May 14, 1929. E. F. CHANDLER 1,713,259

APPARATUS FOR ATOMIZING AND SPRAYING

Filed Feb. 5, 1924

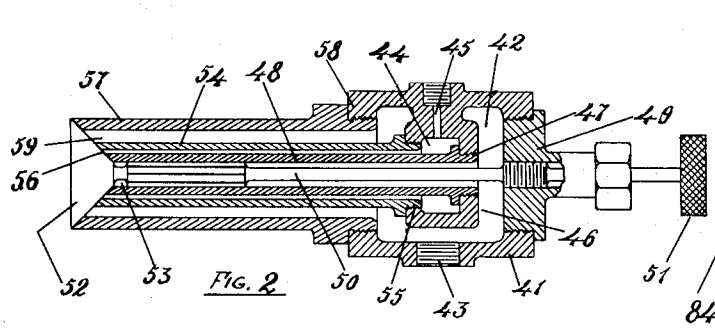


FIG. 2

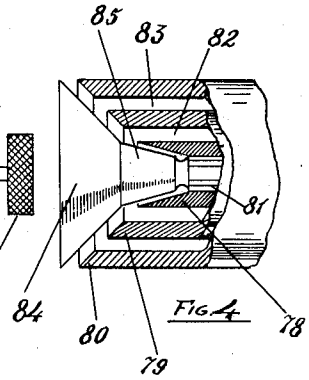


FIG. 4

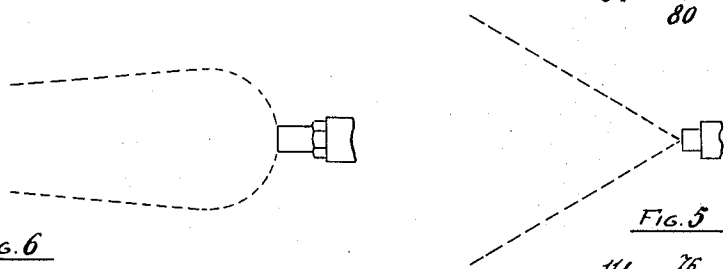


FIG. 6

FIG. 5

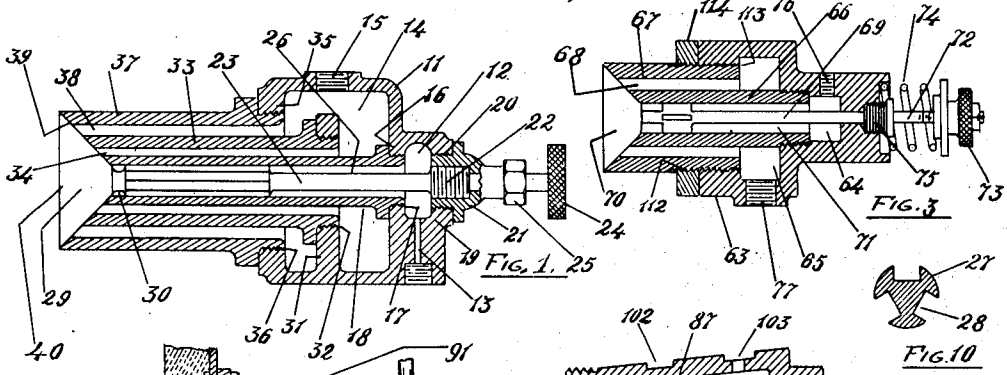


FIG. 1.

