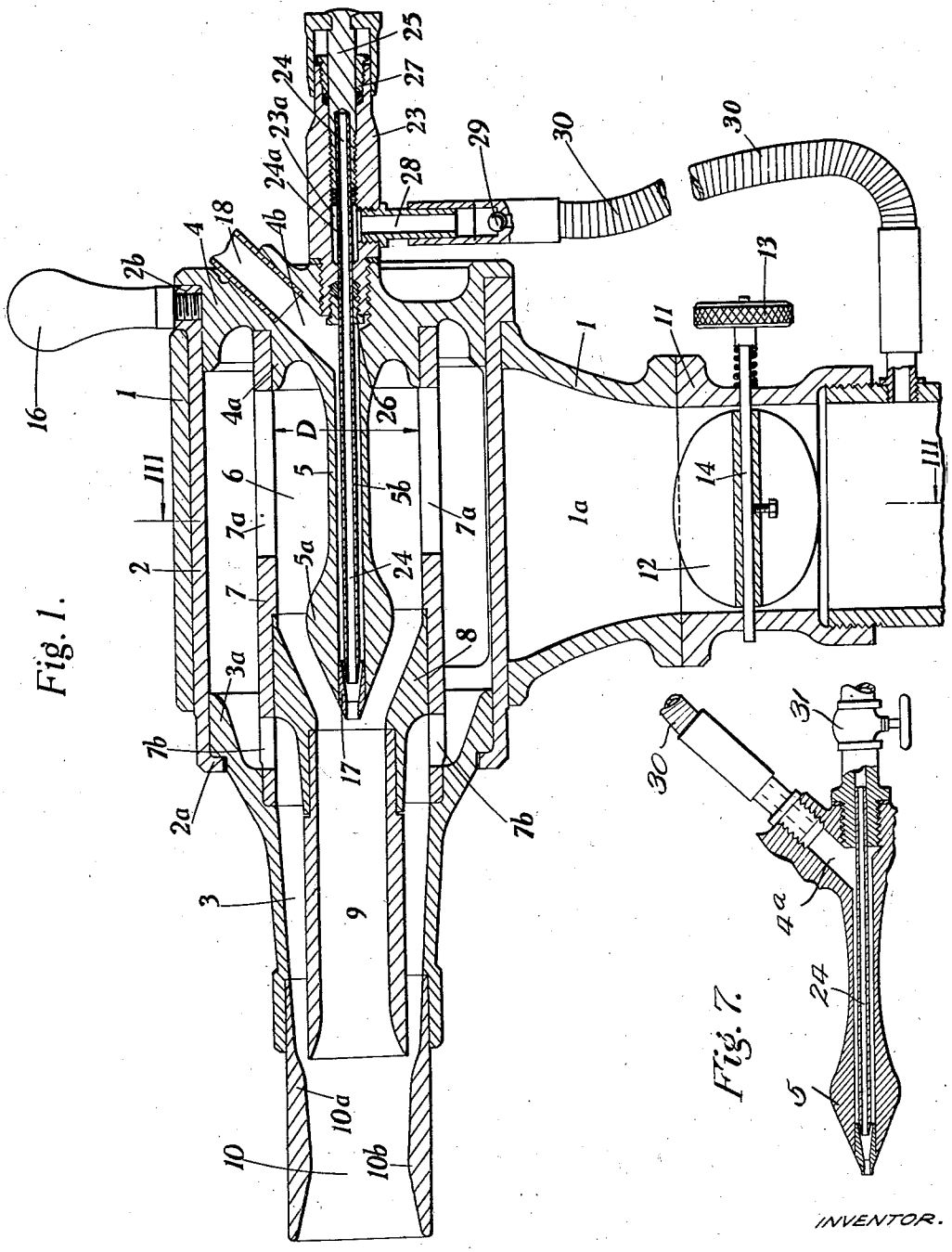


Fig. 1.

Fig. 7.

INVENTOR.

WILLIAM FREDERICK WILTSHIRE.

BY

ATTORNEY.

