2,705,530 C. D. MacCRACKEN

SUOT-CONSUMING DEVICE

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5 Sheets-Sheet 3

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Fig. 4.

Fig. 5.
Soot-Consuming Device


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5 Claims. (Cl. 158—4)

This invention relates to a soot-consuming device for use with oil burners. The invention is particularly (but not exclusively) adapted and intended for use in a heater of the general type described in my prior art patents, e.g., Patent No. 2,488,548, of November 22, 1949 for Forced-Air Heating Apparatus, which is provided with a heat-exchanger of the general type described in said patent and in my Patent No. 2,488,549 of December 22, 1949, and is also provided with an oil-burner structure of the general kind described in my patent application Ser. No. 277,185, filed March 18, 1952.

The invention has two principal objects, first, to provide a combustion chamber in which substantially all of any soot existing in the gaseous products of combustion coming from the oil-burner will be consumed, so that the gaseous products leaving the combustion chamber will be substantially soot-free; and, second, to provide a combustion chamber of small size and low heating capacity through which the products of combustion will travel with turbulence in a tortuous path.

The necessity for eliminating substantially all of any soot existing in the gaseous products of combustion as they come from the oil-burner is due to the fact that when these hot gaseous products are utilized in a heat exchanger the deposit of soot therein is objectionable. The necessity for providing a combustion chamber of small size which will store a minimum of heat arises from the nature of the heating apparatus of the type above mentioned in which the combustion chamber is to be used. In heat-exchanging apparatus of the general kind described in my aforesaid patent, the storage of a large amount of heat within the apparatus is objectionable, because the dissipation of heat from the apparatus normally depends upon the flow through it of air supplied by the fan or air compressor (instead of the natural draft of a chimney), and when the heating apparatus stops functioning for any reason (as in the case of failure of the power driving the fan or compressor) such flow of air ceases.

It is of common practice to line the fire-box or combustion chamber of oil-burning heating apparatus (such as house heaters) with refractory material of various kinds built up from bricks or blocks or otherwise formed. The problem here has been to make the space within such a fire-box or chamber so great relative to the size of the flame that direct impingement of the flame on the refractory material is largely avoided, principally to prevent the loss of the refractory material and to avoid the deposit of carbon on the refractory material which may occur at a point of flame contact. As one of the leading authorities has said "Oil flames must be allowed to have their full swing. That is to say, according to the prior teaching of the art, oil flames should be given plenty of space in which to burn. In such prior teaching, the refractory material is rather massive and heats up rather slowly and stores a large amount of heat, even in the case of so-called insulating fire-brick, but the dissipation of heat from it ordinarily presents no problem. While it is recognized that carbon or soot will be burned to some extent on the walls of such prior heating apparatus lined with refractory material, once that material is sufficiently heated, I have found that effective removal of carbon or soot from the gaseous products of combustion is not usual in such a combustion chamber. The soot or carbon content of the gaseous products of combustion emanating from such a fire-box or chamber of prior art heating apparatus is usually greater than is found in the successful operation of heating apparatus of the general kind described in my aforesaid patents, although said carbon content may cause no serious difficulties in some heating apparatus of the prior art because of the comparatively large dimensions of the passages traversed by the products of combustion.

The present invention is contrary to the teaching of the prior art in that I provide a combustion chamber, mostly lined with rather thin refractory material, which closely confines the flame gases coming from the oil burner and causes the mixture of air and gaseous products of combustion to flow in a tortuous and confining path with the creation of turbulence, for substantially as long as combustion is taking place, thereby causing the flame gases and any soot and tar to impinge repeatedly on the refractory material of the walls of the combustion chamber. Since this refractory material is continuously heated because the combustion chamber confines the flame gases, any soot in the mixture of air and gaseous products of combustion flowing through the combustion chamber is quickly consumed. Even when the heating unit starts from a cold condition, the refractory material, due to its small mass and the confined condition of the flame gases within the combustion chamber, is heated quickly and any soot momentarily deposited on the refractory material is quickly consumed. Therefore, the hot mixture of air and gases issuing from the combustion chamber is substantially soot-free under all conditions and can be expected to pass through the confined passages of the heat exchanger for long periods of time without a danger of clogging them, or said gases may be utilized in other ways where soot-free hot gases are desired. In a soot-consuming device according to the present invention, the length of the passage through the combustion chamber is about equal to the length of the flame gases directed into it from the oil burner, so that the flame terminates short of or at about the outlet from the combustion chamber. Since the mass of the refractory material which lines most of the combustion chamber is comparatively small, the heat stored in it is not too great to be dissipated without damage to the apparatus and the parts of the heating unit (such as the electric motor which drives the fan or compressor and the fuel oil pump driven by said motor) when the heating apparatus ceases to operate because of a failure of the current supply to the motor.