FIG. 3

FIG. 10

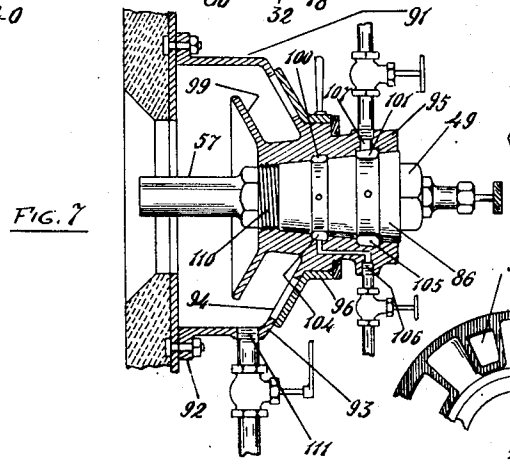


FIG. 7

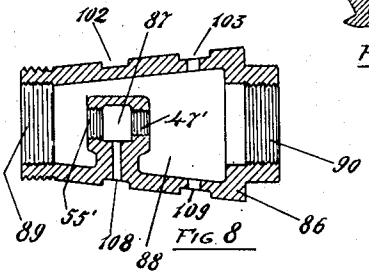


FIG. 8

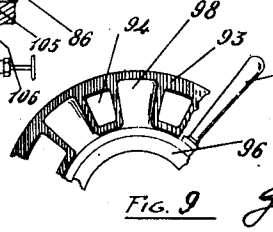


FIG. 9

INVENTOR
Edward F. Chandler
BY
Guilford Saunders
his ATTORNEY

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UNITED STATES PATENT OFFICE.

EDWARD F. CHANDLER, OF BROOKLYN, NEW YORK

APPARATUS FOR ATOMIZING AND SPRAYING.

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This invention relates to atomizing and spraying apparatus to be used in connection with the distribution of fluids and of pulverized materials; and its main object is to provide a novel and improved spraying device, insuring uniform distribution of the material handled over a comparatively large area or volume, in finely divided form.

A further object is to provide an atomizing and spraying device, particularly adapted for use in connection with liquid fuel, whereby the fuel is first distributed over a large area in a thin film, and is then broken up into minute particles forming a nebulous spray, upon leaving the knife-like edge of the distributing surface, due to the velocity imparted to it by compressed air or steam.

A still further object is to provide an atomizing and spraying device, particularly adapted for use in connection with a liquid fuel, the operation of which is such as to permit the unhampered flow of the fuel, and its perfect atomization, in any position, without dripping, producing complete combustion.

With these and other objects in view, as will more fully appear as the description proceeds, this invention furthermore consists in certain novel and improved constructions and arrangements of parts, as will be hereinafter fully described and claimed in the appended claims.

The atomization of fluids is generally effected by forcing the fluid to be atomized through a minute orifice, under pressure high enough to produce high velocity in the fluid, and subsequent breaking up of the same into a quantity of minute particles. The spray thus produced is generally of a conical form, and the atomization is incomplete and non-uniform; this method furthermore calls for the employment of relatively high pressures.

In other types of apparatus, distribution of the oil in a thin film over a relatively large area, previous to atomization, has been resorted to; but the atomization thereof, such as naturally occurs due to the breaking action of the edge surrounding said distributing surface, and to the pressure imparted to the liquid, is generally interfered with by allowing the same to take place before the edge proper is reached, or by adding the disintegrating action of supplementary jets of air under pressure at the point of issue of the atomized fuel, or by introducing other factors influencing the nature and form of the spray; with the result that the peculiar atomizing action due to the keen edge of a distributing surface breaking an ever thinning layer of liquid traveling over the surface towards said edge with a certain velocity, while no obstructing or retarding or antagonistic influences are allowed to come into play, is to a great extent, or entirely, prevented.

By my method, the fluid is caused to travel over the surface of a conical valve element, as a constantly thinning film, until the periphery is reached, where it is blown from the knife-like edge in a nebulous spray.

The proper velocity in an outward direction is imparted to the fluid film before the edge is reached, said direction being that of the distributing surface; so that the spray is directed tangentially to said surface at the moment of leaving it. There is no tendency or cause for any part of the fluid to remain adherent to the surface, and to eventually drip therefrom, and its discharge velocity may be sufficiently low to permit of practically perfect combustion at the normal rate of flame propagation.

In place of the spray in conical form which is obtained when a liquid fuel is forced at high velocity through a minute orifice, this arrangement produces a forwardly directed spray, which is rounded, and of relatively great volume, at its butt end.

This permits a more intimate and complete mixture of the fuel with the air supplied for combustion, with the result that perfect combustion is obtained, and the flame is clean and smokeless.

