Aug. 11, 1964 H. E. JACKSON 3,144,075

OIL BURNER ASSEMBLY WITH AIR/OIL RATE ADJUSTING MEANS

Filed March 22, 1961 4 Sheets-Sheet 1

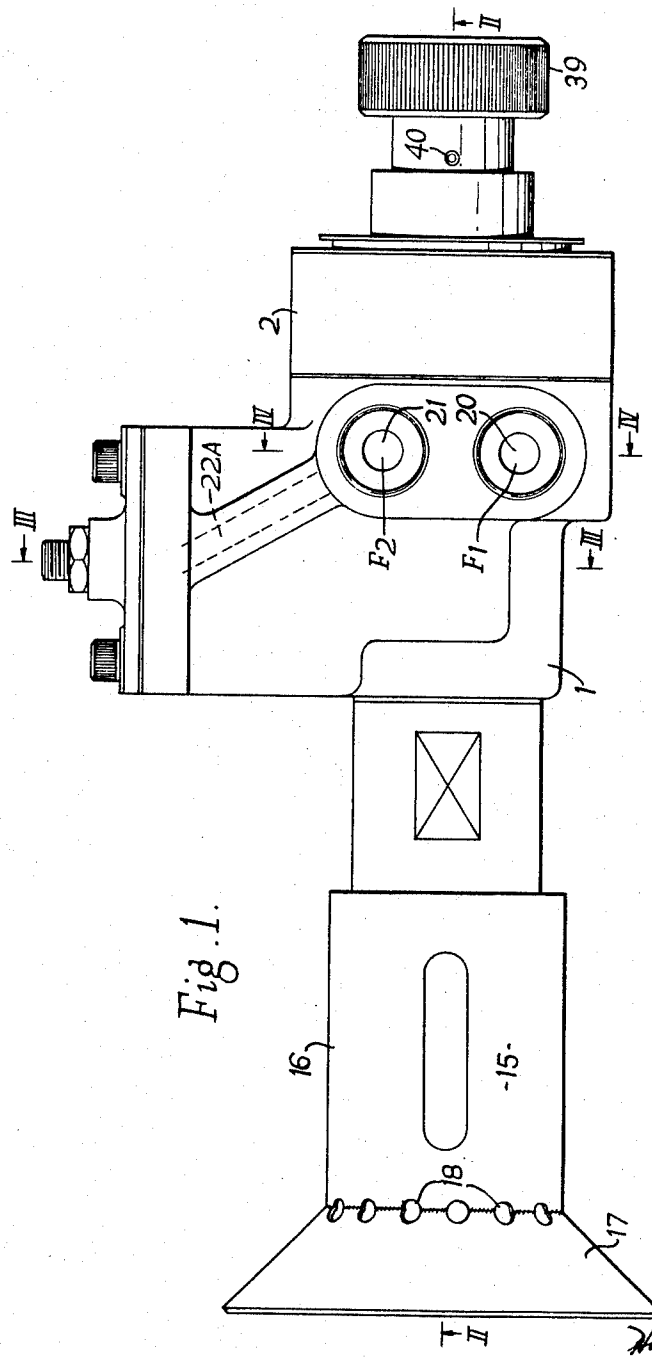

Fig. 1.

