Nov. 1, 1938. J. W. CANNON 2,135,275

FLUID FUEL BURNING APPARATUS

Filed July 22, 1935 3 Sheets-Sheet 1

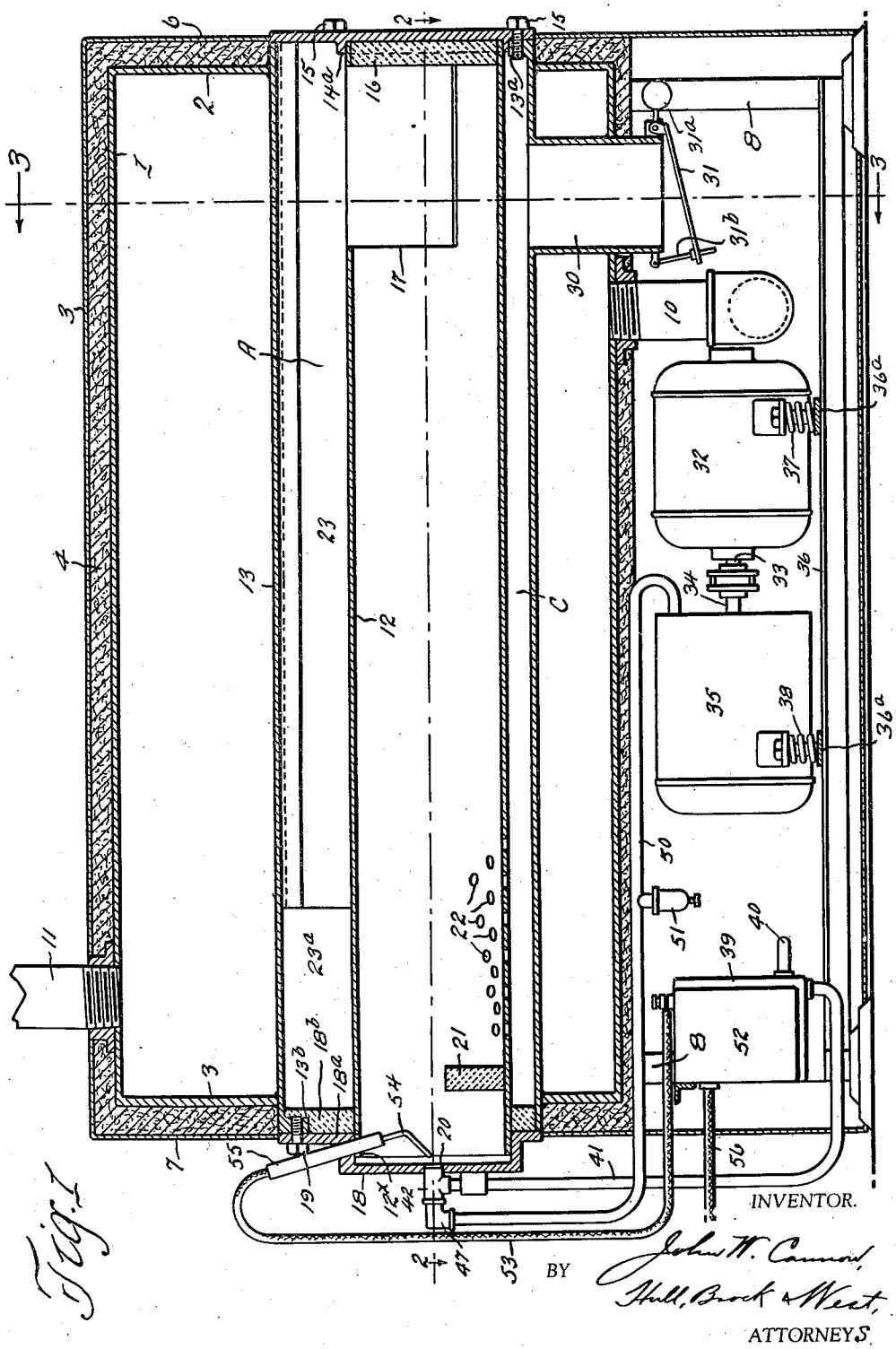


Fig. 1

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FLUID FUEL BURNING APPARATUS