July 14, 1936. W. F. WILTSHIRE 2,047,570

FUEL BURNER

Filed Feb. 5, 1934 3 Sheets-Sheet 2

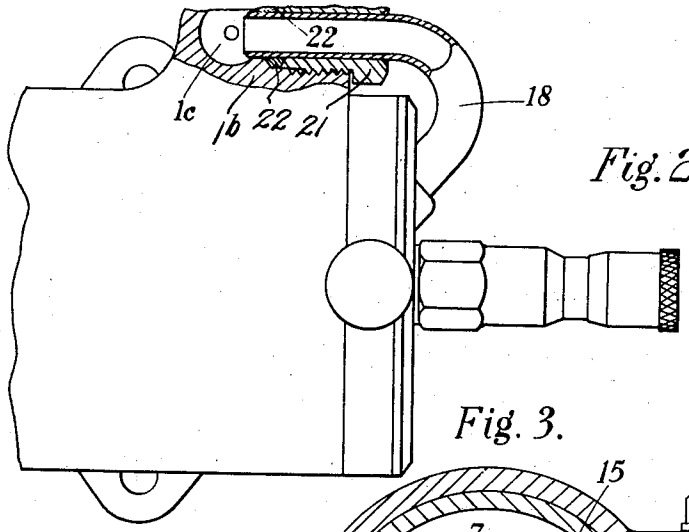
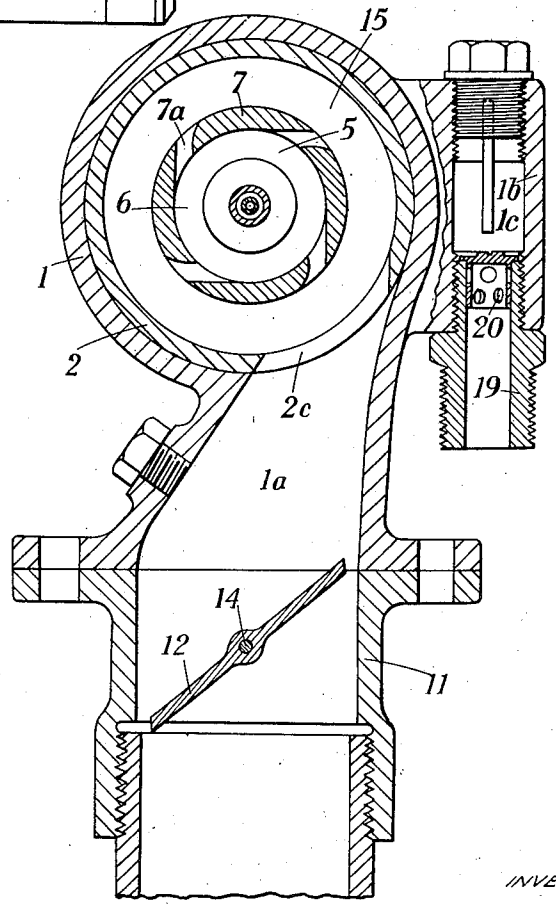


Fig. 2

Fig. 3.



INVENTOR.

WILLIAM FREDERICK WILTSHIRE.

BY

ATTORNEY.

