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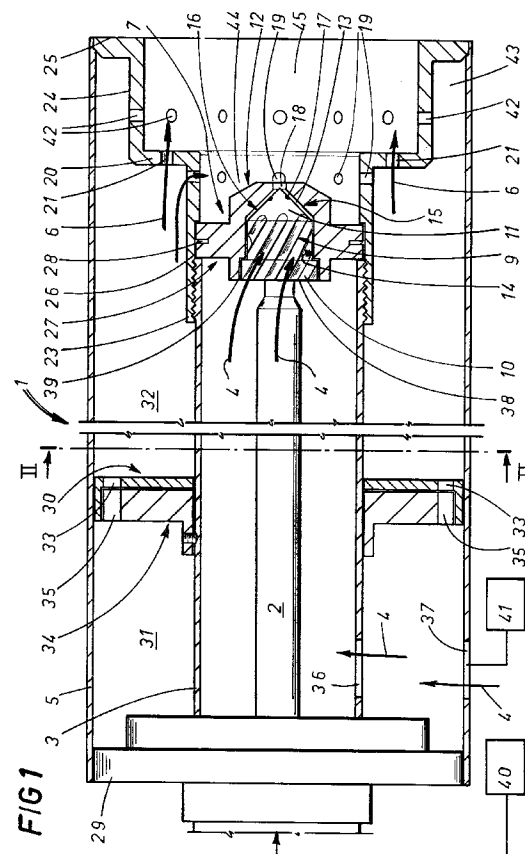
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DE ES FR GB IT NL(30) Priority: **31.10.1994 IT BO940477**(71) Applicant: **SIB SIBER S.r.l.****I-40050 Monte San Pietro (Bologna) (IT)**(72) Inventor: **Monari, Marco****I-40134 Bologna (IT)**(74) Representative: **Lanzoni, Luciano****c/o BUGNION S.p.A.****Via dei Mille, 19****I-40121 Bologna (IT)**(54) **Air-atomized oil burner**

(57) The air-atomized oil burner comprises three co-axial tubes (2, 3, 5), the innermost one (2) being designed to feed fuel oil, while the middle one (3) and outermost one (5) are fed by the same air supply at low pressure and ambient temperature, and comprises also an atomizing nozzle (7) consisting of a head (8) fitted to the innermost tube (2) and having peripheral grooves (10) extending at an angle with respect to the axis of the head (8) and terminating at a conical section (11) of the head (8) itself, and of a casing (12) which closes the said middle tube (3) and which has an axial hole (13) for housing the said head (8); in the axial hole (13) the head (8) defines a small sized atomization chamber (16) into which the grooves (10) and the fuel oil feed holes (17) lead in perpendicular directions; the atomization chamber (16) feeds the atomized oil along the middle tube (3) where it is mixed with secondary air (6) fed through radial holes (19) made in the middle tube (3) itself.

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Description

The present invention relates to an air-atomized oil burner.

It is well known that one of the functions of an oil burner is to finely atomize the fuel oil before mixing it with the combustion air.

Numerous devices have been designed and made to do this. In one of these, the fuel oil is atomized by steam or pressurized air.

One type of air-atomized oil burner consists basically of three coaxial tubes placed one inside the other. The innermost tube has a atomizing nozzle on the end of it which feeds the fuel oil.

The middle tube supplies primary air used for atomizing the fuel oil fed by the atomizing nozzle before combustion. The outermost tube supplies secondary or combustion air, that is, the air which enables combustion of the atomized oil to take place.

The primary and secondary air can be supplied by the same source to simplify the structure of the burner or, preferably, by two different sources, so that there is more margin for adjustment. This is because the amount of secondary air is a function of the amount of fuel oil required, whilst the amount of primary air, or rather, its pressure, depends less on the amount of fuel oil required.