In order to explain the working of my improved atomizer and sprayer, and the principle on which the same is based, I will now proceed to describe the apparatus shown in the drawings, in which a few representative embodiments of my invention are illustrated. In said drawings:

Fig. 1 is a side sectional view in elevation of a type of oil burner embodying some of the features of my invention;

Fig. 2 is a side sectional view in elevation of a preferred form of oil burner;

Fig. 3 is a side sectional view in elevation of a self regulating burner;

Fig. 4 is a fragmentary sectional view in

elevation illustrating a novel method of constructing the oil and air valve in a burner embodying my invention;

Fig. 5 is a diagrammatic view of a flame due to a spray of oil issuing from a nozzle of the ordinary type;

Fig. 6 is a similar view of a flame due to a spray of oil issuing from a nozzle built according to my invention;

Fig. 7 is a fragmentary side sectional view in elevation of an oil burner applied in position in a novel and improved manner;

Fig. 8 is a detail sectional view in the axial direction, of a nozzle holding casing used in the arrangement shown in Fig. 7;

Fig. 9 is a fragmentary cross sectional view in elevation, illustrating the manner of regulating the inflow of air supplied for combustion in the arrangement of Fig. 7; and,

Fig. 10 is a detail cross sectional view of a valve stem such as used in the apparatus of Figs. 1 or 2.

It may be noticed that these drawings all refer to oil burners, and for the sake of simplicity the apparatus will be referred to as such in the following description; although, as stated above, the features characterizing my invention may also be embodied in atomizers and sprayers used for purposes other than oil burning.

It will also be observed, the main features of my invention are to a certain extent independent of the means used for creating the spraying pressure. Some burners employ steam for atomizing the fuel; other use compressed air; and others are of the so-called mechanical type, where the oil is pumped from the storage tanks, and forced, under pressure, to the burner. Any one of these methods may be employed in connection with my device, although I prefer to use air compressed under relatively low pressure, because steam represents a waste of from 3 to 7 per cent, and a proportionate increase in the oil consumption. The atomizing steam passes away with the products of combustion and is not available for condensation, necessitating an appreciable boiler makeup. In plants where fresh water has to be purchased, this factor is important.

In the preferred embodiment of my invention for oil burning purposes, the compressed air used for atomizing represents part of the air needed for combustion, so that the additional air required may be materially reduced and more accurately controlled. In other words, I prefer to strike an average between those methods where the air surrounding the ignited spray is solely depended upon to support combustion, and those methods where the air is entirely provided by the atomizing jet; since in both cases air in considerable excess has to be admitted if complete combustion has to be obtained, and the resulting efficiency will be lower.

Where the oil is forced at a high pressure through a minute orifice, forming a conical spray, the mixture of oil and air in the outer layers of the spray is apparently satisfactory, but the supply of air reaching the inner part of the spray is insufficient and imperfect combustion results.

By my method, the oil issues from the nozzle already thoroughly mixed with the atomizing air, the inner portion of the spray being in condition for efficient combustion at the very start; and the additional air supplied need not all be utilized to support combustion, but may be employed partly as an insulating film, entirely surrounding the zone of combustion, and protecting exposed surfaces from direct contact with the flame.

My atomizing and spraying apparatus, as shown in the burners illustrated in the drawings, consists, essentially, of a set of coaxial tubular casings forming annular passages for the fluid to be atomized and for the atomizing medium if used, and a conical valve simultaneously controlling said passages; said valve forming an outwardly flaring annular, conical, adjustable passage for the fluid to be atomized, or for the mixture of fluid and atomizing medium, between its surface and the end surfaces of said casings, which are adapted to register with said surface when the valve is closed. One of the features of my apparatus is that the entire conical surface of the valve is surrounded by the outer casing when the valve is in its closed position, so that when the same is slightly opened the annular conical slot between its surface and the end surface of the outer casing, extends to the very end of the conical surface. Another feature is that the necessary pressure or velocity is imparted to the fluid entirely before the outer end of the annular conical passage is reached; so that there are no external factors influencing the direction or velocity of the spray, once it has reached, and left, the end of said conical passage. By this construction, the fluid is compelled to move close to the surface of the valve up to the very edge, spreading itself over a gradually increasing area, and forming a correspondingly thinning film which, upon leaving the edge, is broken up forming a finely divided spray of a uniform texture, evenly distributed around said edge, which forms the base of said conical valve.