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4 Sheets-Sheet 2

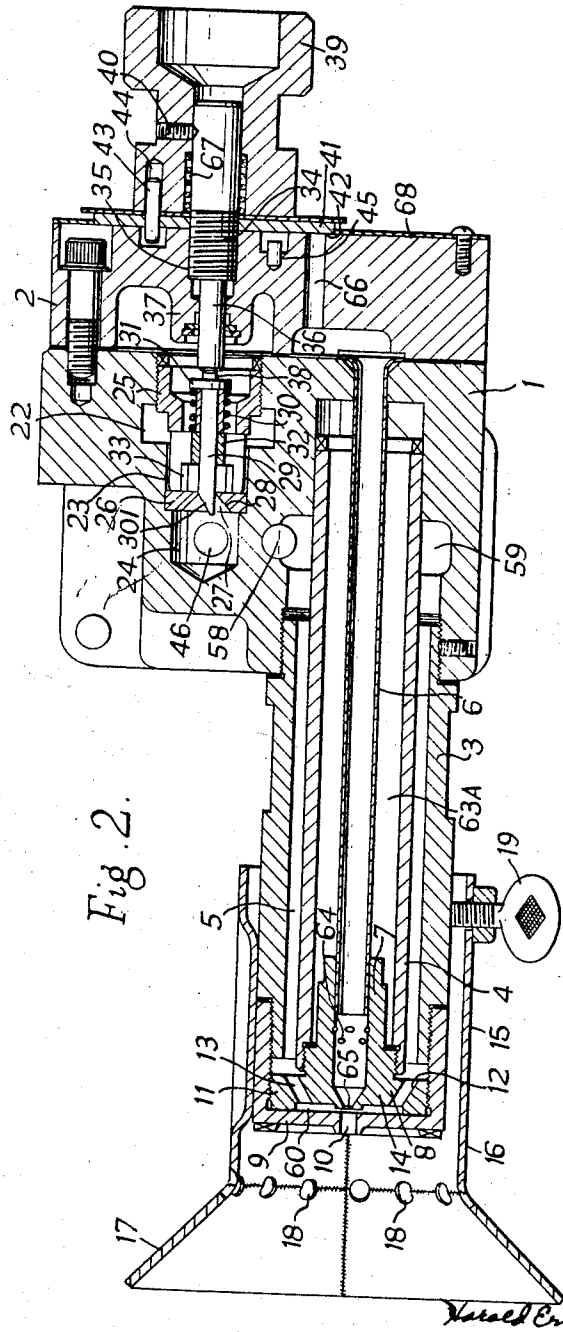

Fig. 2.

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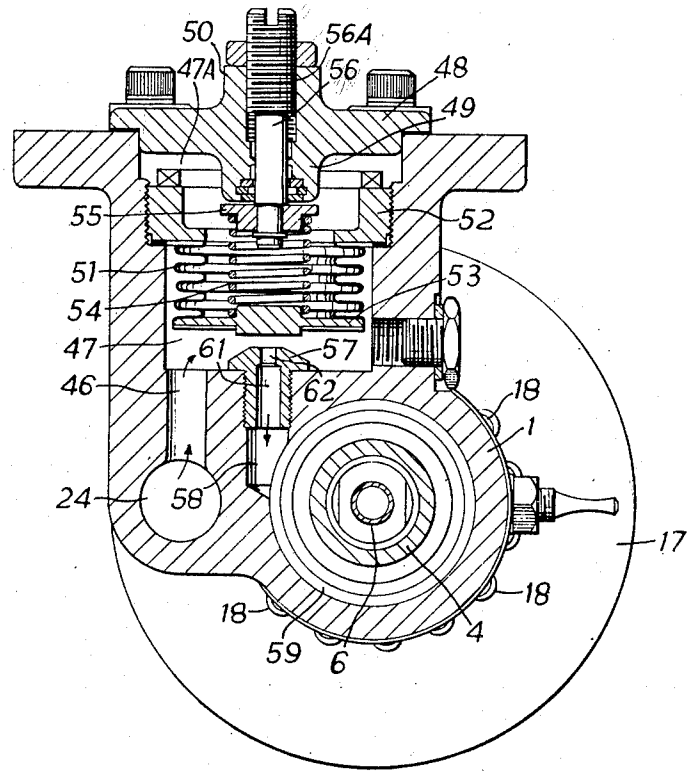
Fig. 3.



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Filed March 22, 1961 4 Sheets-Sheet 4

Fig. 4.

