

Aug. 19, 1930.

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BURNER

1,773,173

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3 Sheets-Sheet 1

Fig. 1.

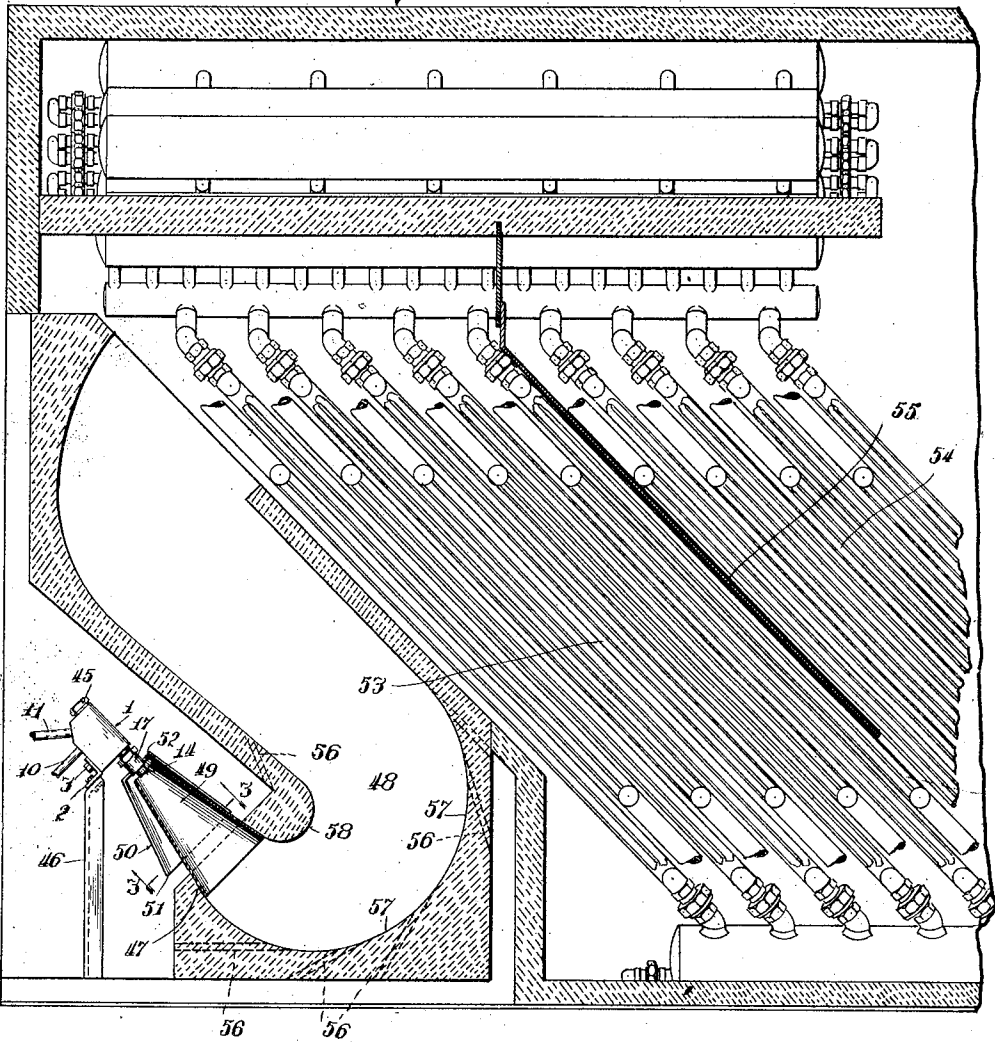
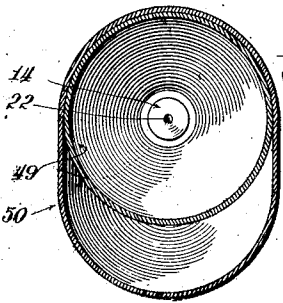


Fig. 3.

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Fig. 2.