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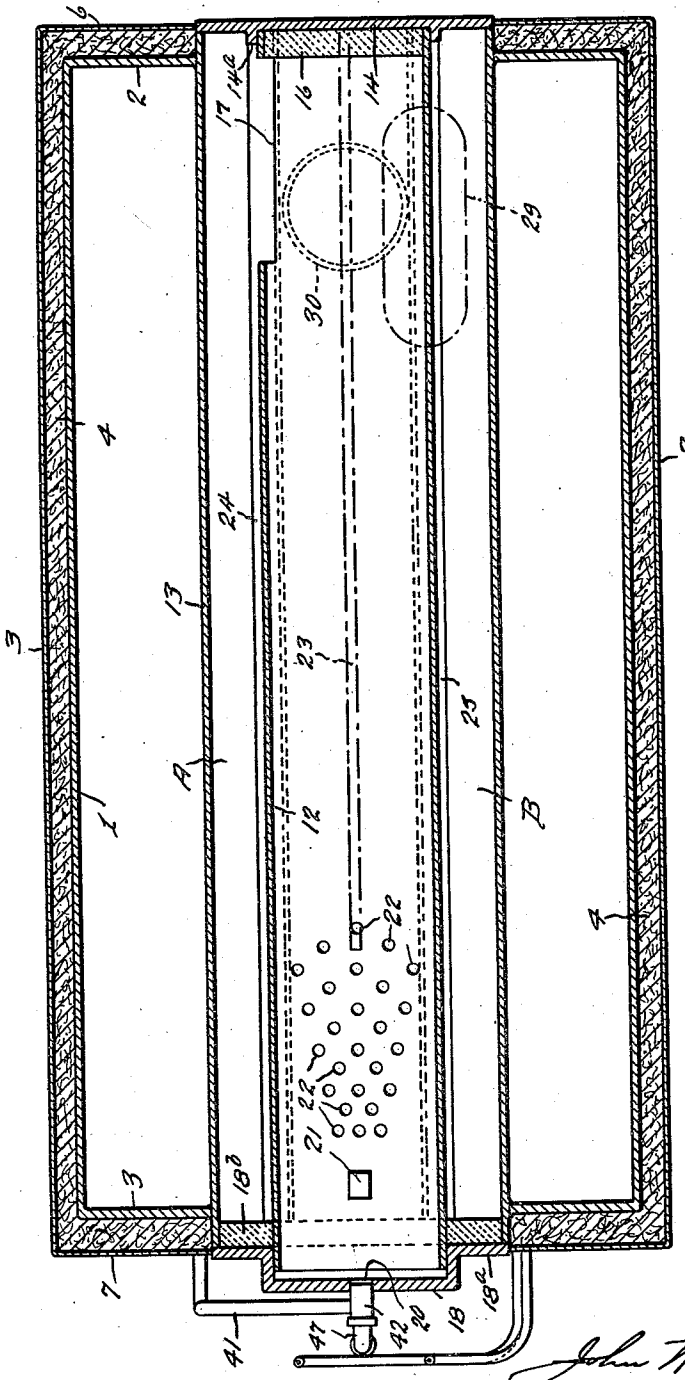


Fig. 2

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FLUID FUEL BURNING APPARATUS

