June 27, 1933. M. H. MAWHINNEY 1,915,470

RECUPERATIVE SOAKING PIT FURNACE

Filed Sept. 16, 1930 4 Sheets-Sheet 1

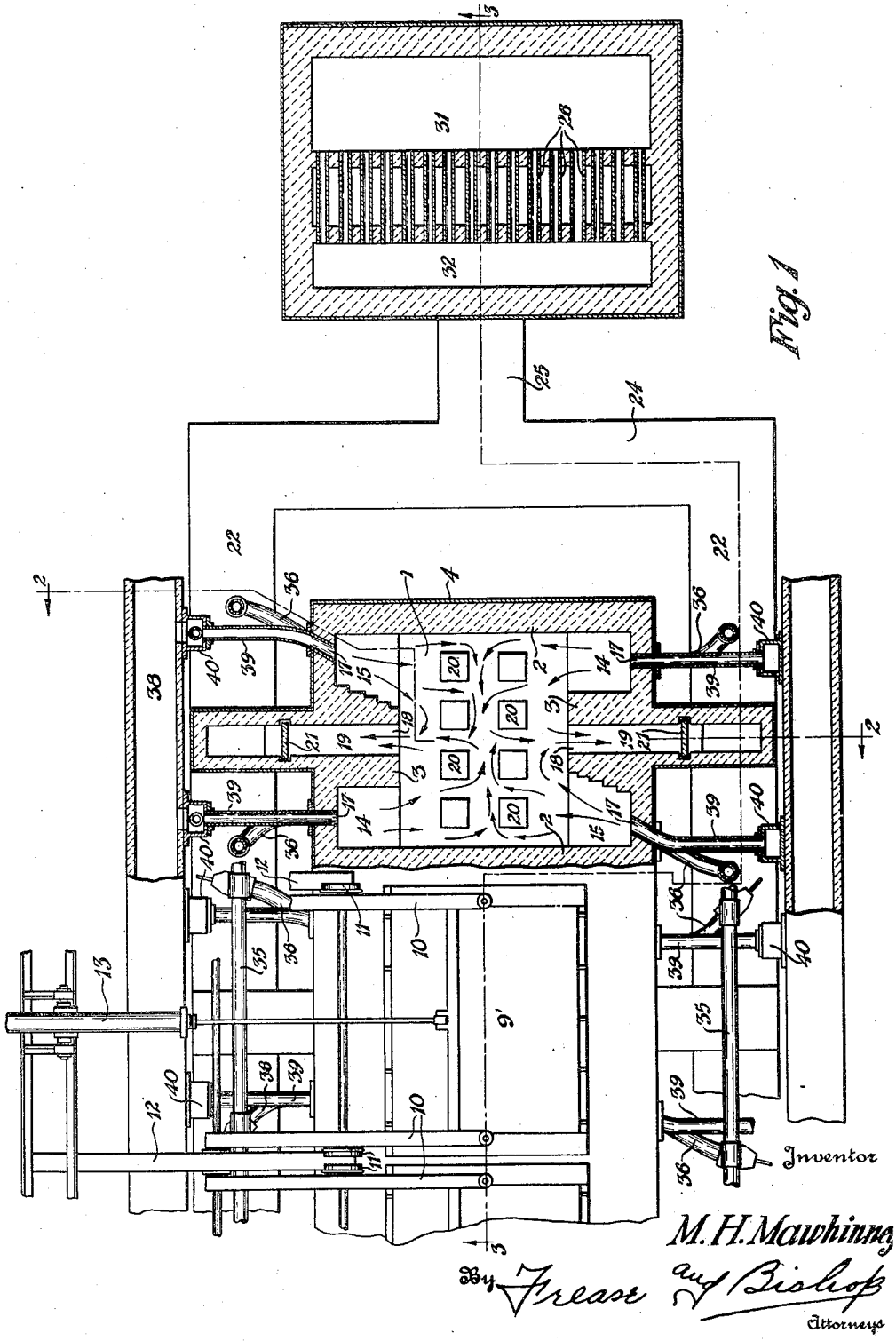


Fig. 1

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