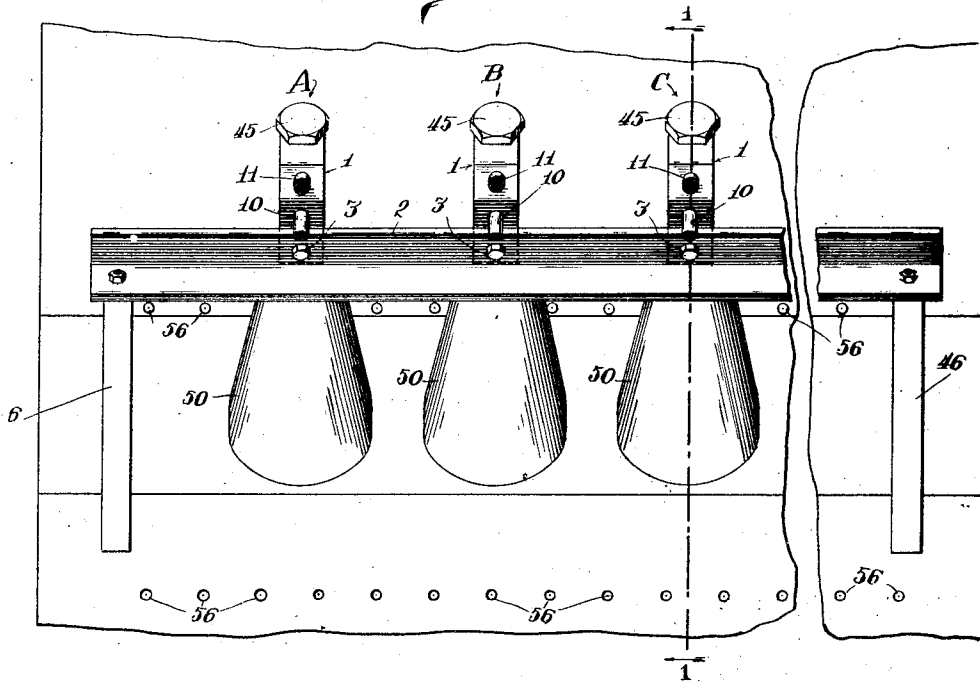
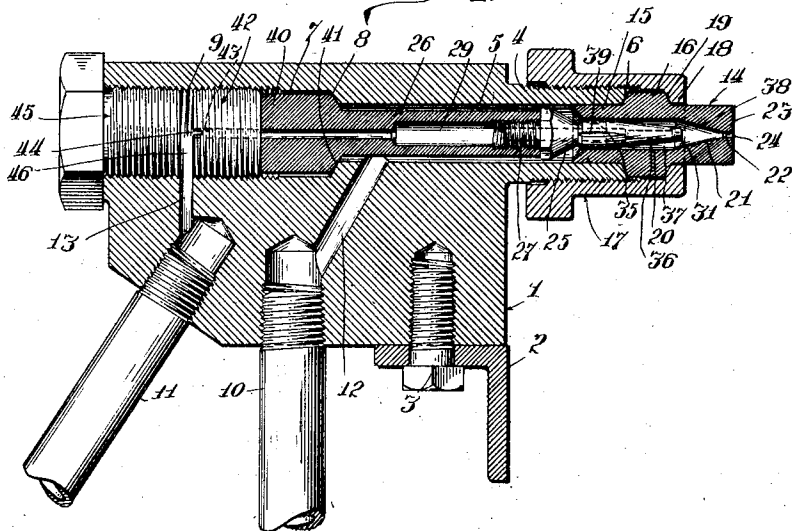


Fig. 4.



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Fig. 5.