Filed July 22, 1935 3 Sheets-Sheet 3

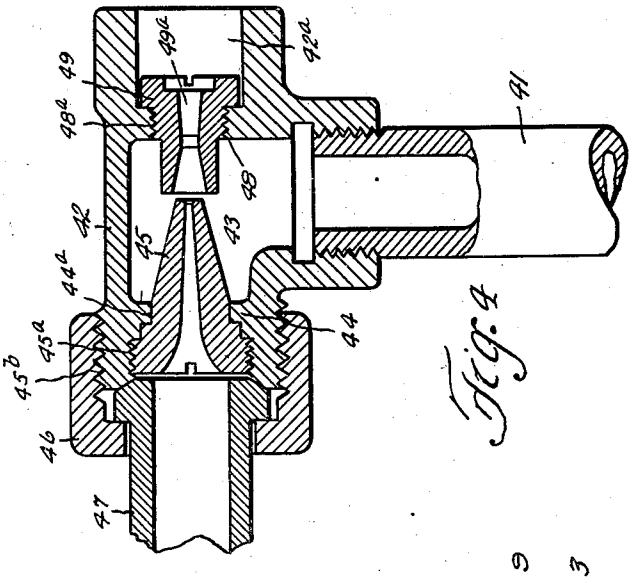


Fig. 4

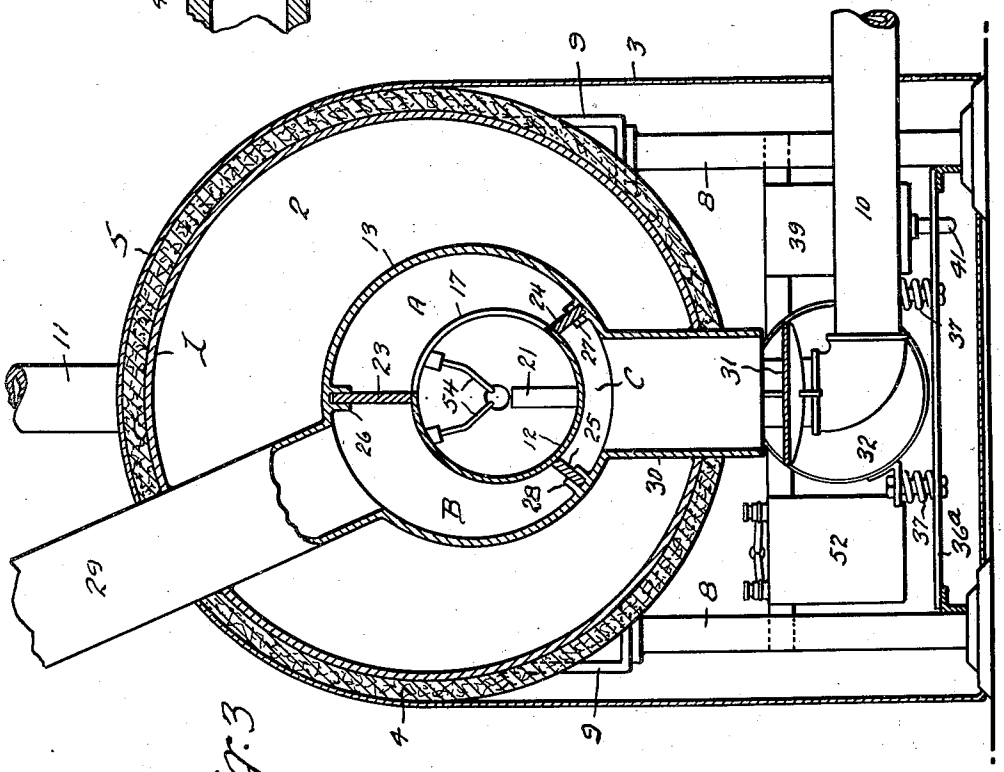


Fig. 3

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2,135,275

UNITED STATES PATENT OFFICE

2,135,275

FLUID FUEL BURNING APPARATUS

John W. Cannon, Plainfield, N. J.

Application July 22, 1935, Serial No. 32,483

7 Claims. (Cl. 158—4)

This invention relates to apparatus for heating water, and for generating steam or vapor, and more particularly to apparatus of this character which are employed for the purpose of heating residences, although the principles embodied therein are capable of use in larger installations.

The principal objects of my invention are to provide an apparatus of this character which possesses the following advantages:—

(*a*) Ability to operate efficiently with very low consumption of fuel oil per hour;

(*b*) Elimination of down-draft and gas pockets;

(*c*) High efficiency, including great heating capacity together with economy in fuel consumption;

(*d*) Cheapness and simplicity of construction;

(*e*) Compactness of construction, whereby the water level is in such proximity to the base of the apparatus as will enable the latter to be installed in a basement or other compartment having a low ceiling;

(*f*) Ease of assembling and disassembling.

Further and more limited objects of the invention will be explained hereinafter in connection with the drawings and the detailed description.