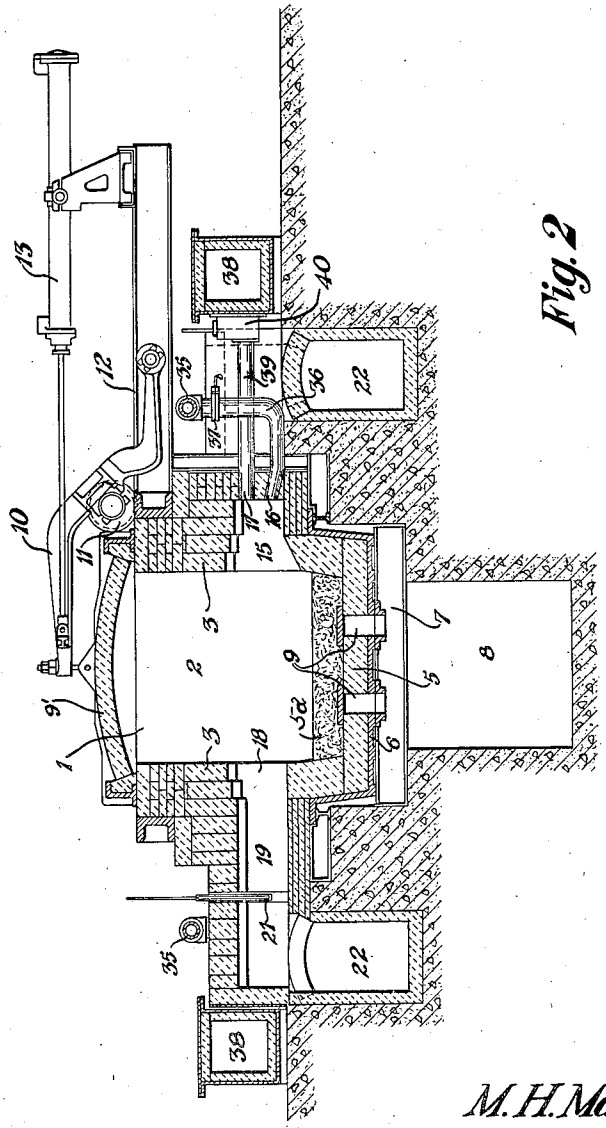


Fig. 2

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RECUPERATIVE SOAKING PIT FURNACE

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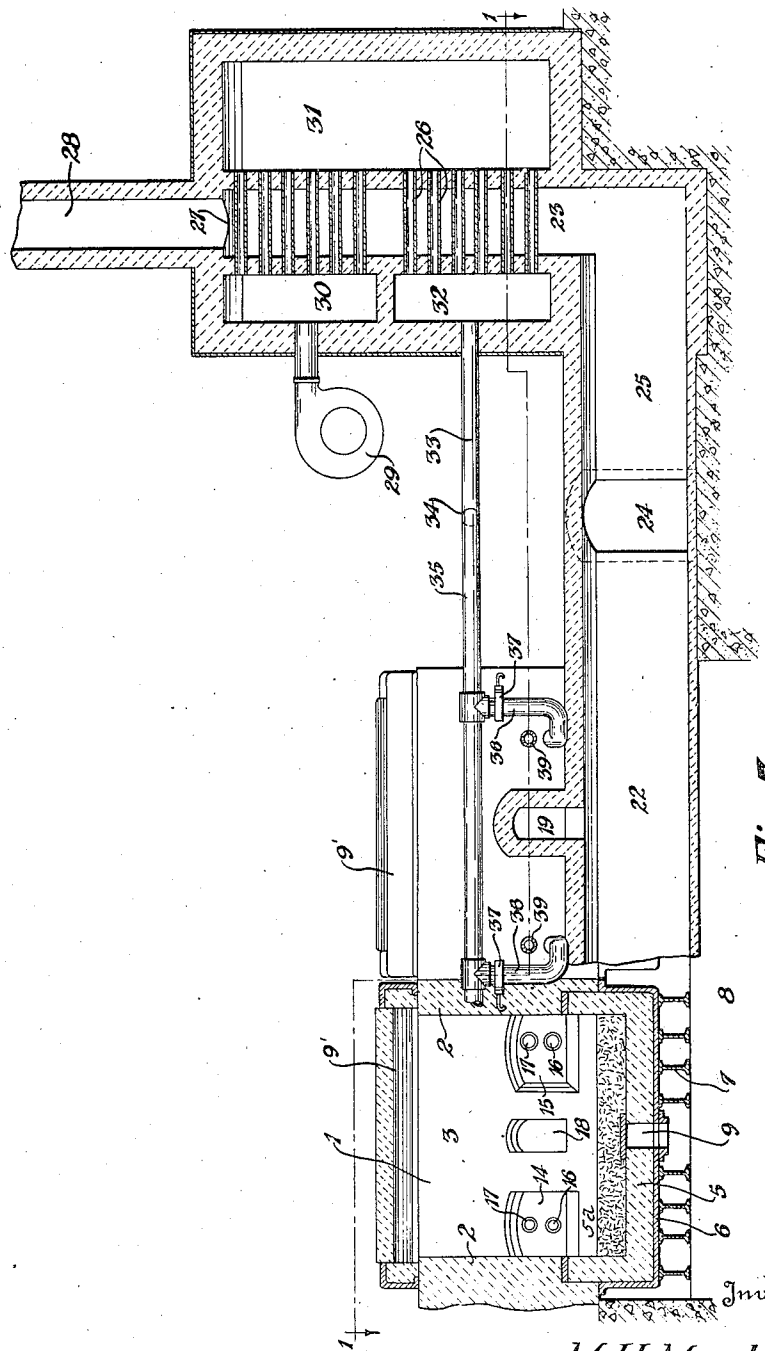