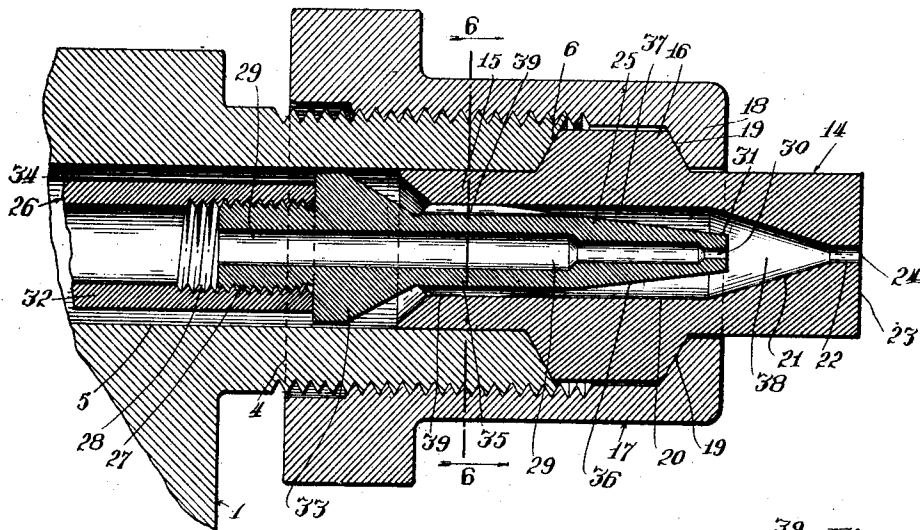


Fig. 7.

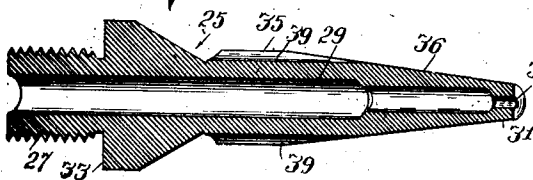


Fig. 6.

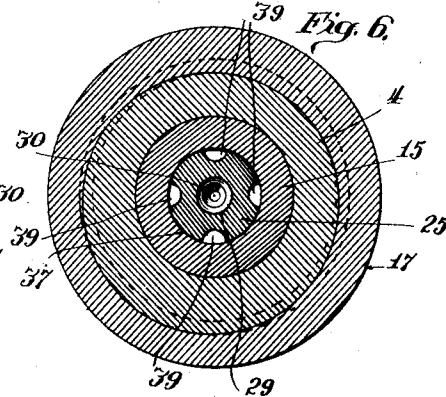


Fig. 8.

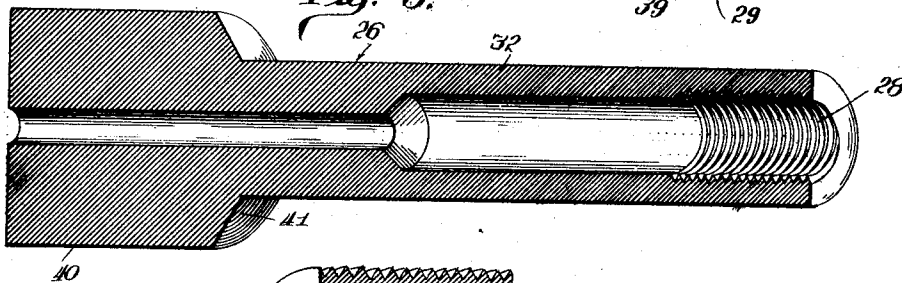
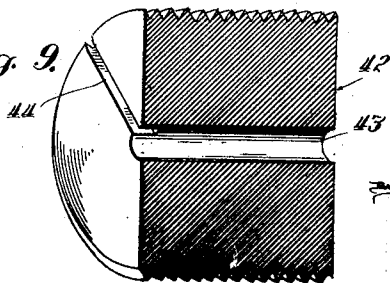


Fig. 9.



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This invention relates to a burner for use in a furnace burning liquid fuel, and more particularly to a compact and efficient fuel atomizer, that will operate with very small quantities of liquid fuel, in a quiet, cleanly, efficient and economical manner, in which the fuel is easily ignited under all temperature conditions, and which will require little attention, and be capable of long and continuous service.

One object of the invention is to provide a fuel atomizer unit which may be made quite small, and is capable of operating continuously and efficiently on very small quantities of fuel. A plurality of these atomizers may be used in battery formation to heat the same furnace, whereby only one or more of these units may be used as conditions may require, the atomizers in use being operated at full efficiency. This atomizer will handle a wide range of fuels without adjustment, and will effectively atomize quite heavy liquids in spite of the fact that the quantity used is very small. Fuel atomized by this device may be easily and instantly ignited by a match, hot wire, or equivalent means, without the use of a primer or auxiliary heater of any kind. The parts of the atomizer are so designed, and the materials used are so selected, that the atomizer will automatically accommodate the expansion of the parts due to temperature changes without affecting the adjustment. The atomizer is so designed that the liquid and the air may be supplied to the atomizer at the same pressure, and only a very low pressure is required. The atomizer will not carbonize, or choke up, and there will be no dribbling of liquid fuel at the discharge ports.