In the aforesaid drawings, Fig. 1 represents a central longitudinal vertical section through an apparatus constructed in accordance with my invention, the water-supply connection and the fuel ejector and its connections being shown in elevation; Fig. 2 a horizontal sectional view corresponding substantially to the line 2—2 of Fig. 1, the burner being shown in elevation; Fig. 3 a sectional view taken on the line 3—3 of Fig. 1 and looking in the direction of the arrows; and Fig. 4 a detail in section of the burner or fuel ejector.

Describing the parts by reference characters, 1 denotes the cylindrical shell of the boiler, the same being provided with the heads 2 and 3. The shell and the heads are covered with insulation, indicated at 4. Surrounding the upper part of the cylindrical shell and partly enclosing the heads 2 and 3 is the external casing 5 of inverted U-shape having end walls 6 and 7 which are spaced from the upper portions of the heads 2 and 3 respectively, the insulating material 4 being interposed between the said heads and the casing ends.

The boiler shell and its insulating covering are supported by means of posts 8 and longitudinally extending angle-iron brackets 9 which are in turn supported on the posts. Water is supplied to the boiler by means of a pipe 10; and hot water, steam or vapor is delivered from the boiler through the pipe 11.

Extending longitudinally of and throughout the length of the boiler is the combustion chamber. This chamber consists of an inner cylindrical shell 12 and an outer cylindrical shell 13, located below the center of the boiler shell. In the average small units, the shells 12 will preferably be made of metal, but in larger units, the shells will preferably be of refractory material having high heat-conductivity, such as carborundum. For convenience of description, the left hand end of the apparatus as shown in Figs. 1 and 2 will be considered the front of the apparatus and the right hand end the rear of the same. The rear end of the inner shell is fitted within a circular flange 14ª carried by a cover plate 14 which is secured by bolts 15 to lugs 13ª projecting from the outer shell 13. Extending across and filling the rear end of the shell 12 is a head 16 of heat-resistant insulating material; and in the top and at one side of the shell 12, immediately in front of the head 16, there is a large outlet port 17. The front end of the shell is slidably mounted within a cover plate 18, having an outwardly projecting cylindrical central portion for the reception of such end of the shell and having a flange 18ª surrounding such cylindrical portion whereby it may be secured by bolts 19 to lugs 13ᵇ projecting radially inwardly from the front end of the shell 13. Suitable heat resistant insulating material, indicated at 18ᵇ is shown on the inner surface of the flange 18ª and extends across the space between the front ends of the shells 12 and 13. The cover plate 18 is provided with a centrally arranged opening in the end of the cylindrical portion thereof, said opening being indicated at 20 and being provided for the receipt of the delivery end of the ejector, which will be described hereinafter.

21 denotes a target of suitable refractory material which projects upwardly from the lower portion of the shell 12, adjacent to the front thereof and adjacent to the ejector 20. The top of this target is located below the axis or longitudinal center of the ejector (preferably about one-quarter inch below such axis); and the target occupies only a small proportion of the transverse width of the said chamber, for a purpose to be explained hereinafter. At the rear of the said target, the shell 12 is provided with a series of openings 22 extending rearwardly therefrom in general horsetail shape.

The outer shell 13 has its opposite ends mounted within openings provided therefor in the end

walls 2 and 3 of the boiler shell and in openings provided therefor in the end walls 6 and 7 of the outer casing.

The space between the inner and outer shells 12 and 13 of the combustion chamber is divided into three flues or passes, two of which are for products of combustion and the other of which is for the air supplied to the openings 22, this division being effected by the vertical ribs 23, 24 and 25. These ribs are secured to the inner shell at their inner edges and have their outer edges mounted within slots formed between pairs of ribs 26, 27 and 28, projecting radially inwardly from the shell 13. The first pass A is formed between the two shells and the ribs 23 and 24. The second pass B is formed between the inner and outer shell and the ribs 23 and 25; and the pass B communicates at its rear with the off-take 29. The pass A communicates at its front end with the pass B, around the front end of the rib 23, which is spaced from the front ends of the inner and outer shells, thereby to provide the port 23a. The space C between the outer and inner shell and the ribs 24 and 25 communicates at its rear end with a pipe connection 30 by means of which air is conducted to the openings 22. The bottom of the pipe connection 30 is provided with a damper 31 provided with a counterbalancing weight 31a and prevented from being completely closed by the pivoted stop rod 31b.