Fig. 3

June 27, 1933. M. H. MAWHINNEY 1,915,470

RECUPERATIVE SOAKING PIT FURNACE

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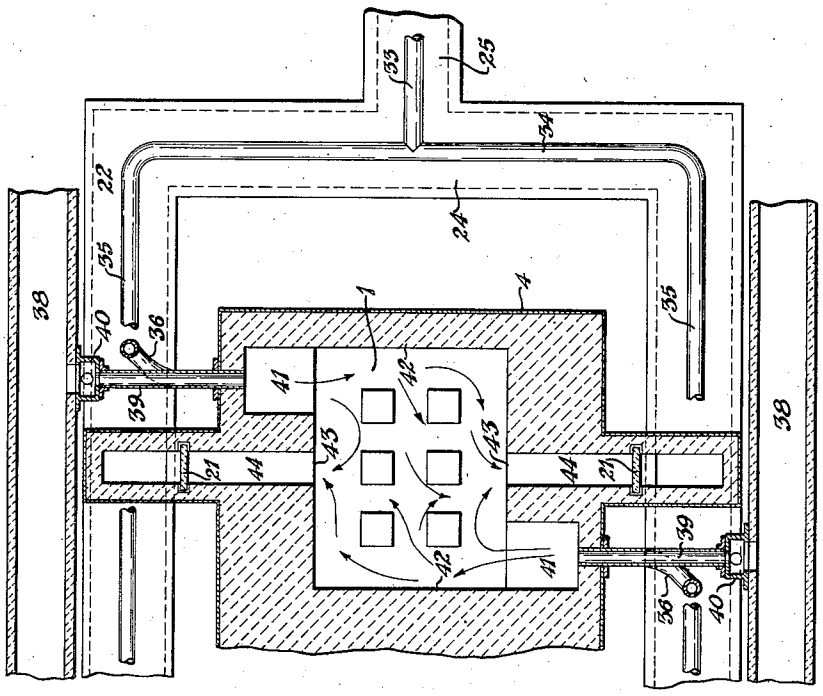


Fig. 4

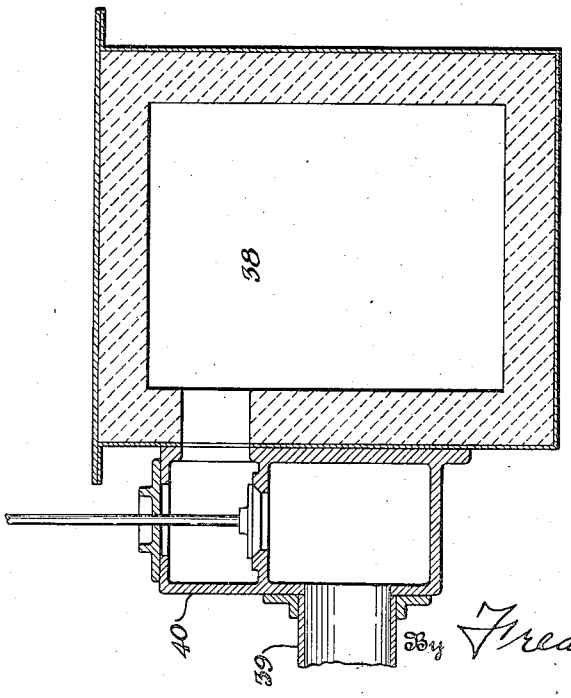


Fig. 5

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UNITED STATES PATENT OFFICE

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RECUPERATIVE SOAKING-PIT FURNACE

Application filed September 16, 1930. Serial No. 482,198.

My invention relates to soaking-pit furnaces such as are commonly used to bring steel ingots, after stripping, to the proper temperature for rolling, and more particularly to soaking-pit furnaces of the recuperative type wherein the products of combustion are led from the working chamber or hearth through a recuperator or continuous heat interchanger and there caused to give up a part of the heat they contain to preheat the air which is subsequently to be used for combustion.