Referring to Fig. 1, 11 designates a casing or frame, formed with an oil chamber 12 provided with an oil inlet 13, and an air chamber 14 provided with an air inlet 15. Said two chambers are separated by a partition 16, provided with a threaded opening 17 adapted to receive oil nozzzle or inner casing 18, outwardly extending in an axial direction.

The other side of the oil chamber is closed by the outer wall 19, which is provided with a threaded opening 20, adapted to receive

bushing 21. Said bushing is internally threaded to adjustably receive an enlarged threaded portion 22 of valve stem 23, which is operated by means of thumb nut 24, and is set in position by means of a check nut 25.

Nozzle 18 is tubular in form, providing a passage 26 for the oil, which is fed under pressure through inlet 13. Valve stem 23 is smaller in diameter than passage 26, but is provided towards its outer end with radially extending ribs or segments 27 guiding said stem within passage 26, said ribs or segments being separated by longitudinal grooves 28 through which the oil may flow. At its outer end, said stem carries a cone valve 29, preferably integral with said stem, which is formed with a neck portion 30 leaving an annular passage acting as a circular distributing chamber for the fuel. A lug 31 transversely projects within chamber 14, and is provided with a threaded opening 32 coaxial with, and of a larger diameter than nozzle 18, adapted to receive an intermediate sleeve or casing 33, the inner surface of which is separated from the outer surface of nozzle 18 by an annular passage 34 opening within the chamber 14 at the rear of lug 31.

In a similar manner, the outer wall 35 of chamber 14 is provided with a threaded opening 36 larger than sleeve or casing 33, adapted to receive outer sleeve or casing 37, the inner surface of which is separated from the outer surface of sleeve or casing 33 by an annular passage 38 opening at the front part of chamber 14. It is thus seen, that an inner passage for the fuel, and an intermediate and an outer annular passage coaxial therewith for the atomizing medium are provided, all directed against the surface of valve 29, the various sleeves or casings having their outer ends beveled as at 39, to form a seat for said valve.

The drawing shows the valve in its closed position, it is obvious that if the same is moved axially to the left, an annular conical slot or passage will be formed between its surface and the end surfaces of the sleeves or casings, through which the mixture of fuel and atomizing medium will be forced.

In the preferred form, the outer diameter of outer sleeve or casing 37 is equal to, or slightly larger than the outer diameter of the cone valve, so that when the valve is closed, as shown in the drawing, the base or outer surface 40 of the valve is flush with, or entirely within the outer edge of said casing or sleeve. Due to this construction the annular conical slot accompanies the surface of the valve to the very edge, so that the atomized fluid cannot leave the surface of the valve before the edge is reached, and the breaking up action of the edge is assured.

In operation the atomizing medium, for instance compressed air, forced through passages 34, 38 is deflected outwardly by the valve surface, and produces a suction upon the oil arriving through passage 26 and annular distributing chamber 30. The oil is therefore impelled upon the surface of valve 29, towards its edge, acquiring a velocity which is a function of the pressure at which air is supplied, but which diminishes as the mixture formed approaches the edge or base of the one, due to the gradually increasing area of the passage.

In this manner, a discharge velocity of the finely divided liquid is obtained, which is sufficiently low to permit a practically perfect combustion at the normal rate of flame propagation; this velocity being also retarded by the breaking up action of the edge of the valve.

The air fed through passages 34, 38, is not quite sufficient for complete combustion, and the necessary excess air is drawn from the outside by means of any suitable apparatus producing an adjustable draft. It is thus possible to obtain a very sensitive adjustment of the supply of air, both from inner and from outer sources, and to form an oxidizing, or a reducing, or a neutral flame at will, without disturbing the distribution of the minute fuel particles, thus assuring uniform contact with sufficient of the combustion supporting medium to effect the desired combustion rate.

