July 28, 1931. G. H. KAEMMERLING 1,816,434

APPARATUS FOR BURNING FUEL

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Fig. 1,

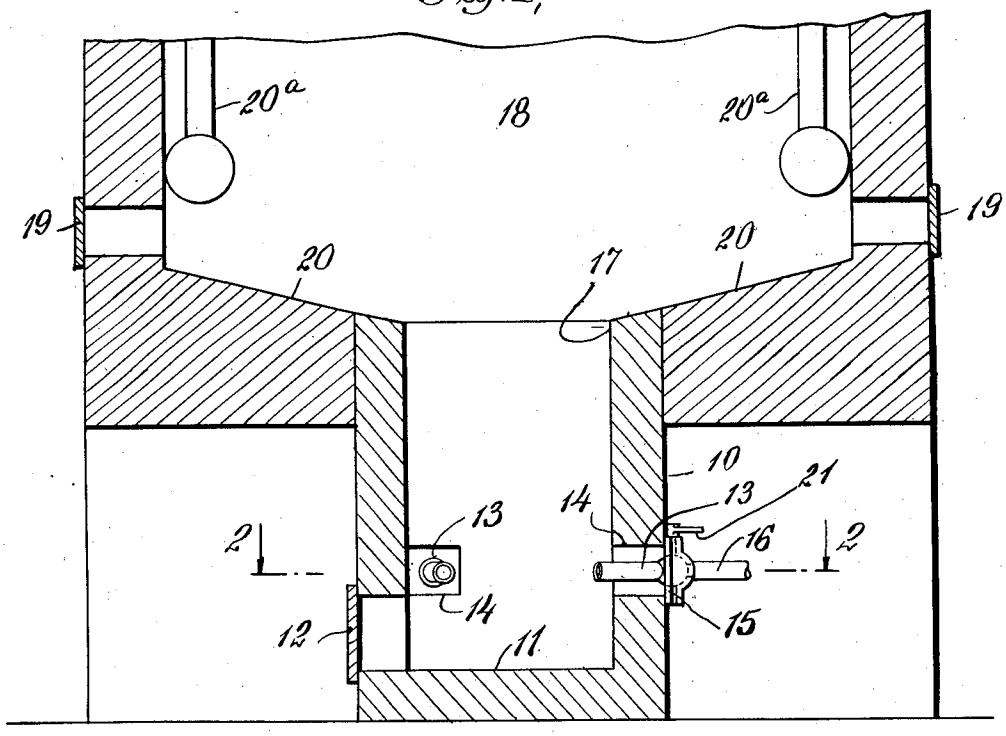


Fig. 3,

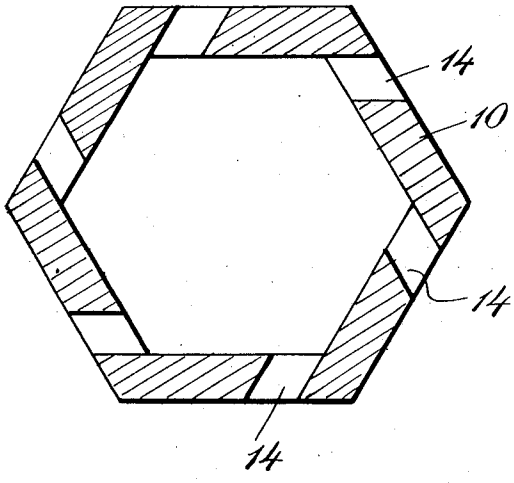
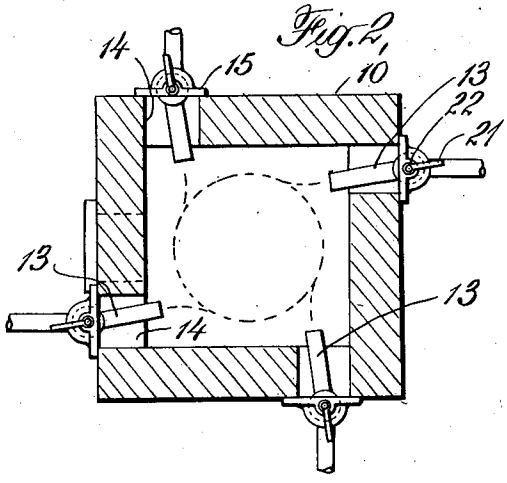