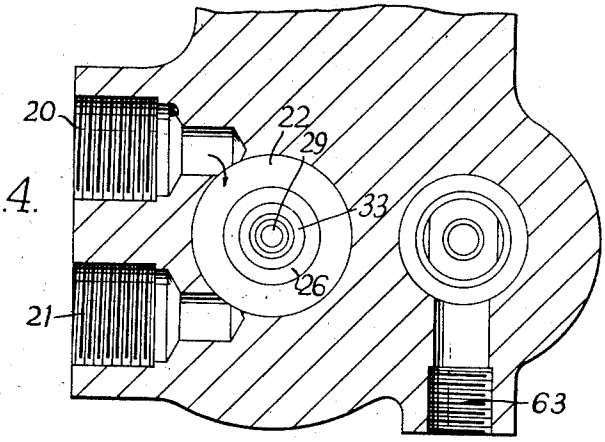
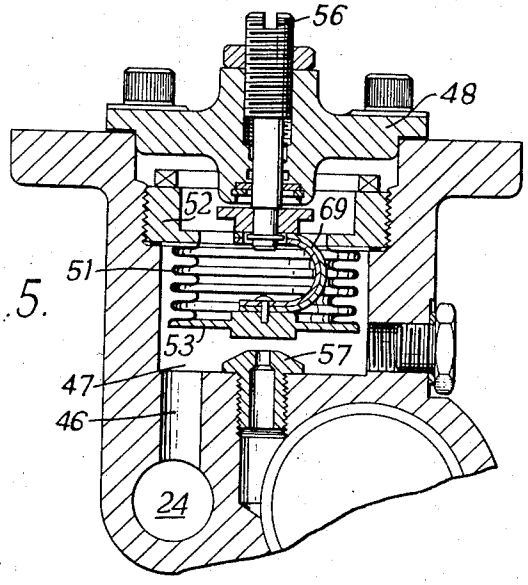


Fig. 5.



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OIL BURNER ASSEMBLY WITH AIR/OIL RATE ADJUSTING MEANS

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17 Claims. (Cl. 158—76)

The present invention is concerned with the provision of improved fuel oil burners and particularly such burners for use with intermittently-acting ceramic kilns, especially such kilns intended for firing bricks, tiles and pipes.

Heavy fuel oil burners of known type when used for firing brick kilns are subject to certain disadvantages, amongst them being their liability to build up a deposit of carbon around the orifice discharging oil into the kiln and thus to cause obstruction, their lack of means to guard against variation in the pressure of oil delivered, and their inability accurately to control the length and formation of the flame projected into the kiln.

One object of the invention is to provide a burner which is not subject to the disadvantages described and one which comprises particular means to overcome the last mentioned difficulty by controlling the ratio of air to fuel.

According to the present invention the burner assembly comprises a burner nozzle, means through which oil under pressure is supplied to the nozzle, means through which air under pressure is supplied to the nozzle, a space in which the oil and air are mixed and the oil is atomised before the mixture is discharged from an air/fuel mixture jet orifice in the nozzle, means for giving the air a rotary turbulence as it enters the said space so as to ensure the correct atomisation of the fuel, and a single control for ensuring that the burner shall have a predetermined maximum/minimum air/fuel ratio by simultaneously proportioning the supply of air and fuel to the nozzle, the supply of air to the burner assembly always being constant.

The said single control may be arranged to adjust simultaneously the quantity of oil fed to the burner nozzle and to control any excess of air fed to the nozzle and which, for correct proportioning of the air/fuel mixture has to be released from the nozzle.

The burner assembly comprises means which ensures the correct flow of oil irrespective of variation of back pressure on the oil as it flows to the burner nozzle and variations in the oil pressure. The assembly also comprises means actuated externally of the assembly for determining the amount of fuel fed to the burner nozzle. Such means may comprise a metering member which cooperates with and is adjustable relatively to a metering orifice through which fuel is fed to a metering chamber and thence to the burner nozzle.

The position of the metering member relative to the metering orifice is adjusted by means of an externally actuated fuel control member. The metering member may consist of an axially-adjustable metering pin having a tapered or chamfered end which cooperates with the metering orifice, the taper of the pin being such that a predetermined forward movement of the pin causes the required predetermined reduction in the effective area of the metering orifice, and vice versa.

In a constructional form of the invention which is described hereinafter, the burner assembly comprises means associated with the oil inlet feed duct in the assembly and disposed between the duct and the metering orifice, and wherein the said means acts upon any variation of pressure drop across the metering orifice to cause a higher or lower back pressure drop across the orifice and to maintain the required pressure drop across the orifice.

