Apr. 17, 1923. 1,452,380

C. G. HAWLEY

LIQUID FUEL FURNACE

Original Filed Jan. 21, 1920

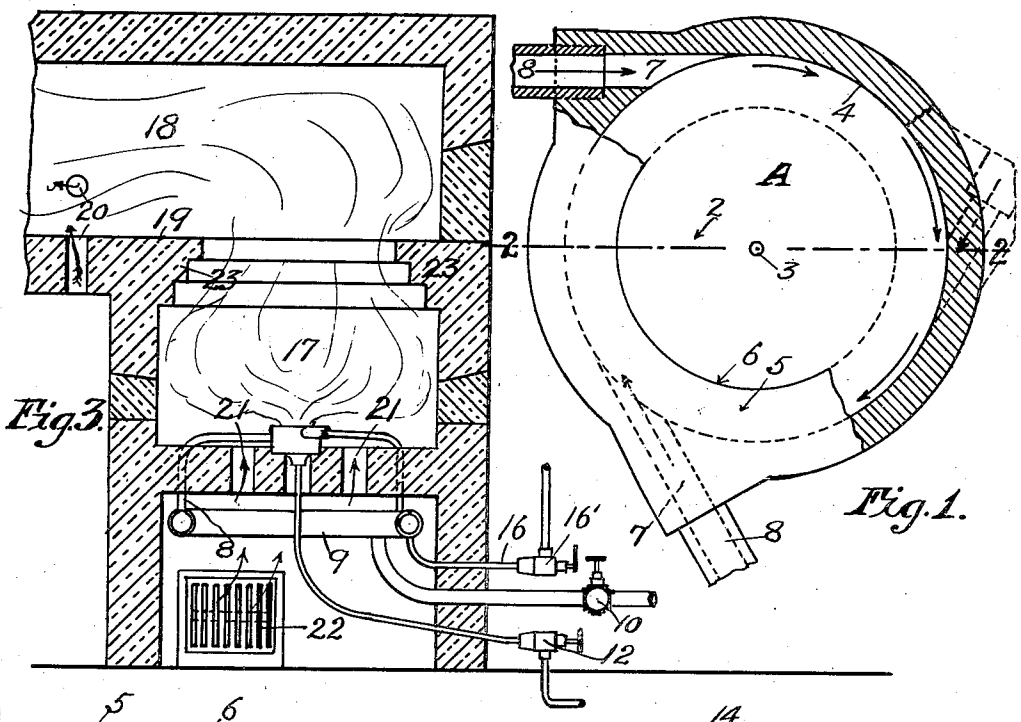

Fig.3.

Fig.1.

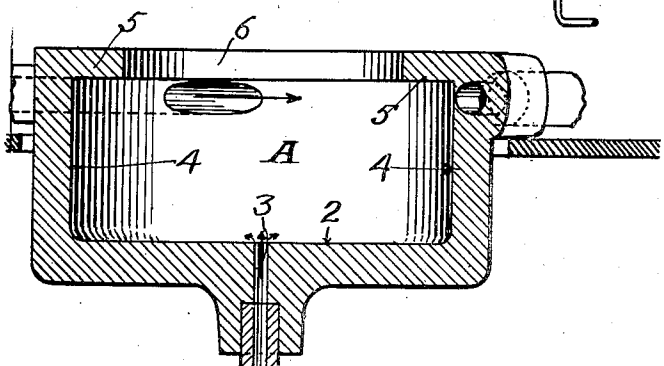

Fig.2.

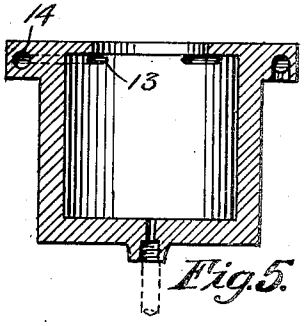

Fig.5.

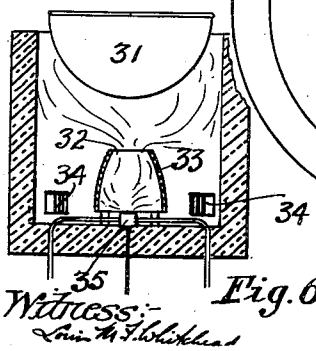

Fig.6.