In order to deliver the fuel into the inner member of the combustion chamber in a manner to obtain high fuel consumption and satisfactory and efficient combustion, I employ the following means for supplying and igniting the oil:—32 denotes an electric motor, the shaft 33 of which is connected with the shaft 34 of an air compressor 35. The motor and the air compressor are shown as mounted upon supporting strips 36, 36a by means of springs 37, 38, respectively. 39 denotes an oil receptacle, shown as located beneath the front of the apparatus and which may be connected with a storage tank through a pipe 40. From the receptacle 39 a pipe 41 leads to the bottom of the body 42 of an ejector. This body has the external shape of a T and is provided with a centrally arranged chamber 43, which receives oil from the pipe 41. 44 denotes a wall extending transversely of one end of the chamber and is provided with a central opening 44a through which extends the delivery end of a nozzle 45. This nozzle is provided at its receiving end with an external thread 45a whereby it may be removably secured within the corresponding end of the body 42, this end of the body being provided also with an external thread 45b for the reception of a shouldered nut 46 by means of which the delivery end of the elbow 47 (see Fig. 1) may be detachably secured to the body 42 with its passageway in register with the passageway of the nozzle.

The opposite end of the chamber 42 is provided with a wall 48 having an internally threaded opening 48a therethrough, the center of said opening and the center of the opening 44a being in axial alignment. Threaded into the opening 48a is the delivery tube 49 of the ejector, the said delivery tube having a Venturi passage 49a therethrough in axial alignment with the passage through the nozzle 45. The body 42 is provided at its delivery end with the outlet opening 42a by means of which the mixture produced by the ejector may be delivered into the inner member of the combustion chamber and by means of which the delivery tube may be assembled in and removed from the body 42.

It will be noted that the delivery end of the nozzle 45 does not enter the receiving end of the delivery tube. In the case of the smaller sizes of my apparatus, the space between the nozzle and the delivery tube is only about 1/64". In order to operate the smaller size of my apparatus with as low a consumption of fuel oil as one quart per hour, it is important that great accuracy be employed in the design and workmanship of the ejector, whereby a high degree of vacuum may be obtained in the chamber 43.

Where air is used as the ejector fluid, it will be supplied from the compressor 35 to the elbow 47 through the pipe 50; and the said pipe is preferably provided with a relief valve 51, thereby to prevent the pressure from becoming excessive; in practice I have found that a pressure of from 20 to 25 pounds to the square inch gives most satisfactory results with the ejector shown herein.

For the purpose of igniting the mixture delivered by the ejector, I employ electrical igniting means comprising a transformer 52, with conductors 53 leading therefrom to electrodes 54 located within the inner member or shell 12 of the combustion chamber and in front of the ejector. The electrodes 54 are mounted in insulating casings 55 extending through slots 12× in the front of the inner member of the combustion chamber and through the cover plate 18. 56 denotes a conductor conveying current to the transformer.

With the parts constructed and arranged as described, it is believed that the operation will be readily understood. Air delivered by the compressor into the nozzle 45 and into the tube 49 serves to draw the oil upwardly from the tank 39 and through the pipe 41 into the chamber 43 of the ejector body. Owing to the construction and arrangement of the nozzle and the delivery tube, the oil is filmed and broken up, without the formation of slugs, and there can be no clogging of the ejector. Due to the small diameter of the inner member or shell of the combustion tube (which, in the smallest commercial installations, does not exceed 4 inches), the ejector nozzle, by which the fuel is shot into the receiving end of the combustion chamber, acts as an injector to draw into the said chamber, through the pass C and the openings 22, the air necessary for combustion. In practice, about 10% of the air needed for combustion is that employed with the ejector, while the remaining 90% is admitted through the specially arranged openings 22, being heated in its passage through the flue C. As the fuel mixture enters the combustion chamber, the majority of this mixture slides over the top of the target and around the sides thereof, without contacting therewith. The location of the target below the center line of the ejector and in proximity thereto (about three inches therefrom in the smallest installations) not only serves to prevent the accumulation of carbon thereon, but also contributes toward quiet operation by preventing pulsation of the flame; it also prevents the flame from extinguishment by temporary interruption of the fuel supply in the absence of continuous ignition. The particular arrangement of the openings 22 prevents too rapid combustion of the fuel mixture and also contributes to the quietness of operation. The burning mixture and the products of combustion pass to the rear end of the inner shell or member 12, thence through the port 17 into the