In one constructional form of the invention which will be described hereinafter, the said means which acts upon any variation of pressure drop across the metering orifice to cause a higher or lower back pressure drop across the orifice consists of a flexible hollow bellows which is arranged in a bellows chamber and is subjected externally to the pressure of oil which passes through the metering orifice on its way through an outlet from the bellows chamber to the burner nozzle, and internally to the pressure of the oil fed into the bellows from the oil inlet feed duct of the burner assembly. The bellows is adapted, on an increase in pressure in the oil feed inlet duct, to expand and to reduce the gap in the bellows chamber between the bellows and the said outlet from the chamber, thus creating a higher back pressure at the metering orifice and maintaining a predetermined pressure drop across the orifice, whereas when the pressure of the oil in the oil feed inlet duct decreases, or when there is an increase in the back pressure, the bellows contacts so as to reduce back pressure at the metering orifice and maintain a predetermined pressure drop across it.

Means associated with the bellows are provided for controlling the initial pressure drop and in the construction referred to above the said means comprises a spring which tends to expand the bellows and an adjusting screw which is operable externally of the burner assembly and is adapted to vary the loading on the spring. The turnable member for controlling the axial setting of the metering pin is associated and acts simultaneously with means for controlling any excess of air which is fed to the burner nozzle and which has to be released from the nozzle. The said means for controlling the excess of air consists of a cam plate or equivalent which acts to open and close by a predetermined amount an air outlet formed in the burner body and communicating with the outlet end of an air-bleed-tube, the inlet end of which latter communicates with an air-swirler device at the rear of an air outlet orifice in the device. The air is supplied to the interior of the said air swirler device through a plurality of tangential holes which provide communication between the interior of the device and an air supply duct which communicates with an air supply source and which surrounds, but is isolated from, the air-bleed-tube.

In the same construction metered oil which has passed through the oil metering orifice is fed to the burner nozzle through an oil supply duct which is isolated from the air supply duct and communicates at its outlet end with an annular oil discharge space connected to a chamber into which air from the air-swirler device is fed and from which the air/fuel mixture is discharged from the burner nozzle through an air/fuel discharge orifice.

The burner assembly is preferably provided with an adjustable member which surrounds the burned nozzle and the adjustment of which provides a measure of control of the shape of the flame, and in the construction referred to above the said member consists of a cowl which is adjustable axially relatively to the burner body and which comprises a flaring mouth and a number of spaced holes which provide communication between the interior and exterior of the mouth.

In a modified construction the said means associated with the bellows for controlling the initial pressure drop consists of a temperature-compensating device which conveniently consists of a bi-metallic strip made from materials chosen both with reference to their electrochemical qualities and to the resilience required to fulfill the function of a spring.

Two constructional forms of the invention both applied to fuel oil burner assemblies for use with intermittently-acting ceramic furnaces, will now be described, by

way of examples, with reference to the accompanying drawings, wherein:

FIGURE 1 is an outside elevation of one of the burner assemblies;

FIGURE 2 is a sectional view of the assembly on the line II—II in FIGURE 1;

FIGURE 3 is a section on the line III—III in FIGURE 1;

FIGURE 4 is a fragmentary section on the line IV—IV in FIGURE 1; and

FIGURE 5 is a fragmentary sectional view of a modified burner assembly in which the bellows spring used in the construction shown in FIGURES 1 to 4 is replaced by a temperature compensating device in the form of a bi-metallic strip of C-shape.

Referring first to FIGURES 1 to 4:

The burner assembly comprises a main body part **1** and a body end part **2** which is bolted to one end of the body. The main body **1** carries the burner unit comprising the outer tube **3** which projects laterally from the face of the body remote from the body end part **2** and is screw-threaded into the body, and an inner tube **4** which is coaxial with and supported within the outer tube and has an external diameter which is less than the internal diameter of the outer tube so that an annular oil delivery space **5** is left between the two tubes.