As a result of the fact that the atomized fuel is intimately mixed with air at the very start, ignition takes place immediately as the mixture leaves the nozzle, and the propagation of the flame causes an increase in pressure which in its turn causes the flame to expand at its butt, and to become substantially spherical at this point, as shown in Fig. 6. This naturally admits of a greater volume of air coming in contact with the various fuel particles, a more intimate and uniform mixture being formed, and a perfect combustion obtained.

In Fig. 2 I illustrate a preferred type of oil burner, in which the oil passage occupies an intermediate position between an inner and an outer air passage. In the same, 41 designates a frame or casing provided with an air chamber 42, to which compressed air may be fed through inlet 43, said casing being formed also with an inner oil chamber 44 having an oil inlet 45. The rear wall 46 of chamber 44 is provided with a threaded opening 47, adapted to receive inner sleeve or casing 48, outwardly projecting therefrom. 49 is the bushing, in which is adjustably mounted valve stem 50 operated by means of thumb nut 51, and provided with guiding radial extensions 27, as shown in Fig. 10. Like in the previous case, said stem carries at its extreme end a cone valve 52, and is formed with a neck or annular reduced portion 53 forming a circular fuel distributing chamber.

An intermediate sleeve or casing 54 is pro-

vided, attached to front wall 55 of chamber 44, leaving a passage 56 between its inner surface and the outer surface of sleeve or casing 48. An outer sleeve or casing 57, coaxial therewith, is also provided, attached to front wall 58 of air chamber 42, leaving an annular passage 59 between its inner surface and the outer surface of sleeve or casing 54.

The intermediate passage 56, connects with the inner oil chamber, and the inner and outer passages connect with the air chamber 42. The ends of the various sleeves or casings are beveled, as in the previous case, to form a seat for the valve 52.

The specific feature of this construction, which is otherwise similar to the one previously described, consists in the feeding of the oil between two jets of compressed air; the inner jet producing pressure, and the outer jet producing suction, the important result being, however, that in the resulting spray the oil particles issue from the nozzle between two layers of air, mixing with the air on both sides; a thorough and uniform mixture is, as a consequence assured.

In both types of burners, I show a chamber leading to one of the passages, and another chamber leading to the two other passages; but it is obvious that, simply by providing a number of chambers equal to the number of passages, each chamber having its individual inlet, all the possible and desired combinations may be obtained with a single type of valve.

For other purpose, such as painting, for instance, chamber 14 of Fig. 1, or chamber 42 of Fig. 2, may be provided with two inlets instead of one, if desired, the other chamber being used for the supply of compressed air; and by feeding to said chamber 14 or 42 two different kinds of paint, the chamber may become a mixing chamber where two different colors may be compounded to form a third.

This is only cited as one of the many possibilities of applying my invention in various fields by making but slight modifications of minor details of construction, while retaining the more important features.

When the device is used in connection with oil burning, there are additional advantages to be realized as against oil burners of the ordinary design, which are of great practical importance. For instance, the forcing of oil through a small orifice necessitates the employment of relatively high pressures, while low pressures are sufficient and advisable for the operation of my device. In the former type it is practically impossible to avoid clogging of the burner tip, due to formation of tar or other deposits, and no such occurrence takes place in connection with my device; however, should any inconvenience or obstruction arise, all passages are accessible, and may be cleaned without difficulty, especially the passage for the spray, which is entirely exposed, and which may be increased at will.

Furthermore, great heat develops at the tip of ordinary burners, while my type of burner remains quite cool; to this is probably due the absence of distillation products and other residues at the issuing point of the spray, and undue stresses and deformations of the various parts are likewise avoided, owing to this condition.

The application of my principle does not necessarily entail the use of a plurality of passages for the atomizing medium; for instance, a simpler construction is illustrated in Fig. 3, where only two passages, one for the fuel, and one for the air, are provided.

In the same, 63 designates the frame or casing, provided with a rear chamber 64, and a front chamber 65. A central sleeve or casing 66 extends from chamber 64, and a larger sleeve or casing 67, coaxial therewith, extends from chamber 65, leaving an annular passage 68 between its inner surface and the outer surface of sleeve 66.