Irrespective of oil and air temperature, oil atomization has until now been optimized using nozzles with complex shapes and structures and by directing the flow of the primary and secondary air supplies in such a way that they are as parallel as possible to the fuel oil flow in such a way as to mix them effectively and to improve the carrying of the fuel oil by the atomizing fluid, that is, the air or steam. For example, the nozzle and middle tubes were made in the form of a Venturi tube and the nozzle and inner tubes coaxially slidable relative to each other in order to satisfy different operating requirements.

In other words, the efficiency of burners was gradually improved but at the same time their complexity and production costs were increased.

The object of the present invention is to provide an air-atomized oil burner that is not only efficient and highly reliable in terms of combustion but also simple in terms of structure.

The technical characteristics of the invention are laid out in the claims below and the advantages of the disclosure are apparent from the detailed description which follows, with reference to the accompanying drawings, which illustrate preferred embodiments of the invention by way of example and in which:

- Figure 1 is a longitudinal section through the centre of the air-atomized oil burner disclosed by the present invention;
- Figure 2 is a sectional view along line II-II shown in Fig. 1.
- Figure 3 is a perspective detail view of the burner

disclosed by the present invention, showing a head forming part of the fuel oil atomizing nozzle illustrated in Fig. 1;

- Figure 4 is a side view of another embodiment of the atomizing nozzle shown in Fig. 1, with some parts cut away in order to better illustrate others;
- Figure 5 is a side view of yet another embodiment of the atomizing nozzle shown in Fig. 1, with some parts cut away in order to better illustrate others.

With reference to the drawings listed above, the numeral 1 indicates the air-atomized oil burner disclosed by the present invention. The said oil burner 1 consists of three coaxial tubes 2, 3 and 5 placed one inside the other and an atomizing nozzle 7 keyed to one end of the innermost tube 2, as can be clearly seen in Fig. 1. The innermost tube 2 communicates with fuel oil supply means which feed the fuel oil at a preset, adjustable pressure. The said means are illustrated schematically as a block 40 since they are of known type and do not fall within the scope of the present invention. The middle tube 3 and the outermost tube 5 are both connected to the same source of compressed air, which is illustrated schematically as a second block 41 for the same reason mentioned as regards the fuel oil supply means 40.

A closer look at the structure of the burner 1 shows that the innermost tube 2 has keyed at opposite ends of it the atomizing nozzle 7 and an end flange 29 to which one end of the outermost tube 5 is also keyed. The end flange 29 also has one end of the middle tube 3 sealed onto it. That means the end flange 29 acts not only as a spacer but also as a fixing element for tubes 2, 3 and 5.

The atomizing nozzle 7 consists of a head 8 and a casing 12 which fits snugly over the head 8. The casing 12 is flanged at 27 with an outer diameter that is substantially the same as the outer diameter of the middle tube 3. The free end of the middle tube 3 is connected to the free end of the outermost tube 5 by means of a tubular union 22 divided into two consecutive sections 23 and 24 which differ in diameter. The smaller diameter tubular section 23 is keyed to the free end of the middle tube 3 and joined to the larger diameter tubular section 24 through a transverse wall 20 with holes 21 whose axes are parallel to the axis of the union 22. Near the transverse wall 20, the tubular section 23 has a plurality of radial holes 19 and, in practice constitutes an extension of the middle tube 3. The tubular section 23 itself has inside it a seat 26 to receive the flange 27 of the casing 12. The seat 26 is open towards the end flange 29 so that the middle tube 3 holds the flange 27 in the seat 26. At its free end, the tubular section 24 is equipped with a flange 25 to which the free end of the outermost tube 5 is connected. The tubular section 24 also has radial holes 42 and, in conjunction with the outermost tube 5, defines an annular chamber 43. The tubular sections 23 and 24 of the union 22 define two consecutive chambers 44 and 45, respectively, which constitute the combustion chamber of the burner 1, as de-

scribed below.