An object of my invention is to employ in a recuperative soaking-pit furnace such an arrangement of the passages through which gas and air are admitted to and the products of combustion exhausted from the working chamber that the greatest possible advantage is taken of the natural convection currents of the hot gases in the said chamber to maintain uniformity of temperature.

A further object is to employ in a recuperative soaking-pit furnace such a disposition of the admission and exhaust passages as to cause the flames to encircle the ingots in the working chamber and avoid both injurious local overheating and the formation of dead spaces.

A still further object is to employ in a recuperative soaking-pit furnace such a relative disposition of admission passages as to produce a delayed mixing of fuel gas and air, so as to give a flame of soft rather than sharp character. This, in combination with the above-mentioned objects, makes possible the employment of highly preheated air without producing local overheating, and thus reduces the amount of fuel required.

Another object is to dispose the recuperator so that the natural upward draft of the hot gases passing therethrough will assist in evacuating the products of combustion from the working chamber.

Another object is to employ in a recuperative soaking-pit furnace means for controlling the admission of gas and air to, and the escape of the products of combustion from the working chamber, whereby the pressure within the working chamber may be regulated so as to improve the uniformity of temperature.

That these and other objects are accomplished in a recuperative soaking-pit furnace embodying my invention will be seen from the following explanation.

It is well known that for many years soaking-pit furnaces of the regenerative type have been used, each working chamber of such furnaces being equipped with duplicate pairs of regenerators filled with checkerwork for absorbing and storing heat from the products of combustion. In such furnaces air and gas are commonly supplied to the working chamber separately through one pair of regenerators, while the products of combustion are led out through the second pair. Means are provided for reversing the direction of flow periodically so as to employ the heat stored up by the checkerwork for preheating the incoming gas and air.

Because of the great space occupied by the duplicate sets of regenerators, the complicated and troublesome mechanism required for reversing the flow, and the high cost of maintaining the regenerators on account of damage from frequent heating and cooling, it is obviously desirable to substitute a simpler apparatus for the regenerators.

With this object, recuperators, or continuous heat interchangers, have been used. These occupy much less space than regenerators, require no reversing valves, are not subject to injurious temperature changes, and may be so employed as to recover a greater amount of heat than regenerators from the waste products of combustion.

Such recuperative soaking-pit furnaces as have so far been constructed, however, have been only partly successful, because of the impossibility of maintaining a uniform temperature throughout the working chamber. In certain of these furnaces the gas and preheated air are admitted through an efficient mixing burner or burners located in one wall near the top of the working chamber and the products of combustion are led out through a passage whose entrance is disposed in the same wall near the bottom of the chamber.

Because of the thorough mixing of air and gas, the flame is intensely hot, especially if the air is highly preheated. Since combustion is substantially completed in the region near the burner, and since this is located near the top of the chamber, the hottest gases tend to remain in the upper part of the chamber, producing a very unsatisfactory temperature difference between the top and bottom of the ingots in the chamber. The temperature near the wall in which the burner and exhaust passage entrance are located is also higher than that near the opposite wall.

These conditions make it necessary to construct the working chamber with relatively great depth so that no part of the ingots will be located in the zone near the burner, to employ a low rate of combustion in order to avoid damaging the tops of the ingots by local overheating, and to employ air preheated only to a relatively low temperature. Thus, the charging and removing of ingots is rendered more difficult, the time required for producing a satisfactory temperature uniformity is increased, extreme care in regulating combustion is necessary to avoid damaging the ingots, and the amount of fuel required is relatively large.

To overcome these and similar disadvantages of other recuperative soaking-pit furnaces, I dispose the ports or passages through which the gas and preheated air are admitted so as to enter the working chamber below the center thereof, and also locate the passages through which the products of combustion are led away near the bottom. I thus cause combustion to take place in a zone which would otherwise be relatively cooler than the top.

I also introduce the gas and heated air through burners embodying an ignition chamber located outside of and communicating with the working chamber proper, and so dispose the gas and air passages communicating with the ignition chamber that mixing is delayed and the resulting combustion is soft and gradual rather than harsh and intense.

I further dispose the burners and exhaust passages in an arrangement which is symmetrical when viewed from above, and direct them so as to produce a horizontal circulation generally in a rotary direction, thus causing all parts of the chamber to be reached and the ingots enveloped by gases of even temperature.