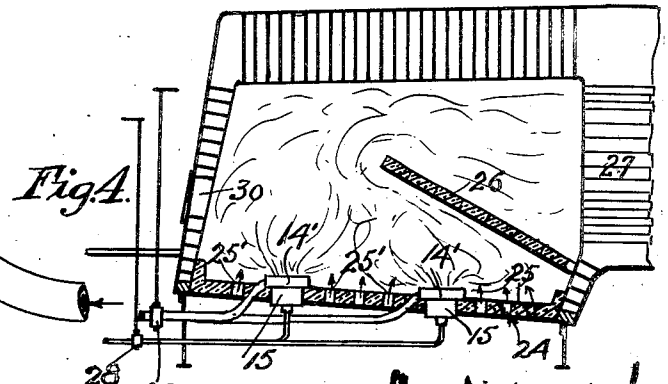

Fig.4.

Witness:

Inventor: Charles G. Hawley

Patented Apr. 17, 1923. 1,452,380

UNITED STATES PATENT OFFICE.

CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS.

LIQUID-FUEL FURNACE.

Application filed January 21, 1920, Serial No. 353,045. Renewed September 25, 1922. Serial No. 590,536.

To all whom it may concern:

Be it known that I, CHARLES GILBERT HAWLEY, a citizen of the United States, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in and for Liquid-Fuel Furnaces, of which the following is a specification.

My invention relates to improvements in burners and furnaces for burning various liquid fuels.

The object of the invention is to provide means whereby liquid fuels may be gasified, and burned, more efficiently and more safely; and without resort to an atomizing blast. A further object is to provide a liquid fuel burner which shall emit a wide-spread volume of gas and flame; and whereby to avoid the usual blow-pipe action of most liquid fuel burners now in use. A special object of the invention is to provide a simple gasifier and burner by means of which liquid may be easily converted into a substantially fixed gas and later burned with a proper admixture of air.

In its simplest and best form, my invention comprises a circular burner or pot which is closed at the bottom, save for a small fuel inlet, and the top of which pot contains a large gas outlet opening; leaving part of the top intact in the form of an overhanging ledge, ring or abutment; in combination with one or more twyers that enter the top of the chamber directly beneath such abutment and substantially at a tangent or tangents to the inner walls thereof. These twyers serve to admit air and sometimes superheated steam, under pressure. The depth of the pot proper (the circular chamber) may vary from a dimension equal to about one fourth the diameter of the pot to a depth about equaling its diameter; according to the nature of the liquid to be handled and the character of the flame to be produced.

Suitable controlling devices are provided for regulating the flow of the fuel, and of the air or steam; and, though not so shown herein, such devices may be automatic in operation. It will become apparent that my device may be operated as a wholly self-contained burner and, positioned in the open air, may be made to emit an intensely white flame so that it may well be used as a lighting torch. But usually there is a fire-chamber or furnace proper which contains the burner and which is provided with suitable openings for the admission of a secondary supply of air as required to complete combustion to the extent desired; also an opening or openings for the exit of completed or burned gases.

As will be apparent herefrom, my invention is adapted to many uses, ranging from the production of refined vapors (and hence liquids) and gases; and the production of either short or long flames; at extremely high temperatures suited to the most exacting metallurgical purposes as well as to the less exacting but very economical making of steam in boilers. The marked advantage is that such results now become possible with tars and the heaviest of oils as the heat-producing fuels; and this without excluding from use the lighter oils and fats.