July 14, 1936. W. F. WILTSHIRE 2,047,570

FUEL BURNER

Filed Feb. 5, 1934 3 Sheets-Sheet 3

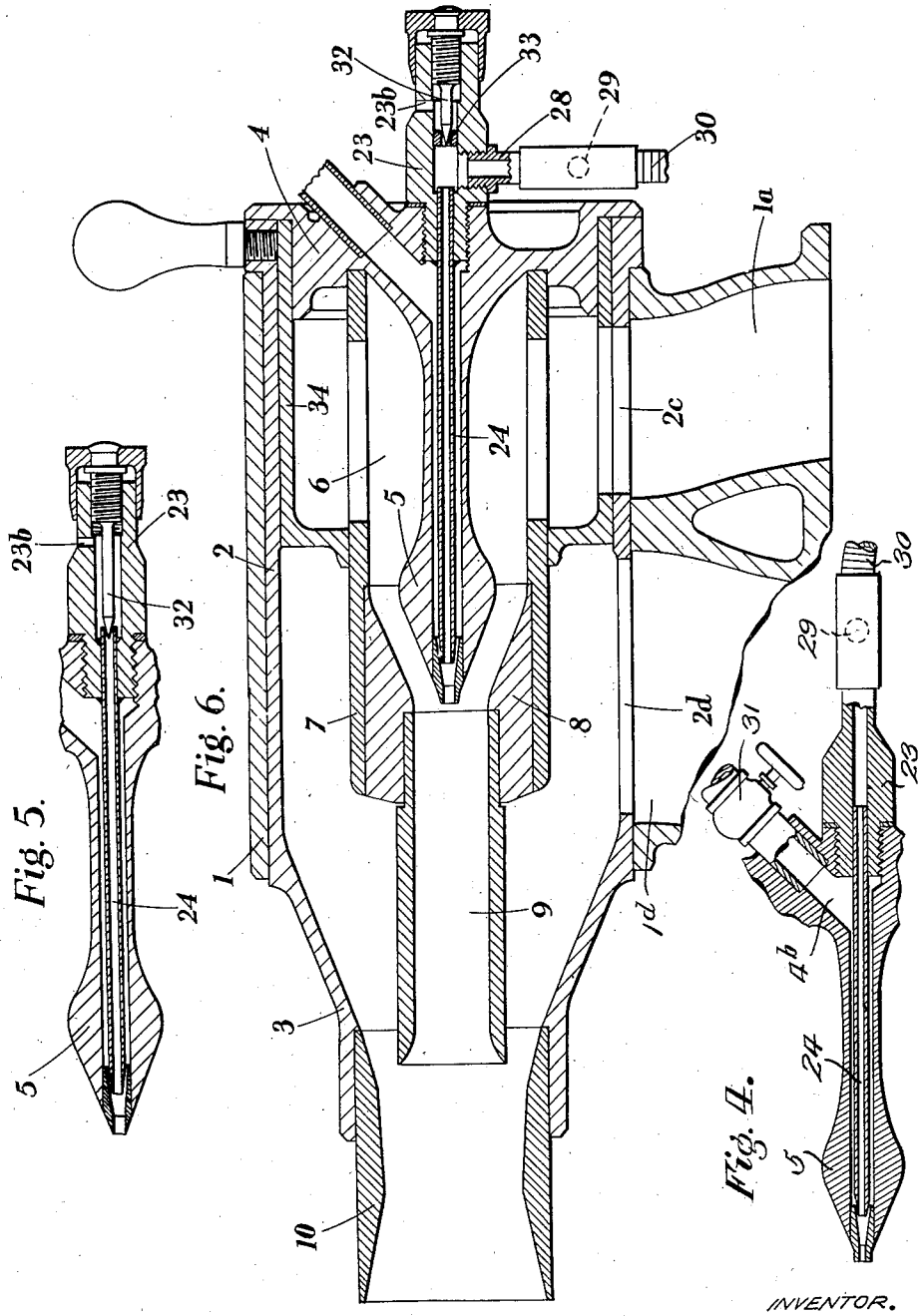


Fig. 5.

Fig. 6.

Fig. 4.

INVENTOR.

WILLIAM FREDERICK WILTSHIRE.

BY

ATTORNEY.

Patented July 14, 1936 2,047,570

UNITED STATES PATENT OFFICE

2,047,570

FUEL BURNER

William Frederick Wiltshire, King's Norton, Birmingham, England

Application February 5, 1934, Serial No. 709,890
In Great Britain February 10, 1933

10 Claims. (Cl. 158—76)

This invention relates to fuel burners for burning liquid, pulverized or colloidal fuel.

The object of the invention is to provide a burner which will enable pressure or gravity feed arrangement of the fuel to the burner to be dispensed with. Another object is to provide a single control means the operation of which regulates the air and cuts off or turns on the fuel supply. A further object is to provide a burner with unit control in which the mixture ratio remains constant. A still further object is to provide a burner which is entirely safe and free from the possibility of leakage even if an operator has omitted some necessary operation.

According to the invention the body of the burner contains an inner chamber (hereinafter referred to as the vortex chamber) of circular cross section into which projects a coaxial fuel jet, the said chamber being closed at the end through which the jet projects, but open at its other end which terminates at or near the throat of the burner nozzle, while one or more ports are formed adjacent its closed end for the admission of air in the form of a vortex in order to create a partial vacuum about the fuel jet orifice which is coaxial with the vortex.