The above and other objects and advantages of this invention, will be apparent from the following detailed description of one approved form of apparatus involving the features of this invention.

In the accompanying drawings:

Fig. 1 is a longitudinal vertical section through the assembled furnace, this view being taken substantially on the line 1—1 of Fig. 2.

Fig. 2 is an elevation looking from the left at Fig. 1, and on a somewhat larger scale.

Fig. 3 is a sectional view through the cones on an enlarged scale, the view being taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a longitudinal vertical central section through the atomizer, this view showing a unit adapted for use in the heating plant of a steam automobile in substantially full size.

Fig. 5 is a similar view, on a greatly enlarged scale, through the discharge end of the atomizer.

Fig. 6 is a transverse section taken substantially on the line 6—6 of Fig. 5.

Figs. 7 and 8 are perspective views, partly in central longitudinal section, through the two portions of the inner liquid nozzle.

Fig. 9 is a similar view of the nut for holding this inner nozzle in place within the atomizer casing.

The improved atomizer shown in Figs. 4 to 9 inclusive, will be first described.

In this connection it should first be noted that this atomizer may be made in a wide variety of sizes according to the use for which it is designed, but it is capable of being made quite small. Fig. 4 showing one of the devices in substantially full size. The parts as shown in Figs. 5 to 9 are considerably enlarged, to facilitate the disclosure and explanation of the construction and operation. The main block or casing 1 of the atomizer may be mounted on any suitable support such as angle bar 2, for example by means of a screw bolt 3 extending through a portion of support 2 into the body of block 1. The casing 1 has a tubular externally threaded extension 4 on its forward end, and a cylindrical passage 5 extends centrally through this tubular portion 4 and completely through the casing 1. The outer end of extension 4 is internally beveled as at 6. From a point substantially midway of the block 1, and extending through the rear face of the block, passage 5 is enlarged as indicated at 7. The inner connecting walls 8 between the smaller and larger portions of passage 5 are beveled or have a spherical contour for a purpose hereinafter described. The greater portion

of enlarged passage 7 is internally screw-threaded as at 9. Pipe sections 10 and 11, screwed into the block 1, deliver air and liquid respectively through the atomizer. The air is delivered through internal passage 12 into passage 5, and the liquid is delivered from pipe 11 through internal passage 13 into the larger passage 7. A smaller block or housing 14 has a rear cylindrical portion 15 adapted to fit accurately within the outer end of passage 5, and an enlarged collar 16 provided with a beveled face adapted to bear against the internally beveled end 6 of extension 4. A collar 17, which screws on to the outer surface of extension 4, has an inwardly projecting flange 18 adapted to bear against the outer beveled surface 19 of the collar 16, and hold housing 14 firmly in position within the outer end of tubular extension 4. A cylindrical passage 20 extends centrally through the greater portion of housing 14, but this passage terminates in a forward conical portion 21 converging to meet the inner end of discharge port 22, positioned centrally in the outer end of housing 14, which serves as the discharge nozzle for the fuel and air mixture. The outer end 23 of nozzle 14 is cut off sheer and perpendicular with the discharge port 22, and the outer circumferential edge 24 of port 22 is made as clean and sharp as possible, for reasons hereinafter described.

The inner liquid or fuel nozzle is formed of two sections, the forward section 25 being shown separately in Fig. 7, and the rear section 26 being shown separately in Fig. 8. The threaded extension 27 at the rear of member 25, screws into the internally threaded portion 28 at the forward end of member 26. When thus assembled the two sections act as a single nozzle member, and in fact they might be made of one piece, but are preferably constructed separately for ease in manufacture. A central passage 29 extends throughout the length of this nozzle member and terminates in a very small outlet or discharge port 30 positioned centrally in the tip 31 of the nozzle. As here shown the passage 29 is made of varying sizes at different points throughout the length of the nozzle member, but this is merely for the purpose of facilitating the boring operations. It is only essential that this passage 29 be sufficiently large to provide a free and unobstructed passage for the liquid fuel, and that the discharge port 30 be relatively quite small, so that a very fine stream of the liquid under high velocity will be discharged therefrom. That portion 32 of member 26 which is positioned within passage 5, and the larger rear end 33 of member 25, are appreciably smaller in greatest diameter than the interior diameter of passage 5, so that a free annular air passage 34 will remain around the members. The central portion 35 of member 25 is of the same diameter, or only slightly small-