The valve stem, 69, carries cone valve 70 at its outer end, and is slidably mounted within passage 71 of sleeve or casing 66, projecting through the rear of said frame or casing 63, at 72. The end 72 of said stem is threaded to receive an adjustable thumb nut and washer 73, by means of which the pressure of a spring 74, interposed between said washer and the rear surface of frame 63, may be adjusted.

A packing nut 75 within which stem 69 may freely slide may also be provided to insure tightness.

The smaller chamber, 64, is preferably used for oil, fed through inlet 76, and the larger chamber, 65, is used for air, fed through inlet 77. The operation of the burner, in so far as the production of the spray is concerned, is similar to that explained in connection with Figs. 1 and 2, the only difference being that the atomizing medium operates entirely by suction, and through one jet only, issuing from annular passage 68; this obviously entails a simpler construction of burner, which may be used for smaller capacities, and for lighter fluids.

The novel feature of this burner, as compared with the previous ones, is the provision of adjustable spring pressure to maintain the valve in a closed position. The feeding of compressed air to chamber 65 will cause a counterpressure against the surface of valve 70, which will force the same open to a certain extent. Said valve will open more or less according to the amount of pressure used, and to regulate the same it will be sufficient to regulate the pressure of the air supply. The volume of air supplied increases when the pressure increases, and therefore more fuel should be admitted; and

accordingly all the passages increase or decrease in section at the same time. It is obvious that this feature may be applied, if desired, in connection with the types of sprayers shown in Figs. 1 and 2.

Another improvement which may be introduced in their construction, is shown in Fig. 4, illustrating the front part of a burner similar to the one of Fig. 1. The same comprises an inner sleeve or casing 78, an intermediate sleeve or casing 79, and an outer sleeve or casing 80, coaxially mounted, respectively forming an inner tubular passage 81, an intermediate annular passage 82, and an outer annular passage 83. The improvement relates to the proportioning of the relative quantities of fluid to be atomized and of the atomizing medium, to be admitted in forming the right mixture, and in Fig. 4 the case is illustrated where oil is admitted through the inner passage 81, while air is admitted through the other two passages.

It is obvious that for a proper combustion a larger quantity of air is needed than of oil; and while a part of the air is drawn from the outside, still the volume of air injected in the spray remains larger than the volume of oil. The proper proportions may be determined by the ratio between the area of the air passages and the area of the oil passage, the larger diameter of the air passages being one of the factors making for a larger area. Another means is provided by the possible adjustment of the air pressure.

However, it may be desirable to introduce still another factor, in the proportioning not only of the initial quantities admitted, but also of the possible increases and decreases, in a ratio different from that provided by a cone valve having a uniform angle, such as shown in the previous cases.

When a valve such as shown at 29 or 52 is used, the quantities of fuel and air admitted may be varied, but the relative proportions always remain the same, because the width of the conical annular passage increases or decreases of a like quantity in correspondence of all passages. On the other hand it is desirable to increase the proportion of air to oil, as the admitted quantities of both increase.

To this end, I resort to the construction shown in Fig. 4, where the cone valve used comprises a portion, 84, regulating the air passages, inclined at a certain angle, and another portion, 85, regulating the oil passage, inclined at a more acute angle. The result is, obviously, that the relative increases in width produced in the annular conical passages formed, when the valve is moved away from the sleeves, are proportional to the different surface angles.

For instance, if the angle of cone portion 84 to the axis is 40 degrees, and the angle of cone portion 85 is 20 degrees, the increases in width of the relative cone passages will be in the ratio of 2 to 1; so that an increase of a quantity a of oil will be accompanied by an increase 2^a in volume of air.

At times, experience has seemed to indicate that if the conical passage between the outer casing and the valve were made wider than that between the inner casing or casings and said valve, combustion conditions improve. This is in effect the result obtained by the arrangement of Fig. 4 in relation to the inner casing; but a parallel effect may be had by the use of the uniform angle valve shown in Figs. 1, 2, 3, by making the tubular casings, or the outer tubular casing, adjustable in the axial direction, as shown in Fig. 3. In the arrangement therein shown, front opening 113 of chamber 65 is threaded to receive the threaded inner end 112 of outer casing 67, and a check nut 114 is used to lock the said outer casing in position. It is thus obvious that the outer casing may be adjusted further back than the inner casing, if desired.