Brief reference to the accompanying drawings (Figs. 1 to 6) will clarify the foregoing description of the apparatus; also the following: The fuel flows upward through the small hole in the bottom of the pot and may spread over the bottom thereof. At the start the air which enters through the tangential twyers swirls around the chamber. Due to the presence of the overhanging ledge or ring and its own velocity and coincident centrifugal force the incoming air is prevented from escaping directly through the large top opening and is compelled to whirlingly progress toward the bottom of the pot. Then it moves inwardly toward the center and meets the fuel. The latter having been ignited a large flame is propagated. The flame whirls violently within the pot and as it leaves the large central exit; thus accomplishing the best possible flame distribution and also setting up a strong resultant vortex, moving downward at the center. This vortex from the very beginning serves to suppress the column of liquid that would otherwise shoot upward from the feed opening, accomplishing, instead, the positive spreading of the feed to meet the whirling and inwardly moving column of air, or other supporter of combustion. Shortly after ignition the interior of the burner becomes hot and in the presence of the burning gases the vaporization of the fuel occurs at the instant of entrance to the pot. From that time forward the quantity of air may be greatly

diminished in proportion to the fuel feed. Also from that time on, there need be no actual flaming combustion within the pot itself and by regulation of air and fuel the product may, and should, be limited to a highly inflammable and very hot blue vapor or gas. In most cases this gas will be immediately mixed with a sufficient secondary supply of air within a fire-chamber and used to produce heat. Other uses are obvious, such as the making of light and the manufacture of inflammable gas and in by-product distillation of oils. As these advantages flow naturally from the provision of the device or new facility which makes them possible I need not describe them in detail. All such are necessarily comprehended by the invention.

The body of air, or the like, whirling constantly within the pot serves to hold the incoming fuel at the center of the floor or bottom of the pot and little, if any, thereof reaches the side walls of the pot; therefore no actual combustion takes place thereon, and the walls are extremely durable. The non-vaporizable constituents of the fuel which otherwise would be left in the form of a mound or cake on the bottom of the pot, are continuously reduced and disposed of by oxidizing hot air from the sides of the pot and in consequence the burner or vaporizer is a self-cleaning device. After the gasifying stage is reached, the supply of air or other supporter of combustion may be cut down to a volume little more than necessary to burn away the residue of vaporization. At such time the heat for continual vaporization is supplied by either the limited or complete combustion of the vapors or gases above the burner, at which point the secondary supply of air is introduced. Should a cake build up on the bottom of the pot through lack of sufficient air, it may be quickly disposed of by merely increasing the volume of air at the tangential twyers.

This automatic self-cleaning operation of the burner is most important for thereby it is made possible to vaporize, gasify or burn the heaviest of fuels, such as tars, fats, heavy petroleum residues and fuel oils. Obviously, the burner is fully as well adapted to continue performance with lighter liquid fuels.

The burner or pot proper may be made of any suitable refractory material and in some cases the addition of such materials will facilitate the starting of the operation. But most conveniently, the burner is made of cast iron. In particular, this is made possible by two important characteristics of my invention; to-wit, by the constant cooling of the burner walls by the incoming air or steam and the absence of direct combustion thereon, and especially by the endothermic action of vaporizing the fuel (heat being the agent absorbed) which positively ensures a very practical lowness of temperature throughout the walls of the burner and also in the pipe through which the fuel enters the burner.

These factors of protection are adequate to maintain the burner in perfect working order almost indefinitely notwithstanding the fact that the whole burner may be directly exposed to the very high temperature of a fire-chamber containing it.

While it will be found desirable to start the operation when the burner is in a vertical position, after the stage of gasification is reached it may be placed in any other desired position with respect to the horizontal. Such other positions will be found advantageous in a number of special industries; but ordinarily the burners are used in the position shown in the drawings that being the most convenient and the best from all standpoints.

My invention also includes other important details of construction and arrangement and combinations of the burner and furnace, and the various methods of operating and utilizing the same.

By way of example in the matter of fundamental and preferred details of construction, direct reference will now be made to the accompanying drawings; in which, Fig. 1 is a plan view (partly in section) illustrating a liquid fuel burner embodying my invention; Fig. 2 is a vertical section thereof on the line 2—2 of Fig. 1; Fig. 3 is a sectional elevation of a liquid fuel furnace embodying my invention; Fig. 4 is a sectional elevation of a locomotive boiler firebox of my invention; Fig. 5 illustrates a modified form of my burner that is specially adapted to the lighter or more volative fuels; and, Fig. 6 depicts a furnace containing both the burner proper and an auxiliary combustion limiting or gasifying chamber.