Before looking in more detail at the atomizing nozzle 7, it is worth noting that the innermost tube 3 is fitted over and sealed to a dividing disc 30. The disc 30 divides the annular chamber defined by the middle tube 3 and the outermost tube 5 into two consecutive chambers 31 and 32. The disc 30 has a plurality of slots 33, has a substantially bowl-shaped cross section and contains an annular shutter 34 also fitted to the middle tube 3 and having a series of slots 35. The slots 35 coincide in number and size with the slots 33. The angular position of the annular shutter 34 with respect to the dividing disc 30 may be adjusted from a position in which the slots 33 and 35 are not aligned with each other to one in which they are completely aligned, that is to say, from a position in which the slots 33 in the disc 30 are closed to a position in which they are fully open. The angular position of the annular shutter 34 therefore determines the secondary air flow 6 from the chamber 31 to the chamber 32 towards the union 22.

Between the dividing disc 30 and the end flange 29, the middle tube 3 and the outermost tube 5 have apertures 36 and 37 through which air is fed at low pressure, for example 1000 mm H₂O and at ambient temperature. The apertures 36 and 37 are coaxial so that the air supplied to the burner 1 at aperture 37 flows directly into the innermost tube 3 before occupying the chamber 31 thanks also to the dividing disc 30 and the shutter 34 which increases the pressure drop of the secondary air 6.

The head 8 of the atomizing nozzle 7 consists basically of two consecutive sections, one of which 9 is cylindrical and the other 11 conical. The cylindrical section 9 is equipped with a small end flange 38 and a plurality of grooves 10 terminating at the conical section 11. As shown in Figs. 1 and 3, the grooves 10 extend at an angle with respect to the longitudinal axis of the head 8. To better direct the flow of primary air 4, the grooves 10 may be helical. The conical section 11 has feed holes 17 in it, which communicate with the innermost tube 2 and which feed fuel oil. The feed holes 17 may be made in the conical section 11, as shown in Figs. 1 and 4, or they may be made in the grooves 10 in the cylindrical section 9, as shown in Fig. 5. In either case, it is important that the feed holes 17 are substantially perpendicular to the direction of the primary air supply 4 in contact with the head 8. As we have seen, the head 8 is housed inside the axial hole 13 in the casing 12. The axial hole 13 is divided into three consecutive sections 39, 14 and 13 corresponding, respectively, to the end flange 38, to the cylindrical section 9 and to the conical section 11 of the head 8. The section 39 constitutes a seat for the end flange 38 and the cylindrical section 14 is slightly longer than the corresponding cylindrical section 9 of the head 8. As a result, the conical section 11 of the head 8 and the truncated cone section 15 of the axial hole 13 are not in contact with each other but define an atomization chamber 16 into which the grooves 10 and the feed

holes 17 lead. The cross section of the grooves 10 is larger than that of the atomization chamber 16 so that the primary air 4 that is fed into the atomization chamber 16 through the grooves is subjected to a considerable increase in pressure and speed. The path followed by the primary air 4 flowing through the grooves 10 is such as to generate a vortex which strikes the fuel oil as it drips out of the feed holes 17 and exerts a sucking action which further atomizes the fuel oil. The atomization chamber 16 leads into the tubular section 23 of the union 22 through the end section 18 of the casing 12 whose axial hole 13, or orifice, has a small diameter. The minimum axial dimension of the atomization chamber 16 is determined by the flange 38 when it is as far in the seat 39 as it can go.

In Fig. 5, the feed holes 17 are substantially perpendicular to the grooves 10 through which the primary air 4 flows, whilst in Fig. 4, the direction of the primary air flowing along the grooves 10 into the atomization chamber 16 is tangential to the conical section 11. In both cases, therefore, the feed holes 17 are made in such a way as to be substantially perpendicular to the direction of the primary air flow 4 so as to achieve the aforesaid turbulence to better atomize the fuel oil.

With reference to Fig. 1 in particular, it can be seen that the feed holes 17 lead into the atomization chamber 16 in directions that are substantially perpendicular to the surface of the conical section 11 of the head 8 and, therefore, the directions in which the fuel oil and the primary air 4 are fed into the atomization chamber 16 are substantially perpendicular to each other.