pass A, in contact with the outer shell 13, and thence through the port 23a at the front of the apparatus into the pass B, where it is circulated rearwardly in contact with the shell 13 to the flue connection 29 at the rear of said pass. The location of the ejector adjacent to the axis of the combustion chamber 12 is of importance in realizing the efficient operation of my apparatus.

Due to the construction and arrangement of parts as described herein, I am able to obtain the following important advantages:—

(1) To employ a composite combustion chamber of small diameter in comparison with its length, lending itself to the compactness of apparatus demanded for installation in basements or other compartments having low ceilings; and for carriage through the passageways to the cellars or basements of average houses.

(2) To operate such combustion chambers, not only with a high consumption of oil, but with practically complete combustion of the same. A factor contributing largely to the accomplishment of this second advantage is the location and shape of the target and the location and arrangement of the openings 22; another factor is the use of the particular type of ejector employed, together with the pressure of the ejector fluid employed therein; and a third factor is the fact that the fuel is mixed rapidly with air for combustion and does not come in contact with cold surfaces during the combustion period.

(3) Practical elimination of noise. This is accomplished by the height, shape and location of the target, which eliminates pulsation; also by the use of an ejector fluid under a constant pressure; also by the manner of admitting air through the openings 22.

(4) The accommodation of the apparatus for expansion and contraction due to temperature variations. This is accomplished by the particular manner of mounting the inner shell 12 with reference to the outer shell (which also permits easy removal of the inner shell), and the outer shell within the heads of the boiler shell, such mounting including not only the manner in which the ends of the shells are supported but also the manner in which the ribs 23, 24 and 25 are mounted. The ribs not only accommodate the expansion and contraction, but they do so without permitting any perceptible leakage of gases therearound. It will be noted that there is a clearance between the radially outer edge of the rib 23 and the interior of the shell 13. This clearance is sufficient to accommodate the radial expansion of the inner shell of the combustion chamber, while the ribs 26 serve to seal the radial outer edge of such rib against leakage between the passes on opposite sides thereof.

(5) Great efficiency in heating the water. This efficiency is due, not only to the practically complete combustion of the fuel before its delivery to the off-take 29 by reason of the long travel of the combustion gases, but also to the arrangement of the triple-pass construction whereby there is no down-draft. The flow of the flames and products proceeds from the first pass (within the shell 12) into the second and third passes without imparting any downward direction to the same; in fact, there is an opportunity for the flame and products to rise in going from the first pass to the second, and they are kept in the same position in the third pass, with reference to the opposite sides of the shells 12 and 13, as in pass A. This eliminates the formation of gas pockets.

(6) With the smallest size unit (one having an inner shell four inches in diameter) I am able to burn from two to three pints of No. 4 oil and upward; the quality of the grade of oil mentioned being one that will flow at zero temperature.

(7) There is no accumulation of carbon, due to the location and arrangement of target; also to the shape of the flame, which will contact with the inner wall of the shell 12 so slightly as to avoid the deposition of carbon thereon.

(8) The ability to increase the capacity of any installation, if necessary, by substituting a larger nozzle and tube in the body of the ejector, but without varying the pressure of the air or other ejecting fluid.

(9) Safety in operation, due to the location of the oil level in the tank or receptacle 39. Should the supply of ejecting fluid be cut off or fail, there can be no accumulation of oil in the combustion chamber.

(10) The ability to produce a cheap and self-contained boiler-burner unit capable of being installed at low cost in existing dwellings and buildings.

(11) Ability to operate at as low a rate of consumption of fuel oil as one quart per hour, without preheating the oil, and to produce a continuous flame and complete combustion. The ability to supply the oil at such a low rate is due to the great accuracy in the design and workmanship employed in producing the ejector, whereby a high degree of vacuum may be obtained in the chamber 43.