One of the serious inconveniences experienced by the users of oil burners, is the necessity of entirely disassembling the burners in all their parts, for cleaning, owing to the imperfect methods of mounting used.

In Figs. 7 and 8 I illustrate a method of mounting a burner, necessitating a special design of frame, which may be applied in connection with the burners previously described, whereby the burner may be readily removed for inspection or cleaning without disturbing any other part.

By this method, instead of frames or casings 11, 41, shown in Figs. 1, 2, a tapering frame or casing 86, shown in detail in Fig. 8 is used. The type shown in said Fig. 8 is designed to replace the frame or casing of the burner shown in Fig. 2, and is accordingly provided with an inner chamber 87 provided with threaded openings 47', 55', adapted to receive the inner and the intermediate sleeves or casings; and with an outer chamber 88, provided with a threaded opening 89 in front adapted to receive the outer sleeve or casing, and with a threaded opening 90 at the rear adapted to receive bushing 49. Said bushing is shown in Fig. 7, and also outer sleeve or casing 57, frame or casing 86 being shown inserted in position at the front of a furnace.

The arrangement shown in said Fig. 7 also includes a combined burner holder, and air register 91, comprising a flange 92 for attaching the same to the front of the furnace, a front plate 93 provided with a plurality of openings or air inlets 94 arranged along a circumference, a central body portion 95 adapted to receive frame or casing 86, a spider 96 operable by means of handle 97, rotatably mounted on said central body portion, and formed with a plurality of radial

extensions 98 adapted to control openings 94, and a baffle plate 99 between the inner extension of the burner and the front plate 93.

Said central body portion is tapered to receive frame or casing 86, and its opening is formed with two circular grooves 100, 101, corresponding to circular grooves 102, 103 in frame 86. When frame 86 is inserted in position, therefore, two annular passages 104, 105 are formed between said frame and the inner surface of central body portion 95, communicating with inlets 106, 107, respectively, for oil and for compressed air. Grooves 102, 103, in their turn lead to chambers 87, 88, respectively, by means of passages 108, 109, so that when frame 86 is inserted in position, connection between said chambers 87, 88, and inlets 106, 107, becomes as a result established.

Frame 86 is secured in position by screwing its front portion 110 within the front portion of the taper opening in central body portion 95, as shown in Fig. 7, and merely by thus inserting or detaching said frame, the burner may be entirely set or removed in a few seconds, without disturbing any of the connections.

The supplementary air admitted to assist combustion, through openings 94, may be regulated by operating spider 96; however, additional compressed air may be admitted to the burner through inlet 111, instead of, or together with outside air, if desired, and according to various conditions which may affect different installations.

The importance of the devices forming the object of the present invention, in connection with oil burning, may be better realized by considering the results obtained with oil burners of the ordinary type, and arrangements which have been resorted to, in order to correct defective conditions.

The pressure necessary for atomizing the oil forced out of a minute orifice is very great, and the velocity imparted to the fuel particles is considerable. There is practically no mixture with the air at the tip, mixing only taking place as the spray spreads away from the burner; and combustion occurs at a point distant from the tip of the burner, and consequently distant from the air register. All these conditions tend to favor poor combustion, through a defective air supply, and poor, not uniform mixture. To correct this condition to a certain extent, some manufacturers have provided a special type of air register, the openings of which are arranged along a cylindrical surface around the burner, and controlled by vanes pivoted on axes parallel to the axis of the burner; the result being a turbine-like arrangement of vanes, intended to admit the air with a rotary motion around the burner, which is in its turn intended to impart a turbinous motion to the spray as it issues from the tip of the burner, facilitating the mixing of the oil and air.

The arrangement of the outer ends of the tubular members, described, is referred to in the claims by reciting that the tip ends of said members are in "conical alignment" with one another, this being intended to convey the idea of a conical surface formed by spaced angular elements parallel to the surface of the valve.