The radial holes 19 are made in a plane substantially tangent to the end of the casing 12 facing the tubular section 23: in this way, the directions of the atomized fuel oil flow and of the secondary air flow 6 are also substantially perpendicular to each other. The same applies to the atomized fuel oil and the secondary air 6 fed through holes 42 of the tubular section 24. The effect of the turbulence generated by the air and fuel oil flowing perpendicularly to each other at the different points as described above is firstly to more effectively atomize the fuel oil and, secondly, to better mix the atomized fuel oil with the secondary air 6.

In Figs. 1 and 2, the flange 27 has grooves 28 made at an angle to the axis of the middle tube 3 and enabling the secondary air 6 to be fed in directions perpendicular to the radial holes 19 in such a way as to increase the turbulence.

The burner 1 can be easily adjusted in a wide range by varying the flow rate of fuel oil and air.

Unlike the burners known to prior art, however, the reduced flow of air to the burner 1 does not reduce efficiency because the air is fed directly into the middle tube 3 through apertures 37 and 36 where most of it becomes primary air 4 flowing along the grooves 10 and a small part of it becomes secondary air 6 flowing along the grooves 28. When the primary air 4 reaches a certain pressure within the middle tube 3, the air in excess starts

occupying the chamber 31 and then the chamber 32 and from there into the union 22 through the radial holes 19, the holes 21 and the radial holes 42. The primary air 4 is subjected to a first increase in pressure and speed as it passes from the middle tube 3 to the grooves 10 and to a second similar increase in pressure and speed as it passes from the grooves 10 to the atomization chamber 16.

Inside the atomization chamber, the primary air 4 generates a vortex which strikes the fuel oil fed by the feed holes 17 and finely atomizes it. The atomized fuel oil flows out through the orifice 18 of the casing 12 along the axis of the union 22 inside which it meets the secondary air 6 fed through the radial holes 19. The flame generated will depend on the amount of fuel oil supplied through the feed holes 17 and will be directed along the axis of tubes 2, 3 and 5. When the flow of fuel oil is small, the flame occupies the central part of the chamber 44. As the flow rate of the fuel oil and the flow rate of the air supplied by the source 41 increase, the flame tends to occupy the entire chamber 44 and gradually also the chamber 45 through the holes 21 and the radial holes 42.

As shown in Figs. 4 and 5, flow regulator means 46 are envisaged in the head 8 to prevent low flow rates from causing the fuel oil to flow through the feed holes 17 discontinuously on account of the distance between the feed holes and the supply means 40 and on account of the small inner diameter of the innermost tube 2. In Figs. 4 and 5, the flow regulator means 46 consist of a single-acting minimum pressure valve 47, which by approximately adjusting the flow rate and pressure of the fuel oil to a value greater than necessary, keeps the flow rate through the feed holes 17 at the required level. In practice, the fine adjustment of the fuel oil flow rate is achieved not by operating on the supply means 40 but by appropriately setting valve 47. Valve 47 is of a known type and consists of a shutter 48 kept in the closed position by appropriate elastic means 50. The shutter 48 may be spherical (see Fig. 4) or in the shape of truncated cone (see Fig. 5). The elastic means 50, for example a helical spring, may also be located inside the head 8 (see Fig. 4) or, as shown in Fig. 5, may be fitted to the outside of the innermost tube 2 at a point far from the head 8 and far from the flame generated by the atomized fuel oil fed through the atomizing nozzle 7. In this embodiment, the spring 50 operates on the shutter 48 through a control rod 49 which slides freely within the innermost tube 2. This configuration makes it possible to obtain a regular flow rate even when the operating temperature of the atomizing nozzle 7 is so high as to vary the setting of a spring 50 located inside the head 8.

The structure of the burner 1 is therefore very simple, thanks also to the absence of moving parts, and is capable of satisfying diverse requirements. In particular, atomization has been significantly improved using air at low pressure from a single source 41 and only by modifying the geometry of the paths it follows.