er than, the passage 20 in nozzle member 14, so that this portion 35 will fit snugly within the rear end portion of passage 20. The forward portion of nozzle member 25 has a conical formation, tapering gradually from the cylindrical portion 35 to the small tip end 31. This provides an annular air passage 37 between the conical portion 36 and the walls of passage 20, which has a cross sectional area increasing from practically nothing adjacent the cylindrical portion 35 to a maximum area surrounding the tip 31 where this annular air passage 37 merges into the low pressure combining chamber 38 within housing 14. As previously stated, this chamber 38 tapers outwardly with a gradually decreasing area as at 21 until it merges with the discharge port 22 in the outer end of the atomizer nozzle 14. A circumferential series of small slots 39, here shown as 4 in number, are formed in the cylindrical portion 35 of the nozzle member 25, to permit the air in passage 34 to flow into the annular expanding passage 37 surrounding the conical tip of the liquid nozzle. These passages 39 are preferably quite small, in the size of atomizer here shown preferably being not over .005 of an inch in depth. The rear portion 40 of member 26 is enlarged to more nearly the diameter of passage 7, in which this portion of the nozzle member is located, and the wall 41 connecting this enlarged portion 40 with the cylindrical portion 32 is beveled or has a spherical contour to correspond with the wall 8 in the casing 1.

When the atomizer is being assembled, the outer nozzle housing 14 is first inserted within the end of extension 4 of the casing 1, and is secured in place by means of the screw collar 17. The two sections 25 and 26 of the inner liquid nozzle are then assembled and inserted through the rear end of passage 7 until cylindrical portion 35 has slipped into the rear end of passage 20 in housing 14, and the two beveled or spherical faces 8 and 41 are in contact. The inner nozzle is forced into place, and held in place by the nut 42 (shown in Fig. 9), which screws into the passage 7. This nut 42 has a central passage 43 forming substantially a continuation of the passage 29 in the liquid nozzle member. A cross slot 44 in the outer end of the nut facilitates screwing the nut into position within the casing 1. The engaging beveled faces 8 and 41 serve as a centering device whereby the liquid nozzle will automatically center itself within the outer nozzle housing 14 without binding or distortion of the parts. These tightly engaging surfaces 8 and 41 also serve as a liquid seal to prevent any liquid which may work its way past the nut 42 from entering the air passage 34. A screw plug 45 is finally inserted to close the rear end of passage 7.

Preferably an equal pressure, which need not be over one to four pounds, is applied to

the air and liquid supplied through the pipes 10 and 11 respectively. It is not essential or necessary that the same pressure be used on both the air and liquid, but it is more convenient and easier to control when this is the case.

5 The liquid flows from pipe 11 through passage 13 to the space 46 between the plug 45 and the rear end of nut 42. The liquid then flows through the passage 43 in the nut and the passage 29 in the nozzle member and is projected at high velocity from the restricted port 30 in the tip 31 of the nozzle as a very fine stream directed through chamber 38 toward and centrally through the outer discharge port 22. The small outlet port 30 causes a pressure to be developed behind the fine fuel stream, which is high relative to the air pressure in chamber 38, thus giving great velocity to the stream. The air flows from pipe 10 through passage 12 to the annular passage 34, surrounding the cylindrical portion 32 of the liquid nozzle. This air then flows through grooves 39, from which it spreads into the very thin inner portion of passage 37. Since passage 37 enlarges outwardly toward the tip 31 of the nozzle, the air will expand as it flows through this passage 37 into mixing chamber 38. This rarefied air in chamber 38 offers decreased resistance to the progress of the fluid stream so that its velocity is unimpeded and its substantial continuity is not broken. The air will be drawn along as an envelop about the liquid and slightly mixed therewith as it is projected from chamber 38 through the discharge port 22. The tapering conical portion 21 of chamber 38 serves to again compress the air and fuel as the materials approach the discharge orifice.