Fig. 2,



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Fig. 4,

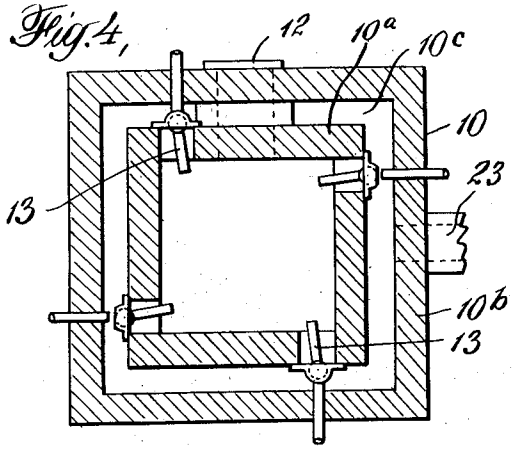


Fig. 6,

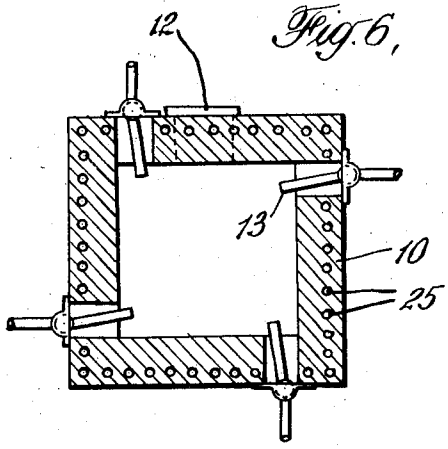


Fig. 5,

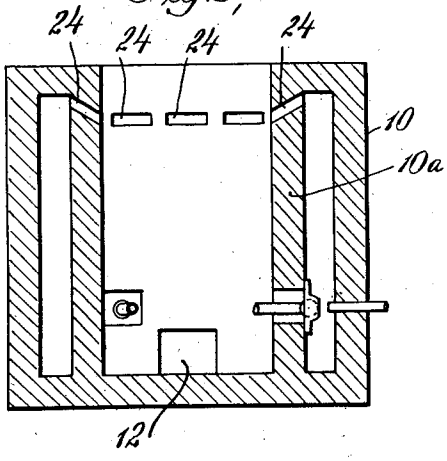


Fig. 7,

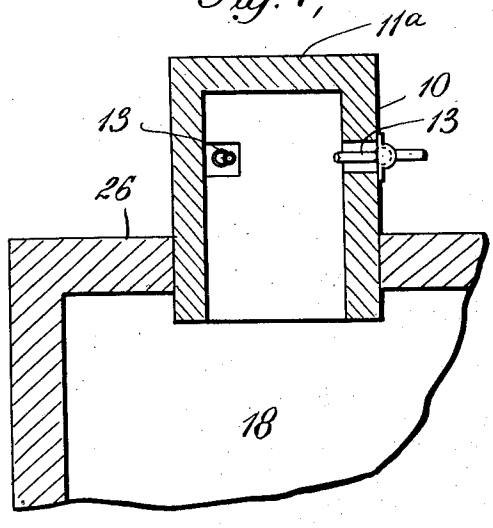
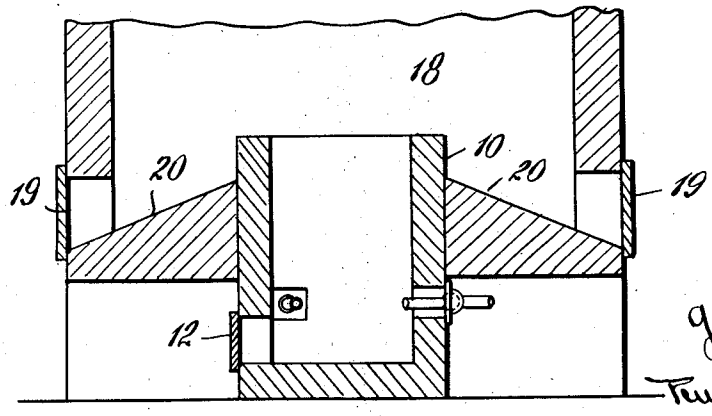


Fig. 8,



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UNITED STATES PATENT OFFICE

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APPARATUS FOR BURNING FUEL

Application filed November 6, 1923. Serial No. 673,076.