A particularly important feature is the union 22 which, in practice, defines the geometry of the most important part of the combustion chamber, that is, the part of the combustion chamber near the atomizing nozzle 7, where the flame is generated.

The fact that the combustion chamber 44 is divided into two parts, namely chambers 44 and 45, varying in diameter makes it possible to limit the size of the combustion chamber itself in accordance with the size of the flame, that is, according to the supply of fuel and air. In fact, when small quantities of fuel oil and air are supplied, the flame is small and combustion is restricted to the chamber 44 which is smaller in diameter. In this way, even if the secondary air 6 flows at a low speed, it is fed in the proximity of the orifice 18 through which the atomized oil is fed. As the fuel oil and air flow rates increase, the flame gets larger and the combustion extends to the chamber 45, which is larger in diameter. In this case, even if the secondary air 6 flowing out of the radial holes is further away from the orifice 18, it travels at a higher speed and therefore reaches the atomized fuel oil all the same. The variation in the diameter of the combustion chamber is made possible not only by the union 22, which is divided into the two tubular sections 23 and 24, which differ in diameter, but also by the radial holes 19 and 42 which feed the secondary air 6 into the chamber 44 and the chamber 45 independently of each other.

The invention described can be subject to modifications and variations without thereby departing from the scope of the inventive concept. Moreover, all the details of the invention may be substituted by technically equivalent elements.

Claims

1. An air-atomized oil burner of the type consisting of three coaxial tubes (2, 3, 5), placed one inside the other, of which the innermost one (2) feeds fuel oil, the middle one (3) primary or atomizing air (4), and the outermost one (5) secondary or combustion air (6), and an atomizing nozzle (7) fitted to the end of the innermost tube (2), the said burner being characterized in that the middle tube (3) and the outermost tube (5) are fed by the same low-pressure air supply, and that the atomizing nozzle (7) consists of a head (8) keyed to one end of the innermost tube (2) and comprising two consecutive sections, a cylindrical section (9) with grooves (10) extending at an angle with respect to the axis of the head (8) itself and a conical section (11) tapering from the cylindrical section (9), the head (8) consisting also of a casing (12), which closes the said middle tube (3) and which has an axial hole (13) made up of two consecutive sections, one cylindrical (14) and one (15) in the shape of a truncated cone, corresponding, respectively, to the cylindrical section (9) and

conical section (11) of the head (8), the latter being seated snugly in the casing (12) and being kept with its conical section (11) at a short distance from the truncated cone section (15) of the axial hole (13) of the casing (12) so as to define an atomization chamber (16) into which the grooves (10) of the cylindrical section (9) of the head (8) lead, the latter also having fuel oil feed holes (17) communicating with the said innermost tube (2) and substantially perpendicular to the direction of primary air flow (4) in contact with the head (8), the said atomization chamber (16) leading through a small diameter section (18) of the axial hole (13), or orifice, of the casing (12) into the middle tube (3) just upstream or in the proximity of a plurality of radial holes (19) made in the middle tube (3), there being envisaged between the latter and the outermost tube (5), downstream of the radial holes (19), a transverse wall (20) with holes (21) whose axes are parallel to the coincident axes of the said tubes (2, 3, 5).

2. The burner according to claim 1 characterized in that the middle tube (3) is connected to the outermost tube (5) at the end corresponding to the atomizing nozzle (7) through a union (22) consisting of two cylindrical, tubular sections (23, 24) coaxial with each other differing in diameter and joined together through a transverse wall coinciding with the said transverse wall (20), the tubular section (23), smaller in diameter, constituting an extension of the middle tube (3), having in it the said radial holes (19) and seating inside it the said atomizing nozzle (7), the tubular section (24), larger in diameter, being equipped at its free end with a flange (25) which closes it and connects it to the corresponding end of the outermost tube (5) and having plurality of second radial holes (42); the said smaller tubular section (23) defining a chamber (44) supplied with secondary air (6) through the first radial holes (19) and containing the atomizing nozzle (7); the said larger tubular section (24) defining a chamber (45) supplied with secondary air (6) through the second radial holes (42) and through the holes (21) in the transverse wall (20).