An air-bleed-back tube **6** is also supported in the body coaxially with the outer and inner tubes **3** and **4** and within the inner tube, the inner end of the bleed-back tube being fixed in the body **1** and its outer end being fixed in the shank part **7** of a hollow, headed air-swirler device **8** which is screwed into the outer end of the inner tube. A dish-shaped end cap **9** forming the burner nozzle is screwed onto the outer tube **3** and its base is formed centrally with an air-fuel jet orifice **10**. A ring **11** having a flared inner surface is threaded into the end cap **9** and bears against the inner surface of the base of the cap. The flared inner surface **12** of the conical ring **11** is of such dimensions that an annular, conical oil-discharge space **13** is left between the conical head **14** of the air-swirler device **8** and the inner surface of the ring, the space sloping from the back of the ring towards the front of the latter i.e., towards the axis of the burner unit. The cylindrical part **15** of a nose cowl **16** of heat-resisting steel is adjustably fitted on the outer tube **3**, the end of the cowl being formed with an outwardly-flaring mouth **17** and with a number of spaced holes **18** formed at the junction of the flared mouth and the cylindrical part of the cowl. An adjustable screw **19** is provided for fixing the cowl in its adjusted positions on the outer tube. The adjustment of the cowl provides a measure of control of the shape of the flame.

The burner itself is a medium pressure atomising burner which, in the present construction, is intended to have maximum/minimum fuel ratios of 12:1. The fuel is atomised by air pressure and the air/fuel mixture is self-proportioned at all settings. A fuel flow control device, which is described hereinafter, is also incorporated in order to ensure that correct flow is maintained irrespective of variations in back pressure which may be caused by obstruction of the nozzle when firing, or variations in inlet pressure caused by faulty operation of the oil delivery pump or constriction of the oil supply line. The burner is intended to work on all grades of fuel oil, which in case of heavy grades is previously heated in order to give it the required viscosity.

Oil is supplied to the burner assembly under pressure from an outside source through two spaced lateral ports **20** and **21** formed in the body, either of which ports can be used for the inlet or outlet of the oil. The port which is not in use for the purpose of feeding the oil into the burner assembly is employed as a return to the oil main, this feature ensuring constant circulation of the oil. Each of the lateral ports **20** and **21** communicates with an annular inlet chamber **22**, FIGS. 2 and 4, which is formed transversely in the body around an intermediate part **23** of a bore which is offset from the axis of the burner unit and the end **24** of which, remote from the body end part, is of reduced diameter. The end of the bore adjacent to the body end part is screw-threaded to receive the threaded end of a hollow sleeve **25**.

A valve seat disc **26** is fitted in the said bore in the body at the junction of the intermediate part **23** and the end of the bore **24** of reduced diameter and the disc is formed with a central orifice **27**, the mouth **28** of which is flared outwardly from the inner face of the disc in the direction of the bore of reduced diameter. The orifice may be closed or partially or fully opened by means of an axially slidable metering pin **29**, having a tip **301** which is slidable within the orifice and is chamfered at an angle to the axis of the pin, the arrangement being such that by varying the axial position of the pin a greater or less opening of the orifice **27** in the disc can be arrived at. The metering pin **29** is urged rearwards, i.e., away from the valve seat disc **26** by means of a spring **30** which reacts between the head **31** of the pin and a sleeve **32** in which the pin is guided and the opposite end of which bears on a perforated sleeve **33** integral with the valve seat disc.

The axial adjustment of the metering pin **29** and, therefore, the position of the chamfered tip **301** of the pin relative to the orifice **27** in the valve seat disc **26** is arrived at by means of a metering pin adjusting screw **34** which is screwed into a threaded hole **35** formed in the body end part **2**. The inner end **36** of the adjusting screw is slidably guided in a boss **37** on the body end part **2** and its tip contacts with a pip **38** projecting from the head **31** of the metering pin **29**. The adjusting screw **34** also projects out of the body end part and carries an adjusting knob **39** which is fixed to it by means of a grub screw **40**. A cam plate **41**, the purpose of which will be described hereinafter, is fitted between the inner face of the knob and the machined outer face **42** of the body end part. The cam plate **41** is turnable with the knob by means of a stop pin **43** which is fixed in the cam plate and which, at its outer end, engages in a hole **44** in the knob, while at its inner end the stop pin engages in an arcuate slot **45** in the body end part. The range of movement of the adjusting screw **34** is just under one pitch of the screw and is controlled by the stop pin **43**. The metering pin is initially set by releasing the said grub screw **40** and adjusting the screw by means of a screw driver. The amount of taper of the tip **301** of the metering pin **29** is such that a forward movement of the pin of just less than one pitch of the adjusting screw will cause a 12:1 reduction in the effective area of the orifice **27** in the valve seat disc **26**.