This invention relates to the art of burning pulverulent fuel in furnaces, and involves more particularly an improved method of burning such fuel in a furnace of small volume; and the invention further comprehends a furnace construction resembling in form a well or pit, for carrying out the method indicated. The method and apparatus, though suited especially to the burning of pulverulent fuel, would serve to advantage in the burning of gaseous and liquid fuel as well. With all such fuels the principle of the method can be applied to secure improved conditions of combustion and the highest efficiencies, while obviating the main difficulties attendant upon the burning of fuels of this character in accordance with present practice, and at the same time effecting economy in the cost of furnace installations and their upkeep.

The present method of burning pulverulent fuel is applicable as well to gaseous and liquid fuel as carried out in a small furnace or well, and aim to accelerate the combustion process by improving the mixture of fuel and air and making use of a novel means of ignition. The fuel and sufficient air for combustion are brought into the furnace at high velocity in a plurality of streams which are made to impinge one upon another in succession, creating great turbulence and hence intimate and thorough mixture of the fuel and air. The impinging or intersecting streams merge in a common rapidly rotating flaming mass which serves to ignite the incoming fuel and air streams, and the interaction between the rotating mass and the fuel and air streams serves further to enhance the intermixture by agitation and turbulence.

The separate streams, which may be one or more fuel streams and air streams, or one or more intermixed fuel and air streams, are directed to intersect or strike one another in the manner described, and in such a way, by relative adjustment of the streams, that the path of each stream will be diverted from the refractory walls against which they would otherwise strike if allowed to travel without interruption. The intersecting fuel and flame streams produce, as before noted, great turbulence or agitation which is a condition conducive to the most thorough intermixture of fuel particles and air, and the fuel is ignited by the rotating flaming mass, resulting in quick and complete combustion. Thus it will be seen that the thorough intermixture of fuel and air, which is obtained ordinarily in present practice only by the provision of long flames, and then only to a degree resulting in satisfactory combustion conditions, is obtained in accordance with the present method by the use of a plurality of short streams impinging upon one another in succession around the combustion chamber, and yet without flame impingement on the refractory walls, although a very small furnace volume is required.

The furnace construction, with several modifications, for carrying out the method described, will be described in detail hereinafter by reference to the drawings. The furnace is composed of refractory walls forming a structure resembling a well or pit, closed at one end and preferably polygonal in cross section, and is characterized by its small volume and the provision of tubes which may be adjusted for directing the fuel and flame streams, or fuel and air streams, to cause their intersection. The tubes project through openings in the longitudinal side walls of the furnace and are preferably positioned nearer the closed end of the furnace.

Figure 1 is a sectional view in elevation of a furnace construction comprising a well furnace and a secondary or distributing chamber adapted for stationary boilers.

Fig. 2 is a section along the line 2—2 of Fig. 1.

Fig. 3 is a cross-sectional view of a hexagonal form of well furnace showing inclined openings in each of the side walls to accommodate burner tubes.

Fig. 4 is a cross-sectional view of a modified form of well furnace of hollow wall construction to provide air cooling for the furnace walls and preheated air admission to the tubes.

Fig. 5 is a sectional view in elevation of a well furnace of hollow wall construction in-

troducing further modifications for air cooling and secondary air admission.

Fig. 6 is a further modification of the well furnace construction showing water cooled walls.

Fig. 7 is a modified form of boiler furnace arrangement in which the well furnace is inverted and projects through the roof or arch of the receiving or distributing chamber.