As illustrated in Figs. 1 and 2,—A, is the pot or vaporizing chamber proper, before mentioned. 2 is the bottom of the chamber, and 3 the central fuel hole therein. The side or vertical walls are marked, 4. 5 represents the beforementioned annular overhanging ledge or abutment ring, within which is the large central gas outlet and vortex admission opening, 6. As before stated, there may be any desired number of tangential twyers. 7. Three are here shown. These enter preferably at true tangents to the inner, vertical wall, 4, and are positioned directly beneath the overhanging abutment portion, 5. The latter by preference is so thin as to ensure the adequate cooling and maintenance thereof by the incoming air from the twyers 7, notwithstanding the high temperature to which

it is subjected. Or the top may be made of different refractory material. Thus the burner proper is complete.

In installing the burner, it is equipped with the necessary air pipes, 8, which usually are exposed within the fire-chamber, as shown in Fig. 3; in order that the incoming air may be preheated before it enters the burner. Such preheating is of advantage at the start of the described operation. As shown, in Fig. 3, air pipes, 8, may join a common header or pressure drum, 9, and are controlled by means of a hand or automatic valve, 10, as shown in Fig. 3. No great pressure of air is required. Ordinary fan pressure is sufficient; or pressure air may be derived from a pressure tank or from a blower; the latter being particularly desirable in case of a large installation; and the pressure tank being desirable in the use of the burner as a lighting torch, or as a portable heating device. The liquid fuel enters the burner through a pipe, 11, communicating with the central feed opening, 3. This pipe leads from a source of pressure (a slightly elevated tank is correct practice) and contains a regulating valve, 12, by which the flow of fuel is controlled.

The device illustrated in Figs. 1 and 2 is of sufficient size and of right proportions for the burning of fuel oil, oil tar, and the like. For the lighter fuels it is sometimes desirable to diminish the rate of vaporization and this may be done by increasing the depth of the burner, as indicated in Fig. 5. Incidentally, Fig. 5 illustrates an expedient to which I sometimes resort when a plurality of tangential twyers, 13, are desired, to-wit, a header or communicating space, 14, formed by coring out the upper portion of the casting which comprises the burner. This integral twyer head preferably is utilized in the instance of burners employed in locomotive boiler fireboxes and the like, as suggested in Fig. 4, wherein 14′, 14′ represents the twyer heads of the two burners there depicted.

As represented in Fig. 3, 16 illustrates a superheated steam supply pipe, containing a regulating valve, 16′, and which enables the substitution of superheated steam at the tangential twyers of the burner; preferably after the burner has been started with air. This is an expedient that I also employ generally with boiler furnace equipments; it should be assumed to be present in Fig. 4. The steam connection is omitted therefrom only to avoid confusion of pipes.

The furnace or firechamber containing the burner may be of any desired form; as sufficiently indicated in Figs. 3, 4, and 6. For metallurgical and heat-treating purposes, I have devised the furnace illustrated in Fig. 3, the same comprising the primary fire chamber 17 (which contains the described burner) and a horizontal oven, 18, which receives the flames and heat from the chamber, 17. The oven, 18, has a hearth or bed, 19, which receives the substances or particles to be treated. This portion is characterized by supplemental air inlet openings, 20. The primary chamber has its own secondary air supply openings, 21, deriving air from the regulable opening, 22, in the base of the furnace. I prefer that the primary fire-chamber, 17, should be partially closed at the top as by corbeling, 23.

My novel locomotive boiler firebox or chamber is characterized by a metal floor, 24, which takes the place of the usual grate. This floor has a covering, 25, of refractory material, which extends upward at the edges, to protect the mud ring and lower parts of the water legs of the boiler. This floor contains the secondary air supply openings, 25′, which, obviously, may be regulated in size, but must always be large and many enough to supply all of the air necessary for the combustion of the gases evolved by the burners, 15. Dividing the firebox into two parts, is an arch, baffle or fire-wall, 26, which may be of any suitable construction and disposition. This divides the firebox and serves the purpose of increasing the gas and flame travel therein; and also prevents direct movement of flames from the burners to the flues, 27, of the boiler. It also makes the starting of the forward burner an easy matter. The fire is regulated by means of the fuel valve, 28, and air, steam valve, 29, in the supply pipes of the burners, 15. The valve stems of these valves rise to convenient positions in the cab of the locomotive and are equipped with operating handles or levers by which the fireman is given control of the fire at all times. I have not attempted to show the device for regulating the flow of secondary air as it comprises no more than a boxing beneath the floor, 24, and having a large air opening or openings with butterfly valves or dampers arranged for convenient operation from the cab. The burners are accessible through the fire-door, 30, of the firebox.