For convenience of identification, the water container within which the combustion chamber is located has been referred to hereinbefore and will be referred to hereinafter as a "boiler", although, as pointed out, the water therein may not be heated to steam-generating temperature, as where my apparatus is to be used in connection with a hot water heating system.

Having thus described my invention, what I claim is:

1. The combination, with an elongated combustion chamber, of a device arranged to deliver a mixture of fluid fuel and air into the front end of said chamber, longitudinally thereof and above the bottom thereof, a narrow target of materially less width than the width of said chamber, located adjacent to said device and extending from the inner surface of said chamber to a point located at a short distance from the axis of said device, the wall of said combustion chamber being provided with perforations located rearwardly of said target, the portion of the wall which is so perforated increasing in width rearwardly of said target.

2. The combination, with an elongated combustion chamber, of an ejector arranged to deliver a mixture of oil and air into the front end of said chamber, longitudinally thereof and above the bottom thereof, a narrow target of materially less width than the width of said chamber, located adjacent to said ejector and extending from the inner surface of said chamber to a point located at a short distance from the axis of said ejector, the said chamber being provided with air admission openings in the wall thereof extending rearwardly from a point adjacent to said target and rearwardly of said target, the portion of the said wall which is provided with air admission openings increasing in width rearwardly of said target.

3. The combination, with an elongated combustion chamber, of an ejector arranged to deliv-

er a stream consisting of a mixture of fluid fuel and air into the front end of said chamber, longitudinally thereof and above the bottom thereof, a narrow target of materially less width than the width of said chamber, located adjacent to said ejector and extending from the inner surface of said chamber toward the axis of said ejector, the said chamber being provided with air admission openings in the wall thereof adjacent to said target and located rearwardly thereof and providing a perforated area varying progressively in width from the front of said area toward the rear thereof, the said openings being spaced progressively farther apart from the front to the rear of said area.

4. The combination, with a narrow elongated combustion chamber, of a device located at the front end of said chamber and adjacent to the axis thereof and arranged to deliver a conical stream of small angularity into the front end of said chamber longitudinally thereof and adjacent to the axis thereof, said stream consisting of a mixture of fluid fuel and air, and a narrow target of materially less width than the width of the said combustion chamber, located adjacent to said device and extending from the inner surface of said chamber toward but not intercepting the central portion of the stream of mixture delivered by said device, said target being of less width than the portion of the stream passing thereby, and means additional to the said device for admitting air to the said chamber.

5. The combination, with a narrow elongated combustion chamber, of a device located at the front end of said chamber, and adjacent to the axis thereof and arranged to deliver a conical stream of small angularity into the front end of said chamber longitudinally thereof and adjacent to the axis thereof, said stream consisting of a mixture of fluid fuel and air, and a narrow target of materially less width than the width of the said combustion chamber, located adjacent to said device and extending from the inner surface of said chamber to a point located at a short distance from the axis of said device, said target being of less width than the portion of the stream passing thereby, and means additional to the said device for admitting air to the said chamber.

6. The combination, with an elongated narrow combustion chamber, of a device for delivering a stream consisting of a mixture of fluid fuel and air into the front end of said chamber, longitudinally thereof and above the bottom thereof, and a narrow target of materially less width than the width of the said combustion chamber, located adjacent to said device and extending from the inner surface of said chamber toward but not intercepting the central portion of the stream of mixture delivered by said device, said target being of less width than the portion of the stream passing thereby, the chamber being perforated adjacent to and at the rear of the target for the admission of air.

7. The combination, with a narrow elongated combustion chamber, of a device located at the front end of said chamber, adjacent to the axis thereof, and arranged to deliver into the front end of said chamber and longitudinally thereof a conical stream of small angularity, said stream consisting of a mixture of fluid fuel and air, and a narrow target of materially less width than the width of said chamber, located adjacent to said device and extending from the inner surface of said chamber, said target being of less width than the width of the portion of the stream passing thereby, the chamber being perforated adjacent to said target for the admission of air to said stream.

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