In all the devices shown, the mechanical distribution and atomization of the fluid used, take place in the same manner, according to the method outlined in the preamble to this specification; the distribution taking place on the conical surface of the valve up to the edge, and the atomization being induced by the combined action of the pressure and of the edge of the valve. The other details vary, according to the purpose for which the atomizer is used, the atomizing medium, however, being in all cases distributed coaxially with the fluid to be atomized, to insure uniform action all around. For instance, when a burner is used with three passages, and three separate chambers, one of the passages may be used for fuel, another for an atomizing medium, and the other for a different atomizing medium, or for the same medium at a different pressure.

With suitable modifications, the main features of my invention may be extended to the spraying of coal dust, and to the spraying of mixtures of coal dust and oil.

The drawings are intended for illustrative purposes only, and not in a limiting sense; and I reserve myself the right to carry my invention into practice in any way or manner which may enter, fairly, into the scope of the appended claims.

I claim:

1. In a device of the class described, the combination with means for feeding fluid to be atomized, and means for feeding an atomizing medium, of an inner, an intermediate and an outer tubular member forming three coaxial longitudinal passages, having a uniform diameter from end to end, said members having their outlet ends beveled to form a conical chamber, and an axially adjustable conical valve adapted to register with said chamber, simultaneously regulating the outflow from all three passages.

2. In a device of the class described, the combination with means for feeding fluid to be atomized, and means for feeding, an atomizing medium, of an inner, an intermediate and outer tubular member forming three coaxial longitudinal passages, having a uniform diameter from end to end, said members having their outlet ends beveled to form a conical chamber, and an axially adjustable conical valve adapted to register with said chamber, simultaneously regulating the outflow from all three passages, the maximum

diameter of said conical chamber being not less than the maximum diameter of said conical valve, so that the conical surface of said valve will be entirely enclosed within said chamber when the valve is in its closed position.

3. In a device of the class described, the combination, with an inner, an intermediate, and an outer tubular member forming coaxial tubular passages, and an axially adjustable valve controlling said passages, of means for feeding fluid to be atomized to the intermediate passage, and atomizing medium to the inner and outer passages.

4. In a device of the class described, the combination of an inner, an intermediate and an outer tubular member forming passages, an axially adjustable conical valve controlling said passages, and means for feeding fluid to be atomized to the intermediate passage, and atomizing medium to the inner and outer passages.

5. In a device of the class described, the combination of a plurality of coaxial tubular members forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber, and means for simultaneously controlling said passages.

6. In a device of the class described, the combination of a plurality of coaxial tubular members forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber and an axially adjustable conical valve, adapted to control said end passages, said conical chamber being formed to provide a seat for said valve.

7. In a device of the class described, the combination of a plurality of coaxial tubular members forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber and an axially adjustable conical valve, adapted to control said end passages, said conical chamber being formed to provide a seat for said valve, said valve having a sharp edge adapted to break up a liquid film outwardly spreading at a relatively high velocity over the surface of said valve into a fine spray, as said film reaches said edge.

8. In a device of the class described, the combination of a plurality of coaxial tubular members forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber and an axially adjustable conical valve, adapted to control said end passages, said conical chamber being formed to provide a seat for said valve, the maximum diameter of said valve being not more than the maximum diameter of the outer tubular member at the delivery end.

9. In a device of the class described, the combination of means for feeding fluid to be atomized and means for feeding an atomizing medium, of a plurality of coaxial tubular members forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber and an axially adjustable conical valve, adapted to control said end passages, said conical chamber being formed to provide a seat for said valve.

10. In a device of the class described, the combination of an inner, an intermediate, and an outer coaxial tubular member, forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber, an axially adjustable conical valve, adapted to control said end passages, said conical chamber being formed to provide a seat for said valve and means for feeding fluid to be atomized to one of said passages, and an atomizing medium to the other two passages.

11. In a device of the class described, the combination of an inner, an intermediate, and an outer coaxial tubular member, forming passages having their longitudinal surfaces at the delivery end parallel to the axis thereof, the tip ends of said members being in conical alignment with one another and forming an outwardly spreading conical chamber, an axially adjustable conical valve, to control said end passages, said conical chamber being formed to provide a seat for said valve, means for feeding fluid to be atomized to the intermediate passage and an atomizing medium to the inner and outer passages.

EDWARD F. CHANDLER.