The converging portion of the vortex chamber may taper uniformly, or it may be a paraboloid, or it may be a venturi or any other suitable form.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional elevation of a form of construction working on a single air supply.

Fig. 2 is a fragmentary plan view of Fig. 1.

Fig. 3 is a cross section taken on the line III—III of Fig. 1.

Fig. 4 is a longitudinal sectional elevation of an alternative form of fuel jet.

Fig. 5 is a similar view to Fig. 4 of another form of jet.

Fig. 6 is a longitudinal sectional elevation of an alternative form of burner in which two air supplies or an air and a low pressure steam supply are employed.

Fig. 7 is a longitudinal sectional elevation of a further form of jet.

Referring more particularly to Figs. 1 to 3, the main body of the burner comprises a cylinder 1 connected to the air supply (not shown), and inside the said cylinder a rotatable ported sleeve 2 which projects therefrom for a short distance. The projecting portion of the sleeve 2 is flanged inwards at 2a to form an abutment against which abouts a shoulder 3a on a converging tube 3, the shoulder 3a having a turning fit in the sleeve 2.

The other end of the sleeve 2 has a flange 2b which abuts against a face on the burner body 1, this end of the sleeve being closed by a short cylindrical base 4 which also has a turning fit therein. The said base 4 is integral with a fuel jet body 5. Around the fuel jet body 5 is arranged a vortex chamber 6 comprising a slotted tube 7 which at its rear end is made to have a driving fit on a boss 4a on the base 4, and at its front end is made to have a push fit in a recess in the tube 3.

Towards the outer end of the tube 7 a contraction member 8 is made to have a push fit in a recessed portion of the tube 7, and having its inner wall converging for a certain distance when at its smallest diameter it assumes a cylindrical form. The outer portion of the member 8 is recessed to receive a parallel vortex extension tube 9 which terminates in a bell mouth.

The following dimensions are given substantially in terms of the larger diameter D of the vortex chamber 6. The diameter of the vortex contraction, or that of the vortex extension tube 9 is preferably .477D, while the distance from the outer end of the tube 9 to the beginning of the vortex contraction, i. e. the vortex extension, is 2.34D, the radius at the bell mouth being .427D opening to a diameter of .688D.

The outer end of the converging tube terminates substantially in the same plane as the vortex extension tube, and may comprise the burner nozzle, but preferably it is recessed to receive a nozzle extension tube 10 having a short sharp inward taper at 10a on its inner wall in the vicinity of the outer end of the tube 9, for the purpose of deflecting the fuel spray towards the centre and so giving a more even distribution of the fuel particles. The taper at 10a may converge at 10b into a slight venturi contraction which has the effect of increasing the flow of air through the vortex, thereby improving the suction on the jet.

Air is introduced to the burner by a passage 1a integral with the burner body and flanged for securing to a corresponding flanged union 11 secured to the air supply. For unit control a butterfly valve 12 is preferably provided in the union 11, the said valve being operated by a knurled head 13 on the valve spindle 14. The passage 1a converges as shown in Fig. 3 so as to direct the air tangentially into the annular space 15 between the rotatable sleeve 2 and the vortex

tube 7, a control port 2c of streamline form being formed in the control sleeve 2. A handle 16 on the flange 2b serves for operating the sleeve 2.

Tangential inlet ports 7a are arranged in and around the tube 7, for communication with the vortex chamber 6, while ports 7b communicate with the tube 3. The ports 7a are in the form of long narrow slots arranged parallel to the axis of the burner, while the outer openings of the said slots are flared on their leading edges so that the air velocity is at a maximum as it issues from the inner openings of the ports 7a. The total area of the ports 7a is preferably .618D².

The fuel jet body 5 is preferably enlarged in diameter at 5a at or near the commencement of the vortex contraction. This throws the air well to the outside and increases the centrifugal effect on the vacuum. The jet body 5 may then taper uniformly or approximately so up to a short distance from its extremity, the latter portion being preferably tapered at a much smaller angle and comprising a hardened steel nipple 17. The best proportions for the jet have been found to be .592D at the enlarged diameter which is streamlined from a smaller diameter of .273D. From the enlarged diameter it tapers towards the extremity to within .045D, the latter length being tapered at a smaller angle.