Fig. 8 is a modification of the form of construction illustrated in Fig. 1 showing the well furnace projecting above the floor of the receiving or distributing chamber.

Referring to the drawings and with reference to Fig. 1, 10 is a furnace of relatively small volume, referred to herein as a combustion chamber, and shown in the form of a well, the walls of which are constructed of refractory material. The well furnace may be square in form as illustrated in Fig. 2, hexagonal as shown in Fig. 3 or have any number of sides, the construction being preferably of polygonal cross section. One end of the furnace is closed as at 11 in Fig. 1, in this case the end closure forming the bottom of the furnace. In Fig. 7, illustrating the inverted type of well furnace, the top end 11*a* is the closed end.

Referring again to Fig. 1, there is provided adjacent the bottom 11 of the furnace clean-out doors 12 and nearer the bottom is a plurality of tubes 13 projecting into the furnace through openings 14 in the walls thereof. These tubes may be used to introduce fuel or air or a mixture of fuel and air.

The openings 14 are made sufficiently large to permit movement of the tubes, which are mounted for adjustment in a vertical or horizontal direction, and the openings 14 are closed against the admission of air except through the burners by cover plates 15, which set against the exterior surface of the furnace walls. Any suitable form of mounting for the burners, permitting universal movement, or horizontal and vertical adjustment, would serve the purposes of the invention. Where the nature of the installation permits of predetermining the position of the burners to function as above described, the feature of adjustability may be eliminated. In the drawings the tubes are shown mounted in spherical sockets or joints permitting universal movement, while at the same time connecting the tubes to fuel or air inlet pipes 16, connected to a source of supply, not shown.

In operation, tubes 13 are adjusted so that the air, fuel and flame streams issuing from them intersect with adjacent streams mixing the fuel and air by agitation or turbulence and preventing impingement of the individual flame streams on the walls of the furnace, and producing a rapidly rotating or whirling mass of flame within the confines of the furnace walls. The combustion proceeds from the points of admission of the fuel near the bottom of the furnace upwardly toward the opening 17 out of which the gases and ash escape into an appropriate receiving or distributing chamber for utilization of the heat therein contained.

In Fig. 1, illustrating an arrangement suited to stationary boiler practice, the receiving chamber 18 corresponds to the usual combustion chamber of a furnace for burning pulverulent fuel, but is of much smaller volume. In this arrangement clean-out doors such as 19 are provided for the removal of incombustible residues and the floor 20 of the chamber may be inclined slightly downwardly toward the pit or well 10. The gases of combustion issuing from the well furnace 10 into the receiving chamber 18 may be made to yield a portion of their heat content to a boiler heating surface extension such as 20*a*, preferably arranged along the walls of the chamber and consisting of headers and boiler tubes connected to the boiler evaporating system of tubing. Such tubes serve to protect the walls and at the same time economy in the utilization of heat is realized. Combustion is carried out to completion in the well furnace 10, since the streams of finely pulverized fuel and air issuing from the tubes 13 are directed, as before described, to intersect, which causes great turbulence and thorough intermixture of fuel and air and quick ignition by the rotating flaming mass is produced. In order that the tubes 13 may be swung to exact position to secure the desired impingement of the separate streams effecting thorough intermixture of fuel and air, and to prevent flame impingement of the individual flames on the walls of the furnace, adjusting devices such as handles 21 mounted on shafts 22 rigidly secured to the tubes 13 are provided. The fuel and air so thoroughly mixed being admitted near the bottom of the furnace and instantly ignited, combustion is substantially complete before the gases and suspended solids therein reach the top of the well.