3. The burner according to claim 2 characterized in that the said fuel oil feed holes (17) are made in the conical section (11) of the head (8).

4. The burner according to claim 2 characterized in that the said fuel oil feed holes (17) are made in the grooves (10) of the cylindrical section (9) of the head (8).

5. The burner according to claim 2 characterized in that the smaller diameter tubular section (23) of the union (22) has at its free end a seat (26) which houses the said atomizing nozzle (7) and is keyed

at the said free end to the corresponding end of the middle tube (3) so as to constitute an axial fixing element of the atomizing nozzle (7) to the middle tube (3) so as to constitute an axial fixing element of the atomizing nozzle (7) to the middle tube (3).

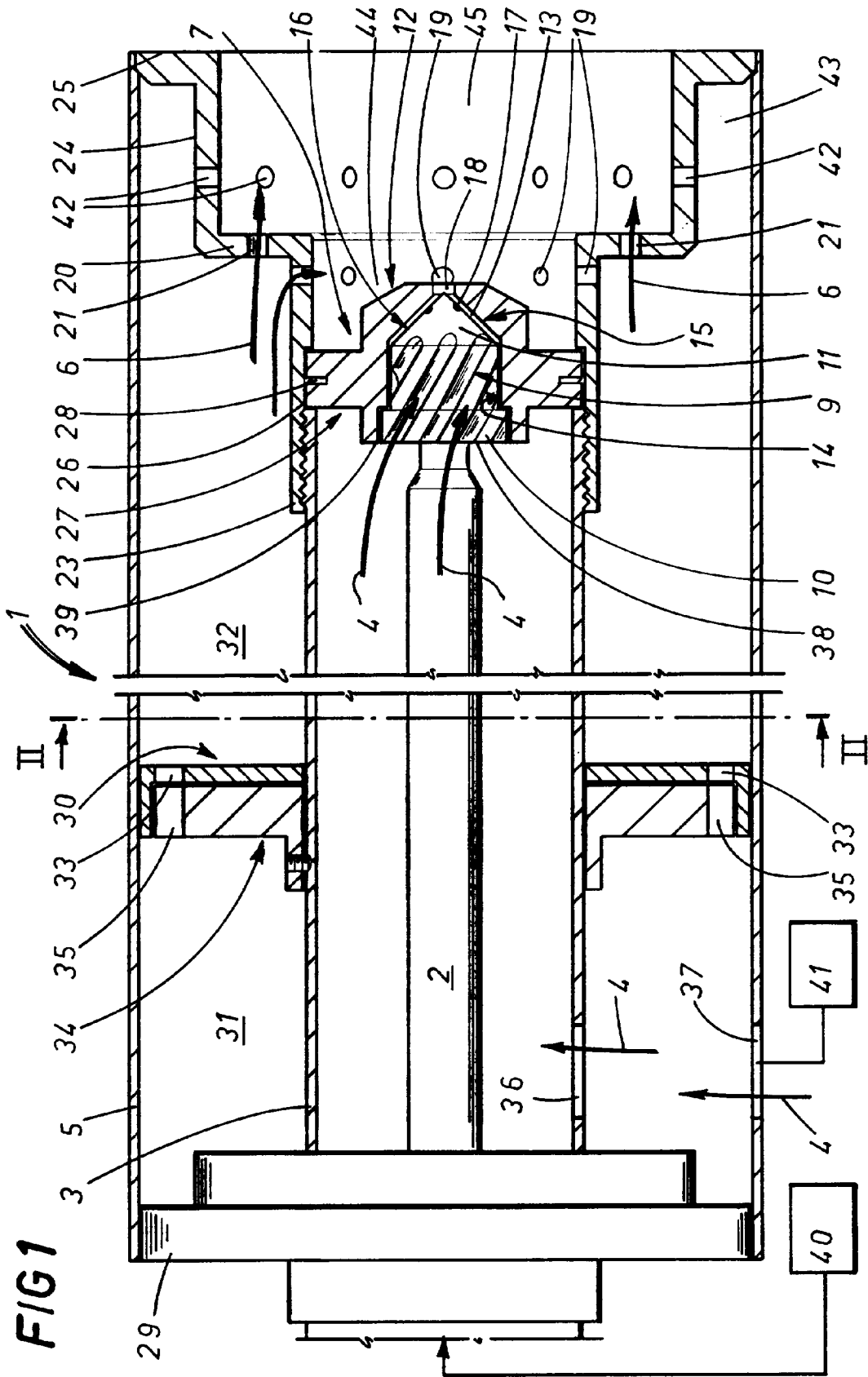
6. The burner according to claim 1 characterized in that inside the said head (8) and between the innermost tube (2) and the fuel oil feed holes (17) there are envisaged flow regulator means (46) designed to control the flow rate of the fuel oil.