A vortex contraction of 20° with a jet contraction of 22½° and 5° at the extreme end have been found to give very good results but are not claimed to be essential for high efficiency as a small alteration in the above dimensions accompanied by corresponding alterations in other directions may be made to give equally good results.

The exact position of the jet relatively to the vortex contraction is of great importance and may be either a little in front of or a little to the rear thereof according to the dimensions and shape of the particular burner.

Oil is led to an axial bore 5b in the fuel jet body 5 through a radial angled passage 4b in the base 4, and a short curved pipe 18 which leads to a socket 1b (Fig. 2) on the outside of the burner body 1, the socket 1b having a vertical bore 1c with which the pipe 18 communicates, and into which is screwed an oil connection 19 having a non-return valve 20. The pipe 18 is secured in the socket 1b by means of a gland nut 21 (Fig. 2) which presses against packing 22 and so nips the pipe 18 circumferentially. This connection also serves to maintain the base 4, sleeve 2 and other associated parts in assembly with the burner body 1, for by merely slackening off the nut 21 the base 4 and its associated parts may be withdrawn axially from the body 1. Alternatively the non-return valve may be placed at some other point in the oil pipe line.

On the outside of the base 4 there is screwed an axial cylindrical socket 23 having an axial bore 23a. The bore 23a is constricted at a point near its inner end to locate a long hollow jet needle or air inlet tube 24 whose outer end is secured in a micrometer screw 25, while its inner end terminates at a point adjacent the nipple 17. The needle or air inlet tube 24 and screw 25 are mounted in an oil tight manner in the socket 23 by means of glands 26, 27. The bore of the tube 24 is preferably as large as conveniently possible, so as to draw a large quantity of air into the fuel raising pipe. In the arrangement shown in Fig. 1 the socket 23 has a union 28 screwed thereinto and communicating with its bore 23a, the said union being adapted to be connected through a non-return valve 29 with a flexible pipe 30 hereinafter referred to.

The operation of the burner is as follows:— To start the burner the sleeve 2 is turned by means of its handle 16 until the port 2c is in the full open position shown in Fig. 3 and in the case of unit control the valve 12 opened. Some of the air passes through the tangential slots 7a into the vortex chamber 6. The air being admitted in this manner is caused to swirl with a rotary movement, at the same time passing forward towards the inner end of the vortex chamber 6. As it does so its tangential velocity is increased on account of the vortex chamber converging to a smaller diameter. A free vortex or a set of conditions similar thereto is thus set up inside the vortex chamber. The increase in air velocity due to the reduction in diameter causes an increase in the centrifugal force at this point, thus creating a region of low pressure along the axis of rotation, such pressure being below that of the atmosphere. This creates a suction on the oil jet which is coaxial with the vortex and terminates at or near the throat of the vortex extension, and is therefore in the region of lowest pressure. The oil is therefore drawn from the jet 5 by suction and atomized by the action of the centrifugal force.

The atomized oil in the form of a spray is carried forward through the throat of the vortex chamber 6.

The remainder of the air passes through the slots 7b (which may be radial or tangential) near the inner end of the tube 7 along the gradually contracting jacket formed between the tube 3 and the vortex tube 9 until it reaches the end of the tube 9 where the space is very restricted so that it is discharged at a very high velocity against the restriction 10a in the tube 10 and any oil on the wall of the tube is blown off and atomized, and made to converge, the venturi contraction 10b further increasing the velocity of the mixture which eventually emerges from the end of the extension tube 10.

In a burner of the above proportions the fuel-air ratio is practically constant at low air pressures when the negative head is reduced to a minimum. The slight discrepancy in the ratio may however be rectified by admitting air to the fuel jet by means of the flexible pipe 30 connected to the main air supply below the valve 12, the said air passing through ports 24a in the air inlet tube 24, whence it passes to the fuel jet. This has the effect of increasing the air to fuel ratio in proportion to the suction when the burner is turned low, owing to the increase in air pressure in the main supply as a result of the reduction in quantity used. This prevents a rich mixture when the burner is turned low, for although the mixture at the nozzle tends to become rich, at the same time the main air supply pressure increases due to back pressure at the regulator, and this increased air pressure may be used to increase the air supply (in proportion to suction) to the jet, thus reducing the fuel supply to the correct amount and tending to keep the ratio constant.