The invention will be understood from the following description, taken in connection with the accompanying drawings in which Fig. 1 is a perspective view of a soot-consuming device embodying the invention; Fig. 2, is a longitudinal sectional elevation on the plane 2—2 of Fig. 1, and also shows in section a fuel burner and Fig. 3, is a sectional view on the plane 3—3 of Fig. 2; Fig. 4 is a sectional elevation on the plane 4—4 of Fig. 3; Fig. 5 is a sectional elevation of the soot-consuming device illustrating how a flame electrode is mounted therein; and Fig. 6 is a sectional elevation, similar to Fig. 2, showing a modified construction of said soot-consuming device.

In Figs. 1, 2, and 3, the soot-consuming device is shown as having a box or dome portion 10 and a cover or bottom portion 12 which are adapted to cooperate with one another (as hereinafter described) so as to provide a combustion chamber 14 which receives the gaseous products of combustion from a fuel burner 16 shown in Fig. 2, which may be of any suitable type, the one illustrated being shown and described in my co-pending application Ser. No. 277,185.

As will be evident from Figs. 2 and 6, the fuel burner 16 there illustrated is provided with a fire-box or chamber, including a fuel nozzle or atomizer 18 of the return-flow type having nut 20 and a return pipe 22. The atomizer 18 supplies the fuel oil, the fuel oil being in the form of a fine cone-shaped spray, as indicated in Fig. 2. The fuel burner has an inner cylindrical shell 24 and a slightly tapering outer shell 26,
which are retained in concentric relation by a circular dish-shaped end wall 28 having its outer portion formed into a circular channel 30 which cooperates with the top 26 and is secured therein in any suitable way. The end wall 28 is provided at its center with an opening through which the fuel spray from the atomizer 18 impinges into the combustion chamber; and mounted on the end wall 28 is a casing 32 which houses the atomizer 18. The inner shell 24 of the fuel burner is perforated with a large number of small holes 34 and 36 provided with several arranged larger holes 38, as will be apparent from Figs. 2 and 6. The purpose of the small holes 34 and 36 is to permit air to seep through the inner shell 24, thereby providing on its inside surface a layer or cushion of air; and the larger holes 38 in the inner shell 24 admit freely not only the air necessary to support substantially complete combustion of the liquid fuel, but also additional air which dilutes the gaseous products of combustion. As shown in Fig. 2, the lower portion of the inner shell 24 is surrounded by a baffle 40, the major portion of which is spaced away a short distance from the end portion of the perforated plate 24, and a baffle 40 retards and increases the heating of the air seeping through the small holes 36 into the lower portion of the fuel burner. An igniter 52 (of any well-known form) is inserted in a member 68 which projects into the baffle or deflector 64 and prevents gases from flowing under the baffle.

In the form of the invention illustrated in Figs. 2, 3 and 4 the cover or bottom portion 12 is provided, at the end adjacent the entrance opening 60 of the plate 54, with a specially constructed flame-deflecting plate portion 69 against which the flame from the fuel burner 16 impinges. The construction of this plate portion 69 will be understood by reference to the figure. A series of circular plates 70 made of a plurality of channel members 70 made of some metal alloy which is oxidation-resistant at high temperatures, such as an alloy containing about 80% nickel and 20% chromium, are provided with series of concentric circular plates in parallel relation with their open sides extending away from the combustion chamber, and the adjacent edges of said channel members 70 are welded to one another as indicated at 72 in Fig. 4, at 74, and the same material are provided at each side of the series of channel members 70, and these angle members 74 are welded to the adjacent channel members as shown and the bottom portion 12 as indicated at 76. Fig. 3 shows in plan how the channel members 70 and angle members 74 form the plate portion 69 which is a part of the cover or bottom portion 12 of the soot-consuming device. As hereinafter explained, the flaming gases from the fuel burner 16 impinge on this plate portion 69 and are deflected by it into the combustion chamber 14 in the soot-consuming device. With the cover portion 10 in form is a sleeve 82 of an insulating material which is hollow and projects through a sleeve 82 of insulating material such as porcelain. Secured to the porcelain sleeve 82 is a metal spider having a hub portion 84 from which arms 86 project. These arms 86 are provided with angularly extending ends 88 having perforations through which extend screws 90 which enter threaded holes in a flange 92 which is secured to the outer face of the sleeve 82 in any suitable manner as by spot welding. It will be noted that an annular space 94 is provided between the porcelain sleeve 82 and the cover portion 10 and is in sleeve 96 in portion 88 in the refractory lining 59 of the soot-consuming device; and it will also be noted that the opening through the flange 92 is of larger diameter than the diameter of the porcelain sleeve 82. Therefore, air is permitted to flow into the soot-consuming device through the annular space 94, thereby cooling the porcelain sleeve 82 which is of course subjected to heating by the flaming gases in the soot-consuming device. In this way, objectionable heating, cracking and sooting of the porcelain sleeve 82 of the flame electrode is prevented; and the rod 90 of the flame electrode is supported in the soot-consuming device in the space provided by the soot-consuming device in the space provided by the soot-consuming device in the space provided by the soot-consuming device in the space provided by the soot-consuming device in the space provided by the soot-consuming device in the sleeve 82.