7. The burner according to claim 6 characterized in that the said flow regulator means (46) consist of an adjustable, single-acting, minimum pressure valve (47).

8. The burner according to claim 7 characterized in that the said single-acting, minimum pressure valve (47) consists of a shutter (48) which blocks the innermost tube (2) and is equipped with a control rod (49) sliding freely inside the innermost tube (2) and subjected to the action of elastic means (50) located and working far away from the said head (8) and from the flame generated by the atomized fuel oil flowing out of the atomizing nozzle (7).

9. The burner according to claim 1 characterized in that the casing (12) of the atomizing nozzle (7) is equipped with a flange (27) for fixing the said casing (12), with at least one groove (28) made between the faces of the said flange (27) and extending at an angle with respect to the axis of the flange itself.

10. The burner according to claim 1 characterized in that the said middle tube (3) and the said outermost tube (5) are fed by the same air supply at low pressure and ambient temperature.



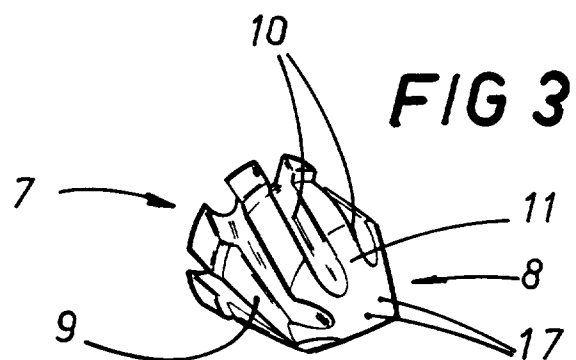
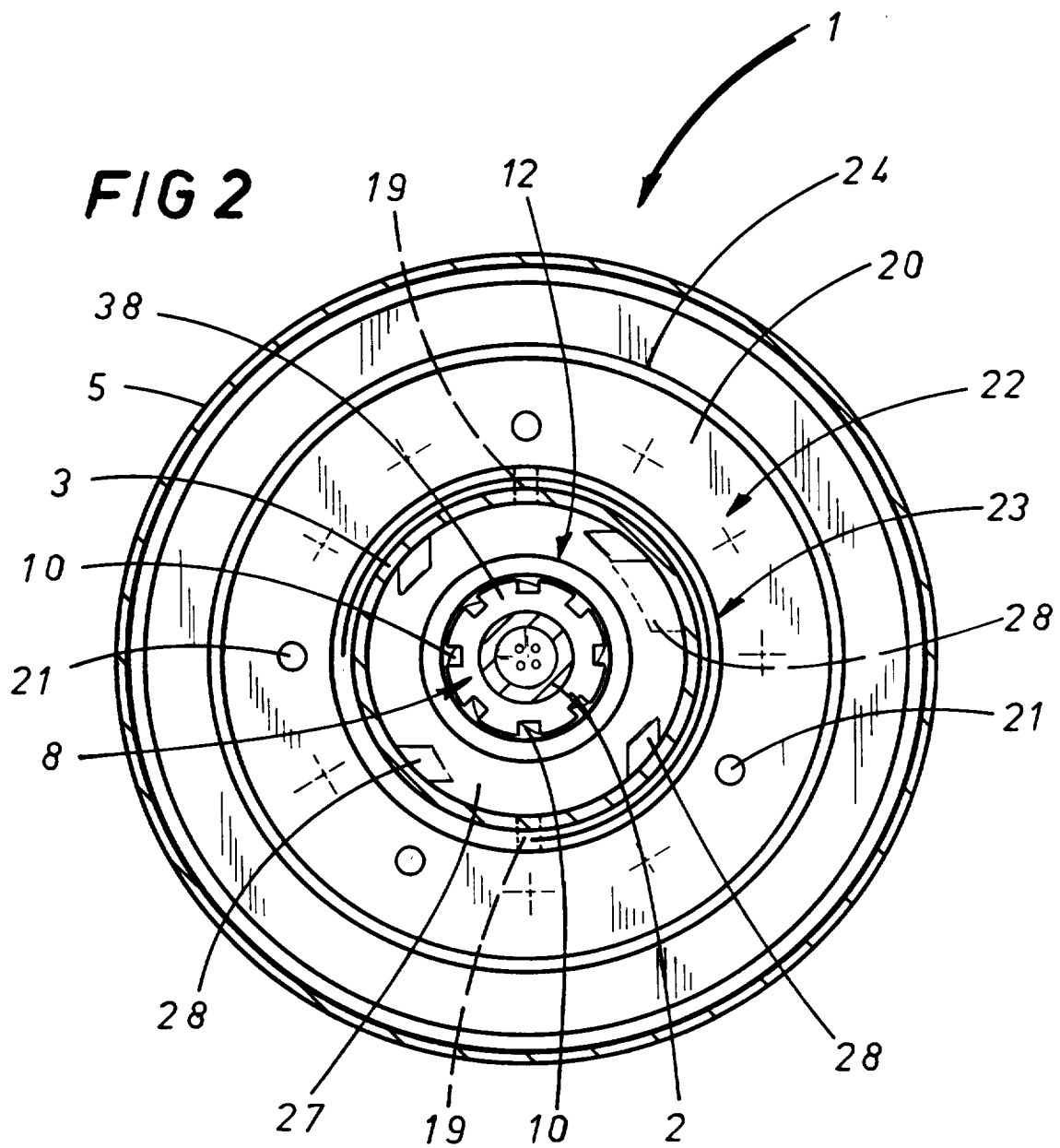


FIG 4

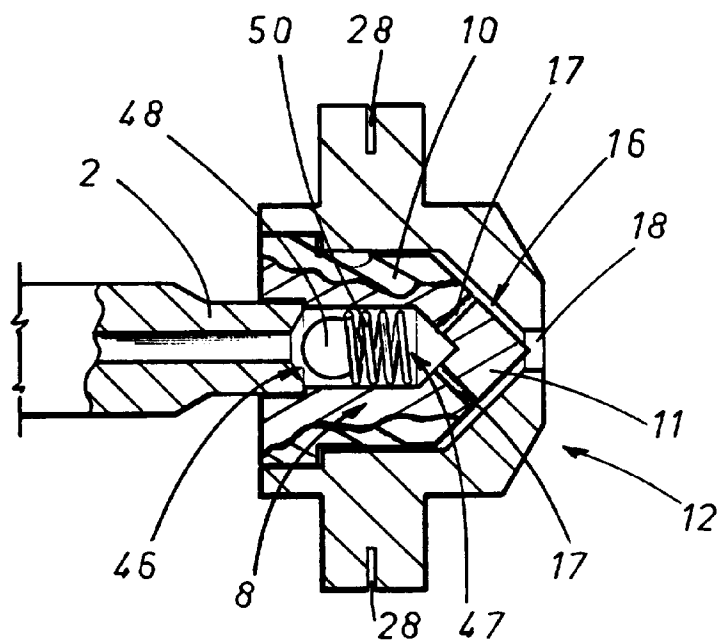


FIG 5