40 The outer discharge port 22 should have about twice the diameter of the inner discharge port 30, and its length should be about one and one-half times its diameter. The liquid and air will be compressed by the conical portion 21 of chamber 38, and the mixed materials will be projected from the discharge port 22 at a very high velocity. The relative proportions of length and diameter of the outlet nozzle, as just stated, aided by the extremely high velocity of the fuel stream will give a "broomy" stream spread by the discharged mixture and cause a complete atomization of the liquid. It has been discovered, that by providing a sheer perpendicular front wall 23 on the nozzle, and providing sharp right angled edges 24 to the outlet of port 22, the dribble of liquid from the outlet port, and the accumulation of liquid on the front face of the nozzle, so common in previous devices of this sort, will be entirely eliminated. This phenomena is probably due to the fact that the return eddy currents which are set up in the outer air by devices of other forms, and which carry the oil-laden vapor back against the face of the

outlet nozzle, are avoided by this improved construction.

The inner nozzle members 25 and 26, and the nut 42 and plug 45 are made of brass or bronze, in contradistinction to the outer casing portions which are of iron or steel. Since all of the parts of the atomizer will expand when heated, it is essential that these inner members have a higher ratio of expansion to keep the joints tight at all temperatures, especially the joint between the cylindrical portion 35 of the inner nozzle and the walls of passage 20. With the metals selected as stated above, the relative ratios of expansion are such that the joints will be maintained tight at all times regardless of the temperature. Obviously, other metals having similar relative ratios of expansion might be used. However, the temperature of this atomizer is never very high. The atomizer is positioned outside of the furnace proper, and furthermore the vaporization of the liquid at the tip will have a substantial cooling effect on this portion of the atomizer. The structure is also cooled by the streams of air and liquid flowing through the internal passages. Since the spray has a very high velocity, the flame, or the point where combustion begins is well beyond the tip of the nozzle 14, and hence there will be no appreciable heating effect from this source, nor any carbonization at the tip, nor inside thereof. Furthermore, if the nut 42 and plug 45 are made of the same metal as casing 1, rust or corrosion will take place between these parts due to the liquids held therebetween. By making these parts of dissimilar metals this corrosion is avoided.

While the atomizer as just described was designed more particularly for burning kerosene, it will successfully atomize much heavier fuels, or mixtures of different fuels. It will also operate as an atomizer for various other liquids, whether used as a fuel or for other purposes. The atomizer works with a very low initial pressure, and gives an exceedingly fine spray, and will stay clean and will not choke up even when heavy liquids are used. The device will atomize any liquid whose viscosity is such that it will flow through the interior passages.

The device is particularly useful for atomizing fuel for the furnace of a steam automobile, or under the boiler of a house-heating plant. In such cases, a small atomizer such as here disclosed will operate successfully on as little as three-quarters of a quart of fuel per hour, with a continuous and uninterrupted flame propagation.

In the furnace installation shown in Figs. 1 and 2, a plurality or battery of these atomizers is used as indicated at A, B and C, Fig. 2. Preferably an odd number of burners will be used. The center one will always be on. If more heat is desired, two more, one at

either side of the original burner, may be added. For further heat a second pair may be added and so on up to the capacity of the installation. In this way, each burner will always be operated at its full and most efficient capacity. All of the burners or atomizers may be mounted on a common support or angle bar 2, mounted at its ends on standards 46. The burners are mounted horizontally, or at a slight downward inclination, preferably not exceeding forty-five degrees. If this downward inclination is not too great, there will be no tendency for the flame to lick back to the nozzle. A slight inclination downward insures the flame passing back when interrupted or weakened. This downward inclination from the horizontal will preferably be between 20 and 40 degrees.