The proportions and shapes of the vortex chamber and fuel jet as described above also apply to a burner using fuel other than liquid, e. g. pulverized or colloidal fuel, but not gas.

Due to the partial vacuum created by the vortex the oil may be drawn by suction direct from the main supply tank situated below burner level. In the arrangement shown in Fig. 1 the jet body 5 is adapted for working with such a negative

head of oil, the oil being raised by means of the partial vacuum in the pipe **30** which, as already stated, communicates with the air inlet tube **24** through ports **24***a* therein. For working with a negative head the connection of the pipe 30 with the main air supply is dispensed with. The discharge of air from the air inlet tube **24** blows a cylindrical film of oil into the vortex tube **9**. For unit control the pipe **30** and non-return valve **29** are dispensed with, and air drawn direct from the atmosphere or from the pressure supply below the butterfly valve **12**, the micrometer screw **25** being turned to give initial adjustment to the fuel supply.

In the alternative form of jet shown in Fig. 4, the air inlet tube **24** is non-adjustable, the fuel adjustment being by means of a valve **31** in the fuel pipe line.

In the further form shown in Fig. 5 which is for unit control or small negative head without fuel raising air, the inlet tube **24** is open at its outer end and forms a seating for a micrometer adjusted needle valve **32**, atmospheric air being admitted through an opening **23***b* in the socket **23**, so that the fuel is controlled by adjusting the air admission.

Referring to the further modification of fuel control means shown in Fig. 6, and which is adapted for use with a negative head of oil, the arrangement is similar to that shown in Fig. 5 with the difference that the needle valve **32** seats against a seating **33** spaced from the end of the air inlet tube **24** to accommodate the union **28**, the non-return valve **29** and pipe **30** being as in Fig. 1 except that the pipe **30** is not connected to the main air supply. This arrangement gives an additional control by means of atmospheric air.

Fig. 6 shows another form of construction of burner which is similar to that described with reference to Fig. 1, but differs—in addition to the fuel connection already described—in that a separate secondary air supply, which may be preheated, is provided, while for the vortex, either air or steam may be used.

According to this construction, the sleeve **2** and converging tube **3** are made in one piece, while an additional port **2***d* is formed in the sleeve **2** for controlling a secondary air passage **1***d* in the burner body **1**, the vortex air or steam and secondary air being maintained separate by means of a ported partition sleeve **34** which has a force fit over the base **4**. The operation of the burner is otherwise similar to that described with reference to Fig. 1.

Turbulence may be given to the secondary air by admitting it through a tangential port. The rotation of the air may be in either direction relative to that of the vortex, depending on the type of flame required.

In the above cases the secondary air may be either forced or induced draught, if the latter, and if it is not preheated, it may be drawn direct from the atmosphere at the burner.

By (1) making the admission of the vortex air and secondary air proportional to one another, for example by admitting them through the same control ports or separate ports arranged to give a constant ratio; (2) reducing the negative head at the jet orifice to a minimum, for example $\frac{1}{32}$", so that its effect on the velocity of discharge at the jet orifice may be neglected, and maintaining the said head constant, for example by drawing the fuel from a tank with constant fuel level; (3) maintaining the viscosity of the fuel constant, for example by automatic temperature control and (4) admitting no air to the fuel unless at constant temperature; the velocity of fuel discharge will be directly proportional to the weight of air passing through the burner. This will give a constant ratio by weight of fuel to air for any adjustment of the air regulator, so that the fuel regulator as such may be entirely dispensed with.

The air regulator may be controlled by the furnace temperature thus making the burner entirely automatic. In this way a number of burners may be controlled and regulated by one remote air valve, either by hand or automatically. This system has the advantage that the constant ratio of air to fuel is by weight, thus enabling the air supply to be preheated, the degree of preheat in no way affecting the mixture ratio by weight. With this arrangement the non-return valve **20** may be dispensed with. If desired, the air supply may be regulated by varying the speed of the motor which drives the fan, instead of by operating an air valve.