Extending from the top portion 44 of the shell and cooperating with the sides 46 and 48, is an inclined plate 54 having therein an entrance opening surrounded by a flange 56 which (as shown in Fig. 2) is adapted to receive the end of the inner shell 24 of the fuel burner. Also extending from the top portion 44 of the shell and parallel with the refractory plate 54 is a sheet metal strip 58 provided with an opening concentrically arranged with reference to the flanged opening in the inclined plate 54. The outer shell 26 of the fuel burner cooperates with the plate 58 in the manner shown in Fig. 2.

The cover or bottom portion 12 of the soot-consuming device is welded as indicated in 59 in Fig. 4 or otherwise secured to flanges 60 extending from the edges of the side plates 24 and 26 of the shell 28. The cover or bottom portion 12 is provided with a deflect or baffle 64 of refractory material which is preferably reinforced with a loosely woven metal fabric 66 which serves the same purpose as the fabric 52 embedded in the refractory lining 58. As shown in Fig. 2, the bottom portion 12 has welded to it a sheet-metal angularly extending member 68 which projects into the baffle or deflector 64 and prevents gases from flowing under the baffle.
flected upwardly into the combustion chamber 14 with-
in-the soot-consuming device. The arrows in Figs. 2
and 6 (more or less roughly) indicate the path of the
flaming gases through the soot-consuming device. It will
be obvious that the flaming gases from the fuel burner
are caused to flow in a tortuous confined path through
the soot-consuming device and that they repeatedly im-
pinge on the refractory material with which the major
portion of the soot-consuming device is lined. There-
fore, any soot particles which may exist in the gaseous
products of combustion are brought into contact with
the hot vitreous lining and are consumed within the
chamber 14 of the soot-consuming device before said
gases leave it through the exit opening bounded by the
flange 62. For that reason, substantially soot-free
combustion gas products of combustion are delivered from the
soot-consuming device, and any danger of the deposit
of soot from those gases, however they may be em-
ployed, is substantially eliminated.

What is claimed is:
1. In a heater, a fuel burner, a soot consuming device
comprising a box having side and end walls and top and
bottom portions cooperating to provide a combustion
chamber of length substantially equal to normal gas
flame length, said box having a lining of thin cast refrac-
tory material, one part of said top portion at one end
of said box comprising a plate inclining outwardly and
downwardly at an acute angle to said bottom, said plate
having an entrance opening to said combustion chamber,
a deflector of refractory material extending from said
bottom portion into said combustion chamber, said bot-
tom portion having on one side of said deflector and im-
mediately adjacent thereto an exit opening and on the
other side of said deflector and immediately adjacent
thereto a flame-deflecting plate which is located opposite
to and in the path of gases entering the combustion
chamber through said entrance opening in said first-named
plate, said burner being mounted on said box above said
entrance opening with its axis normal to said first-named
plate and extending into said entrance opening and di-
rected to discharge flaming gases through said entrance
opening onto said flame-deflecting plate whereby the flam-
ing gases and other products of combustion from the fuel
burner entering said combustion chamber through said
entrance opening impinge on said plate and are deflected
therefrom into said chamber and flow therethrough tur-
bulently in a tortuous confining path and impinge on the
refractory material of said deflector and box portion on
their way to said exit opening.
2. A soot-consuming device according to claim 1 in
which said flame-deflecting plate of said bottom portion
is made of thin cast refractory material similar to the
lining of said box portion.
3. A soot-consuming device according to claim 1 in
which said flame-deflecting plate of said bottom portion
is made of an oxidation-resistant metal.
4. A soot-consuming device according to claim 1 in
which said flame-deflecting plate of said bottom portion
consists of a plurality of channel members made of an
oxidation-resistant metal which are secured to one an-
other in parallel relation with their open sides extending
outwardly.
5. A soot-consuming device according to claim 4 in
which said channel members are secured to one another
by welding at their adjacent edges.

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