As previously stated, the atomizers are positioned outside of the furnace proper, with the discharge nozzle 14 in line with an inlet port 47 leading to the combustion chamber 48, formed of suitable refractory material. A metallic cone 49 is mounted with its larger outer end fitting within port 47 of the furnace, and its smaller inlet end surrounding but not in contact with the discharge nozzle 14 of the atomizer. A second, larger cone 50 surrounds the cone 49, with its larger end 51 spaced from the inlet port 47 as shown in Fig. 1. The smaller end 52 of this cone 50 surrounds, but is out of contact with the smaller end of cone 49 and the discharge nozzle 14. As best shown in Fig. 3, this outer cone 50 is somewhat distorted at its larger outer end 51 so that the upper half of this portion of the cone fits closely against the inner cone 49. This outer cone 50 serves as a means for supplying pre-heated air, for combustion purposes, to the inner cone 49. The air flows in around the inner cone 49 at the lower end 51 of the outer cone, and then passes up and around the inner cone and is drawn in through the upper smaller end of the inner cone by the stream of atomized fuel projected therinto. The proportions of the inner cone substantially conform to the natural expansion of the fluid spray, so that the flame will substantially fill the larger end of the inner cone, which become quite hot, due to the proximity of this flame, and to the heat conducted from the furnace walls. While this portion of the cone will not become hot enough to affect the stability of the metal, its temperature will be sufficient to cause complete vaporization of any large particles of liquid fuel that may remain in the atomized spray, and will eventually insure complete combustion. The closely fitting upper portions of the larger ends of the cones, as indicated in Fig. 3, is to prevent a chimney effect, and insure the pre-heated air passing in through the inlet end of the inner cone. Both cones are completely out of contact with the atomizer, this clearance being provided

to avoid conduction of heat from the rather hot cones to the body of the atomizer. There should be sufficient clearance between the inner ends of the two cones, and between the inner cone and the nozzle 14, to permit free passage of the preheated combustion air through the outer cone, and thence around and into the inner cone. The smaller end 52 of the outer cone should come as close as possible to the atomizer (without actually contacting therewith), to prevent the drawing in of cold air at this place.

It should be understood that the air forced through the atomizer, and mixed with the fuel in discharge port 22, is primarily for atomization purposes and is insufficient to support combustion. This lean mixture is projected from nozzle 14 as a hollow cone or spray, and additional air is necessary for combustion purposes. The burner may be instantly ignited when cold and operated successfully in the open air, the cold combustion air being drawn from the surrounding atmosphere, but in this case combustion will be accompanied by the unpleasant roaring noise common to burners of this general type. When the combustion air is preheated, by means of the inclosing cones described above, the process of combustion takes place easily and quietly and the roaring noise is eliminated. Also the burner is much more efficient, since heat units otherwise dissipated from the furnace walls and the inner enclosing cone are used to preheat the air, and thus delivered back into the furnace.

While the combustion chamber 48 here shown is a substantially S-shape passage, it is to be understood that this shape will vary for different installations, and will depend somewhat on the available space, and partly on the size and angle of mounting of the burner. The furnace here shown was designed for use in the heating plant of a steam automobile, where space is necessarily limited. At 53 and 54 are shown the water-tubes of the boiler, the heated products of combustion passing from the upper part of the S-shaped combustion chamber down among the tubes 53, under partition or baffle plate 55, and then up between the second set of tubes 54 on the far side of the baffle plate.

The lower and back surfaces of the combustion chamber, conforms substantially to the natural contour of the flame projected from the burner, and the cross section of the passage gradually increases to take care of the normal expansion of the heated gases so that practically no internal pressure will be developed. In fact, the pressure in the combustion chamber will be lower than atmospheric pressure, and the furnace will operate with a zero draft. With the chamber designed in this manner, there will be no direct impingement of the flames from the burner on the furnace walls, and the flame will move

along the walls without appreciably eroding them.