The reduced end **24** of the said bore in the body, in which bore the valve seat disc **26** is fitted, is in constant communication through a duct **46** with a bellows chamber **47** which is formed in the body part and is closed at its upper end by a cap **48** having integral internal and external bosses **49** and **50**. A metal flexible bellows **51** is arranged in the bellows chamber **47** with its upper end engaged with the lower surface of a hollow plug **52** screwed into the upper end of the chamber, the lower end of the bellows being fitted with a plate **53**. A coil spring **54** is arranged inside the bellows and reacts between the said bellows plate **53** and a spring stop plate **55** carried at the inner end of a bellows adjusting screw **56** which is screwed into a threaded hole **56***a* in the said external boss **50**. The bellows plate **53** is disposed above the head of a valve seat **57** which is threaded into a duct **58** leading from the base of the bellows chamber **47** to an oil outlet chamber **59** formed in the body and surrounding the said inner tube **4** and communicating with the inlet end of the annular oil delivery space **5** between the outer and inner tubes **4** and **6**. The outlet end of the oil delivery space **5**, FIG. 2, communicates with the annular space **13** between the conical head **14** of the swirler de-

vice 8 and the flared opening 12 in the ring 11 in the burner unit cap and the head of the swirler device and thus also with the jet orifice 10 in the cap.

The chamber 47A, FIG. 3, above the bellows 51 and which communicates with the interior of the bellows is also connected to the oil inlet chamber 22 through a passage 22A shown in FIG. 1, so that any variation in pressure drop across the metering orifice in the valve seat 26, FIG. 2, is reflected in a movement of the bellows.

Thus, any increase in pressure in the oil inlet chamber 22 in the body causes the internal pressure in the bellows 51 to increase, thereby causing the bellows to extend. Such extension of the bollows reduces the effective gap in the bellows chamber 47 between the bellows plate 53 and the opening of the bore 61 of the valve seat 57 in the bellows chamber, thus creating a higher back pressure at the metering orifice 62 which is formed in the valve seat disc 57 and maintaining a predetermined pressure drop across the metering orifice as described below. A decrease in the inlet pressure in the oil inlet chamber 22 or an increase in back pressure will cause the bellows to contract and thus to reduce back pressure at the metering orifice 62 and maintain the required pressure drop against that orifice so as to maintain the rate of flow needed to maintain a given input heat into the kiln. The initial pressure drop is controlled by adjusting the bellows adjusting screw 56 and the spring 54 acting upon the bellows plate.

Low pressure air fed from an outside source is supplied through an air inlet 63, FIG. 4, in the body to the space 63A between the air bleed tube 6 and the inner tube 4 of the burner unit and passes through tangential holes 64 in the shank 7 of the swirler device into the bore of the latter and thus through the air outlet orifice 65 in the head 14 of the swirler device 7 to the jet opening 10 in the base of the burner cap 9 after first entering the spce 60 between the base and the front face of the head of the swirler device. A rotary turbulence is thus given to the air, which then entrains the annular film of oil between the head 14 of the swirler device and the base of the burner cap 9 and atomises it. The mixture of air and atomised oil then passes through the said jet opening 10 into the firing chamber of the kiln after passing through the cowl 17. The flow of air supplied is controlled so as to restrict it to a flow below that which would cause aspiration.

The amount of air required for atomisation of the oil will vary according to the rate of fuel flow. On the other hand, it is necessary to provide a minimum amount of air and also to provide the rotational velocity needed to atomise the oil. Although at low oil flow this minimum quantity of air may be too much to allow formation of suitable flame, it is preferred not to correct the flow of inlet air as this would cause variations in the pressure and volume of air. It is therefore arranged for the supply of air to be constant, the necessary correction being made by bleeding back the surplus amount of air from the air space 63A between the inner tube 4 and the said air bleed tube 6 through the latter. The actual amount of air released to atmosphere via the bleed tube and a duct 66 in the body end part 2 is controlled by means of the aforesaid cam plate 41 which bears against the machined face of the body end part and which is spring-loaded by means of a spring 67 fitted in the fuel control knob 39 on the said adjusting screw 34 for the metering pin 29. The shape of the cam 41 is such that an appropriate area of the outlet end of the air bleed duct 66 in the body end part is uncovered for each setting on a dial 68 which is provided on the body end part of the flow of fuel.