In some instances it is desirable to position a small burner of the kind described in a large fire-chamber; the fire-chamber taking its large size from the boiler or other object therein. Such an instance appears in Fig. 6, wherein 31 represents the object to be heated and 32 the fire-chamber. At such instances I provide a refractory hood, 33, for the burner, 35. This hood preferably is open at the top and is preferably somewhat smaller at the top than at the bottom. All necessary secondary air enters it from the bottom, and also enters the fire-chamber as a whole through the openings, 34. The refractory hood has the effect of temporarily

excluding the full volume of air from the immediate vicinity of the burner and in consequence there emerges from the hood a perfected volume of highly combustible gases which proceed to a final flaming condition over the widely distributed surfaces of the boiler or other object, 31. This combustion-limiting auxiliary will be found to be of great benefit both in the matter of starting and of maintaining a fire in an already existing fire-chamber, and in the matter of localizing the production of the gases in readiness for application for use at another point. Primarily, it has the effect of preventing the formation of carbon dioxide in any considerable measure, until the gases are liberated therefrom. It is also the means by which a long flame may be propagated whenever such a flame is desired. The hood or initial restricted chamber, obviously, retards combustion and ensures the prolongation of combustion after the gases leave the outlet of the hood. The gas outlet of the hood may be in the side, as well as in the top thereof.

The terms "downward" and "upward" in the appended claims are used as meaning toward and from the bottom, 2, of the burner and not with reference to any special position of the burner; for, as hereinbefore explained, the burner as a whole may be placed in any desired position, once the operation thereof has proceeded to the gasifying stage, i. e., the stage in which liquid fuel is virtually excluded from access to the side walls of the burner. The terms "upward" and "downward" and "top" and "bottom" should be so interpreted in the claims.

Various modifications of my apparatus and its various adaptations will suggest themselves to others and therefore I do not limit the invention to the specific structures and methods herein specifically disclosed.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. The herein described improvement in the art of gasifying and using liquid fuel that consists in generating a whirling hollow column of a supporter of combustion, such as air, and causing the same to move downwardly and at a fixed point of progress to move inwardly toward the axis of the column and thence upwardly; and, simultaneously feeding liquid fuel into the bottom of said column and maintaining the mixture in a flaming condition which vaporizes the fuel as rapidly as it enters said column.

2. The herein described improvement in the art of gasifying and using liquid fuel that consists in generating a whirling hollow column of a supporter of combustion, such as air, and causing the same to move downwardly and at a fixed point of progress to move inwardly toward the axis of the column and thence upwardly; and, simultaneously feeding liquid fuel into the bottom of said column and maintaining the mixture in a flaming condition which vaporizes the fuel as rapidly as it enters said column, utilizing said supporter of combustion both in the combustion essential to the maintenance of the vaporizing temperature and for the combustion of the non-vaporizable residue of the fuel.

3. The herein described liquid burner comprising a cylindrical metal pot having a bottom closed save for a small central fuel entrance opening and having a top that is open save for an overhanging ring or flange, in combination with a plurality of tangential twyers entering said pot directly beneath said ring or flange, substantially as described.

4. The herein described liquid burner comprising a cylindrical metal pot having a bottom closed save for a small central fuel entrance opening and having a top that is open save for an overhanging ring or flange, in combination with a plurality of tangential twyers entering said pot directly beneath said ring or flange, and an encompassing combustion restricting hood for said pot, substantially as described.

In testimony whereof, I have hereunto set my hand this 17th day of January, 1920.

CHARLES GILBERT HAWLEY.