The well furnace in construction is preferably simply a hole in the ground lined with refractory brick and is not made a part of the furnace structure in the sense that it is relied upon to support any of the superstructure, as for example in a boiler furnace installation. In this way, the well furnace can be built and rebuilt with comparative ease and rapidity and at small cost. The small size of the furnace, furthermore, permits of the use of brick of exceptionally high refractory properties such as carborundum or other special material within the limits of economical installation and maintenance cost. Regardless of the material used, however, the well furnace construction described has been found to produce regenerative results superior to those obtained in any furnace ar-

rangement heretofore designed. In the method of firing employed, the refractory walls are spared the scouring or abrasive action of direct flame impingement which considerably prolongs the life of the refractory walls, but no effort is made of course to reduce the temperatures developed. On the contrary, the fuel is burned purposely to obtain as high heat as possible in the well furnace, and may be burned with the highest efficiency, therefore, despite the necessity of replacement of refractories from time to time occasioned by the intensely high heat produced. As before explained, it is an expected part of the regular maintenance and upkeep of the furnace to rebuild the walls of the well or pit periodically and this can be done with economy in view of the quantities of fuel burned, efficiencies obtained and the low cost of replacement due to the simplicity of construction and the smallness of size of the furnace.

Referring now to Figs. 4 and 5, the well may be built with a hollow wall construction, there being inner walls 10*a* and outer walls 10*b* with a confined space 10*c* between them. Into the space or chamber 10*c* which is closed at the top and bottom as shown in Fig. 5, air under pressure may be introduced through the inlet pipe 23. Such air would reduce the temperature of the inner walls 10*a*, at the same time being preheated for admission to the furnace through the inner tubes 13 with the fuel or alone, and as secondary air through inlet ports 24, located near the top. With such an arrangement it is possible to obtain a somewhat increased efficiency in the combustion of the fuel over the simple form of well illustrated in Figs. 1 to 3 inclusive, and at the same time prolong the life of the refractory furnace walls by air cooling.

In Fig. 6 is illustrated a well furnace, in the walls of which are embedded tubes 25 for the circulation of cooling water. These tubes would ordinarily be connected in the water circulation system of the boiler, and water passing through them would reduce the temperature of the walls and serve to prolong their duration.

Although air or water cooled walls in accordance with the arrangements of Figs. 4, 5 and 6, may be used to extend the life of the refractories, it is to be observed that such cooling arrangements are by no means necessary to obtain economical and commercial operation. The refractory walls in the method of burning pulverized fuel described are not depended upon to ignite the fuel. As before pointed out, the fuel is ignited by the rapidly rotating flaming mass within the furnace walls and this flaming mass, or at least the high temperature portions thereof, are spaced from the furnace walls. Since, however, the walls are not used for ignition purposes, following the usual practice, this method of burning fuel lends itself admirably to an air or water cooling system for the walls, which may be kept down to a low temperature, and thus be made to serve for an indefinite time without replacement.

Fig. 7 illustrates the well furnace used in conjunction with a boiler furnace or secondary chamber, the well furnace being inverted and projecting through the roof or arch 26 of the chamber 18. In this arrangement the top end is closed as at 11*a* and the tubes 13 for the admission of fuel and air are positioned near the closed end. The opposite end opens into the chamber 18. During process of combustion in the well furnace, the ash particles are carried out by the rapidly rotating flame into the receiving chamber 18 and are removed through the clean-out doors 19.

In Fig. 8, the well furnace 10 is shown projecting above the floor of the chamber 18 as a still further modification in construction. In this form, the ash collecting on the inclined bottom floors 20 would be removed through the clean-out doors 19.

I claim:

1. In combination, a rectangular combustion chamber and a plurality of fuel burners, each disposed in a wall of the chamber adjacent a corner thereof, and adapted to project fuel into said chamber and against a stream of fuel coming from another burner, the burners being so disposed with relation to each other and to the chamber that the resultant of the intersecting streams will form a rotating mass substantially out of contact with the walls of the chamber, and means for adjusting said burners to vary the directions of said streams with relation to each other and to the chamber.

2. In combination, a combustion chamber and a plurality of powdered coal burners spaced from each other around the walls of the chamber and adapted to project fuel into said chamber, the burners being so disposed with relation to each other and to the chamber that the streams of burning coal intersect each other and the resultant forms a rotating mass substantially out of contact with the walls of the chamber, and means for adjusting said burners to vary the directions of said streams with relation to each other and to the chamber.

In testimony whereof I affix my signature.

GUSTAV HENRY KAEMMERLING.