By mounting the cam 41 on the fuel control knob 39 as mentioned above, a movement of one control only is sufficient to control the supply of both the fuel and the air. At high rates of fuel flow the cam is arranged to close the outlet end of the air bleed duct 66 completely, since at such high flow rate all the available air is required in order at atomise the fuel.

In the modified burner assembly shown in FIG. 5, the construction of the bellows unit is somewhat different. The bellows spring 54 referred to above is replaced by a temperature compensating device in which, for example, a bi-metallic strip 69 is fashioned in the form of the letter C. The materials for making this strip are chosen with reference both to their electro-chemical qualities and to the resilience required to fulfill the function of a spring. The bi-metallic spring may be arranged between the said bellows adjustment screw 56 and the bellows plate 53. The bi-metallic spring device will act so as to maintain constant the flow of the oil irrespective of its viscosity changes while the burner is working.

I claim:

1. A burner assembly having a main body comprising a burner nozzle which includes an air-swirler device, an air outlet orifice in said device, an air/fuel mixture chamber disposed in front of said device, an air/fuel jet orifice in said nozzle communicating with said chamber, tapered oil discharge means surrounding said device including oil discharge passage means communicating at its outlet end with said chamber, an oil supply conduit, the outlet end of which communicates with said discharge means, an air supply conduit means defining holes in said air swirler device through which air from said supply conduit passes into the interior of said device and which are so disposed as to give the air a swirling motion in the device, an oil inlet chamber, an oil-metering orifice communicating with said chamber, means for adjusting the effective area of the orifice, a chamber for metered oil which passes through said metering orifice, a bellows chamber, a conduit connecting said chamber for metered oil to the bellows chamber, an outlet from the bellows chamber, said outlet being formed in a valve seat disposed in the chamber, a hollow flexible bellows mounted in said bellows chamber, metering means carried by the bellows disposed above and spaced from the valve seat, movement of said bellows being effective to vary the spacing between said metering means and said valve seat, an oil by-pass conduit connecting the said oil inlet chamber to the interior of the bellows, an air inlet in said body connected to said air supply conduit, an air-bleed conduit connected at its inlet end to said air-swirler device, an air outlet in said body connected to said air bleed conduit, and means disposed externally of the body which simultaneously controls the position of said means for adjusting the effective area of said oil-metering orifice and the degree of opening of said excess air outlet.

2. A fuel burner assembly which comprises, a burner nozzle, oil supply means through which oil under pressure is supplied to said nozzle, air supply means through which a constant supply of air under pressure is fed to said nozzle, mixing means defining a space in the burner assembly upstream of the said nozzle with which said oil and air supply means communicate and in which the oil and air are mixed, air outlet means in said burner assembly defining an excess air outlet and communicating with said air supply means for conveying excess aid from said air supply means, a fuel jet orifice in said burner nozzle extending from said space through said burner nozzle, the fuel being atomised in said space before the mixture is discharged from the said jet orifice, means for giving the air a rotary turbulence as it enters said space so as to ensure the correct atomisation of the fuel, a combined air and fuel control means for controlling the supply of air and fuel to said space by means of which said burner assembly has a predetermined maximum/minimum air/fuel ratio, said air and fuel control means simultaneously proportioning the supply of air and fuel to said nozzle by simultaneously adjusting the quantity of fuel fed to said nozzle and controlling the discharge of any excess of air fed to said nozzle through said outlet means in order to proportion the air/fuel mixture, and means for ensuring a desired flow of fuel irrespective of variation of back pressure on the fuel as it flows to the said jet orifice and variations in the fuel pressure.