Fig. 7 shows a similar jet to that shown in Fig. 4 differing therefrom in that the fuel and air supply connections are reversed, the fuel now being supplied to the tube **24** through the valve **31**, and the air through the passage **4***b*.

In the various forms of fuel jets above described the primary air may be preheated.

I claim:

1. A fuel burner for liquid, pulverized or colloidal fuel comprising a burner body; a cylindrical chamber in said burner body closed at one end and open at the other end; the walls of said chamber having tangentially directed inlet ports formed therein; a duct connected to an air supply and cooperating with said inlet ports to discharge air therethrough whereby a vortex of air is set up within said chamber; the walls of said chamber converging adjacent its open end; a fuel jet projecting into the chamber terminating within the converged portion thereof; and a tubular extension of constant diameter coaxial with and projecting beyond the outer converged end of said chamber.

2. In a fuel burner according to claim 1, the fuel jet being disposed co-axially of the chamber.

3. In combination with a fuel burner as set forth in claim 1, a sleeve rotatably mounted within the body and spaced from the walls of said chamber to form an annular air passage around the chamber; said sleeve having a port adapted to register with the air duct; and said air duct being tangentially disposed with respect to the annular air passage.

4. In combination with a fuel burner as set forth in claim 1, a ported sleeve rotatably mounted within the body and spaced from the walls of said chamber and cooperating with the air duct to form an annular air passage around the chamber; and a nozzle member around the tubular extension converging towards and terminating adjacent the outlet end of the extension and forming with the extension an annular chamber, said chamber having ports registering with the annular air passage for permitting secondary air from said annular air passage to enter said annular chamber.

5. In combination with a fuel burner as set forth in claim 1; a ported sleeve rotatably mounted within the body and spaced from the walls of said chamber and cooperating with the air duct to form an annular air passage around the cham-

ber; a nozzle member around the tubular extension converging towards and terminating adjacent the outlet end of the extension and forming with the extension an annular chamber, said chamber having ports registering with the annular air passage for permitting secondary air from said annular air passage to enter said annular chamber; and a nozzle extension at the converged end of said nozzle and having a relatively short sharp inward taper on its inner wall adjacent the outer end of said tubular extension.

6. In combination with a fuel burner as set forth in claim 1; a ported sleeve rotatably mounted within the body and spaced from the walls of said chamber and cooperating with the air duct to form an annular air passage around the chamber; a nozzle member around the tubular extension converging towards and terminating adjacent the outlet end of the extension and forming with the extension an annular chamber, said chamber having ports registering with the annular air passage for permitting secondary air from said annular air passage to enter said annular chamber; and a nozzle extension on the converged end of said nozzle having a relatively short sharp inward taper on its inner wall adjacent the outer end of said tubular extension and having a venturi contraction within the outer portion thereof.

7. In combination with a fuel burner as set forth in claim 1, a cylindrical base for the chamber carried by the burner body; and the burner body having a fuel inlet therein; a ported air control sleeve rotatably mounted on said base; the fuel jet projecting from said base; a pipe connected at one end to the fuel jet through the base; and a detachable oil-tight connection between the other end of the pipe and the fuel inlet whereby when the detachable connection is broken the sleeve and burner assembly may be removed with the base from the burner body.

8. In a fuel burner as set forth in claim 1, the fuel jet being gradually enlarged in diameter to the point of commencement of the converged portion of the chamber, and gradually contracted in diameter from said point to its outer extremity, both the enlargement and contraction in diameter being of streamline form.

9. In a fuel burner as set forth in claim 1 the fuel jet nozzle having a bore the outer end of which forms the jet orifice; an air inlet tube in said bore of smaller diameter than the bore so as to leave a passage between the tube and the walls of the bore for the fuel; the said tube having its inner end terminating adjacent but to the rear of the jet orifice; and means at the outer end of the tube for connection with an air supply.

10. In combination with a fuel burner as set forth in claim 1; a rotatable air control sleeve cooperating with the air duct in the burner body; said burner body having a secondary air passage; a ported partition sleeve coaxial with said air control sleeve for maintaining the secondary air separate from the main air supply; and said control sleeve having a port cooperating with the ported partition sleeve for controlling said secondary air passage.

WILLIAM FREDERICK WILTSHIRE.