Since the preheated combustion air supplied through cones 49 and 50 passes in as an envelope around the cone of fuel spray, the initial combustion will be in the form of a sheet of flame enveloping the inner portions of the fuel cone, preventing the access of combustion air thereto, and thus precluding immediate complete combustion of the fuel. It is desirable to supply additional combustion air as the materials progress and reverberate through the combustion chamber to utilize the full efficiency of the combustible materials. For this purpose a series of substantially tangential air passages 56 conduct air into this chamber 48 to supply air at spaced points as needed. These passages are small, so that no more air than is needed at any one place is provided. This not only allows the air to become preheated by its passage through the heated furnace walls, but also prevents unduly lowering the temperature of the combustion gases within the chamber by the addition at any one point of an excess amount of cooling air. In general, from the time the atomized fuel is projected from nozzle 14, until combustion of all of the fuel is completed, the combustion air is only supplied in such quantities as are actually needed at that point, and the air thus supplied is preheated, thus minimizing heat losses, and securing the maximum efficiency from the burner. Due to the curvature of the lower portion of the S-shaped combustion chamber, combustion air cannot be supplied as effectively to the inner portion of the curve as to the outer portion. It will be noted that there is only one row of air passages 56 along this inner curved wall. However, the radiant heat projected from the inner walls 57 of the outer curve and concentrated upon the gases along the inner wall 58 where combustion is less complete, will maintain these gases at a high temperature and prevent undue cooling and carbonization at this point.

While in the installation here shown, as single combustion chamber 48 is provided for the entire battery of burners, it is to be understood that divisions may be provided if desired to continue the individual passage of cone 49 for each burner throughout the combustion portion of the furnace.

Obviously, variations in the position and inclination of the atomizer, and in the contour of the combustion chamber may be necessary for different types of furnaces, for example in house-heating plants, but the general principles of the construction described above may be adhered to.

A furnace of this type will be long lived, economical of heat and fuel, and since the atomizer needs practically no adjustment, the entire combination is foolproof and reliable under variable working conditions. Since a

wide range of fuels may be used, the furnace may be successfully operated even when the most desirable fuels are not available. The burners are readily started when cold by the heat of a match, hot wire, or equivalent device, and no primer or auxiliary heater of any sort is required.

I claim:

1. The method of atomizing liquid fuels, consisting in projecting a small stream of the liquid under relatively high pressure through an expansion chamber, delivering to this chamber at relatively low pressure an envelope of air which surrounds the fuel stream, compressing the air and liquid, and then projecting them from the chamber as a small short stream in line with the first liquid stream.

2. The method of atomizing liquid fuels, consisting in projecting a small stream of the liquid under relatively high pressure through an expansion chamber, delivering to this chamber at relatively low pressure an envelope of air which surrounds the fuel stream, the stream and air envelope being projected from the chamber as a confined stream in line with the original liquid stream.

3. The method of atomizing liquid fuels, consisting in projecting a small stream of the liquid under relatively high pressure through a low-pressure air chamber, compressing an envelope of air about the stream and atomizing the stream and envelope as they are discharged from the chamber.

4. A liquid atomizer comprising a casing having inlet passages for separately delivering air and the liquid to the interior of the casing, an inner nozzle connected with the liquid inlet and having a relatively small unobstructed discharge port projecting into an expansion chamber formed within the casing, there being circumferential series of air passages surrounding the rear portion of the inner nozzle and communicating with an annular air passage of continually increasing cross-sectional area, which opens into the expansion chamber around the liquid discharge port, and an outer nozzle having a discharge port in line with the inner liquid discharge port, and communicating with the expansion chamber, the liquid stream from the inner nozzle being projected through the expansion chamber and the discharge port, the chamber decreasing in size as it approaches the discharge port to compress the air around the liquid stream, the envelope of air being projected with the stream through the discharge port.

5. A liquid atomizer comprising a casing having inlet passages for separately delivering liquid and air to the interior of the casing, the casing being formed with a chamber having a cylindrical portion and a conical portion which tapers from the front end of the cylindrical portion to a restricted dis-

charge port leading from the casing, an inner nozzle connected with the liquid inlet and having a relatively small unobstructed discharge port positioned axially within the cylindrical chamber and opening substantially at the larger end of the conical chamber and adapted to project a liquid stream through the conical chamber and the discharge port, the inner nozzle being exteriorly conical with its large end positioned within the rear portion of the cylindrical chamber so as to form an annular air passage about the nozzle of a cross-sectional area continually increasing toward the liquid discharge port, there being a circumferential series of small air passages leading from the air inlet to the smaller end of the annular air passage.

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