3. A burner assembly as claimed in claim 2, wherein the said combined air and fuel control means comprises a control member which is operable externally of the assembly.

4. A burner assembly as claimed in claim 2 and additionally including an adjustable member which surrounds the burner nozzle for providing for an adjustable measure of control of the shape of the flame, and including means for actually positioning said adjustable member relative to said fuel jet orifice.

5. A burner assembly as claimed in claim 4, wherein the said member consists of a cowl which is adjustable axially relatively to the burner body and which comprises a flaring mouth and provided with a plurality of spaced holes which extend through said mouth.

6. A burner assembly as claimed in claim 2, wherein said last-mentioned means includes a metering chamber formed in said burner assembly and means forming a metering orifice in said burner assembly interconnecting said metering chamber and said oil supply means, and wherein the said combined air and fuel control means comprises a metering member which cooperates with and is adjustable relatively to said metering orifice through which fuel is fed to said metering chamber and thence to the burner nozzle.

7. A burner assembly as claimed in claim 6, wherein metered oil which has passed through the oil metering orifice is fed to the burner nozzle through an oil supply duct which is isolated from the air supply duct and communicates at its outlet end with an annular oil discharge space connected to a chamber into which air from the air-swirler device is fed and from which the air/fuel mixture is discharged from the burner nozzle through an air/fuel discharge orifice.

8. A burner assembly as claimed in claim 6, wherein the said metering member consists of an axially-adjustable metering pin having a tapered or chamfered end which cooperates with the metering orifice, the taper of the pin being such that a predetermined movement of the pin causes the required predetermined change in the effective area of the metering orifice.

9. A burner assembly as claimed in claim 8, wherein the metering pin is spring-urged in a direction to open the metering orifice.

10. A burner assembly as claimed in claim 8, wherein the axial-setting of the metering pin is controlled externally of the burner assembly by a turnable adjustable member.

11. A burner assembly as claimed in claim 10, wherein the turnable member for controlling the axial setting of the metering pin is associated and acts simultaneously with means for controlling any excess of air which is fed to the burner nozzle and which has to be released from the nozzle.

12. A burner assembly as claimed in claim 11, wherein the said means for controlling the excess of air consists of a cam plate means which acts to open and close by a predetermined amount said air outlet means and communicating with the outlet end of an air-bleed-tube, the inlet end of which latter communicates with an air-swirler device.

13. A burner assembly as claimed in claim 12, wherein there is provided an air supply duct which communicates with an air supply source and which surrounds, but is isolated from, the air-bleed-tube, and air is supplied to the interior of the said air-swirler device through a plurality of tangential holes which provide communication between the interior of the device and said air supply duct.

14. A burner assembly as claimed in claim 6, wherein the said means which ensures the correct flow of oil irrespective of variation of back pressure on the oil as it flows to the burner nozzle and variations in the oil pressure is associated with the oil inlet feed duct in the assembly and is disposed between the duct and the metering orifice, and wherein the said means acts upon any variation of pressure drop across the metering orifice to cause a higher or lower back pressure drop across the orifice and to maintain the required pressure drop across the orifice.

15. A burner assembly as claimed in claim 14, wherein a bellows chamber is provided in said burner assembly and the said means which insures the correct flow of oil consists of a flexible hollow bellows which is arranged in said bellows chamber, and means are provided for subjecting said bellows externally to the pressure of oil which passes through the metering orifice on its way through an outlet from the bellows chamber to the burner nozzle, and internally to the pressure of the oil fed into the bellows from the oil inlet feed duct of the burner assembly.

16. A burner assembly as claimed in claim 15, wherein the bellows is adapted, on an increase in pressure in the oil feed inlet duct, to expand and to reduce the gap in the said bellows chamber between the bellows and the said outlet from the chamber, thus creating a higher back pressure at the metering orifice and maintaining a predetermined pressure drop across the orifice, whereas when the pressure of the oil in the oil feed inlet duct decreases, or when there is an increase in the back pressure, the bellows contracts so as to reduce back pressure at the metering orifice and maintain a predetermined pressure drop across it.

17. A burner assembly as claimed in claim 15, wherein means associated with the bellows are provided for controlling the initial pressure drop.

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