I provide means for regulating the pressure within the working chamber by dampers in the exhaust passages, thus permitting a pressure slightly above that of the outside atmosphere to be maintained. Since the top of the chamber is usually only imperfectly closed by the cover, it is evident that the escape of gases around the cover will permit gases from the zone of combustion to rise, thus improving the temperature uniformity rather than injuring it as is the case in pits fired by a burner near the top.

I prefer to use a recuperator in which the products of combustion flow in an upward direction, because such a recuperator may be made to occupy relatively little floor space and because the natural draft in it tends to assist in evacuating the products of combustion from the working chamber and through the recuperator, thus reducing the height of stack necessary to produce the desired flow. It will be understood, however, that I may use any convenient form of recuperator without departing from the scope of my invention.

An embodiment of the invention thus set forth in general terms is illustrated in the accompanying drawings, in which

Figure 1 is a plan view, partly in section, showing two working chambers of a multiple-chamber soaking-pit furnace embodying my invention, taken along the line 1—1, in Fig. 3;

Fig. 2, an elevation view, partly in section, taken along the line 2—2, in Fig. 1;

Fig. 3, a sectional elevation, taken along the line 3—3, in Fig. 1;

Fig. 4, a fragmentary sectional plan view, corresponding to Fig. 1, of the working chamber of a soaking-pit having an optional arrangement of burners and exhaust passages; and

Fig. 5, a vertical section through the regulating valves for the producer gas.

Similar numerals refer to similar parts throughout the drawings.

Referring to Figs. 1, 2, and 3, 1 is a working chamber, preferably of rectangular shape when viewed from above, and is enclosed by refractory walls 2 and 3, which may be built within an enclosing casing or shell 4. In a soaking-pit furnace having a plurality of working chambers built in one setting, the walls 3 are parallel to the common center line of the several working chambers, and the walls 2 are at right angles thereto.

The walls 3 may be termed "longitudinal walls" and the walls 2 "cross walls". The floor or bottom 5 is also composed of refractory material and may be covered with a bed of coke breeze 5a for protecting said refractory floor 5. The walls 2 and 3, and the floor 5 rest upon a base 6 supported as by beams 7 above a passageway 8. One or more tap holes 9 of any well known construction may be provided through the base and floor for the removal of any molten slag which may collect in the interior of the working chamber after continued operation. A roof or cover 9′ may be mounted on any suitable form of cover mechanism such as the arms 10, wheels 11, rails or guides 12, and hydraulic cylinder 13, so as to permit opening and closing the working chamber.

Located near the bottom of the working chamber and below the level of the top of a normal charge are recesses 14 and 15 in the walls 3, these recesses serving as ignition chambers in which combustion commences, and, in combination with the air inlet openings 16, and gas inlet openings 17, form burners, which direct the flames in a substantially horizontal direction into the lower portion of the furnace.

Located at substantially the same level are the openings 18 of passages 19 through which the products of combustion escape from the working chamber, these openings being also located in the walls 3.

The air and gas inlet passages entering two of the ignition chambers, as 14, are preferably directed substantially parallel to the walls 2, and those entering the other ignition chambers, as 15, are preferably directed away from the walls 2 at an angle thereto and toward each other as well as toward the center of the working chamber.

This arrangement in combination with the escape openings 18 serves to produce a flow of the hot gases in the working chamber as shown by the arrows in Fig. 1, so that the ingots 20 are enveloped and all parts of the chamber penetrated by moving gases.

The escape passages 19 are provided with regulating dampers 21 by means of which the pressure in the working chamber may be controlled. The passages 19 communicate with flues 22 which in turn lead to the chamber 23 of the recuperator, as by the cross passage 24, and the entrance passage 25.

The hot products of combustion flow upward in the chamber 23, passing around and between the tubes 26, which are formed of heat-conducting material capable of withstanding the temperatures to which they are subjected. Heat from the hot gases is absorbed by the tubes and transmitted through their walls to the air for combustion, which is caused to flow through them, thus preheating the air.

The waste gases escape from the chamber 23 as by an opening 27 which may communicate with a stack 28, the total height of the chamber 23 and stack 28 being such as to produce the desired draft for exhausting gases from the working chamber.

Air for combustion may be forced by a blower 29 into an air chamber 30 of the recuperator, thence through an upper set of the tubes 26 to a second air chamber 31, thence downward in chamber 31, and thence through a lower set of the tubes 26 to the air chamber 32.

From the chamber 32, the air, which has been preheated in passing through the tubes, may be carried to points conveniently near the burners, as by the air pipes 33, 34, and 35. Branch pipes 36, equipped with means for regulating the air flow, as dampers 37, may communicate with the pipes 35 so as to carry air to the air inlet openings 16 in the burners.

Gas may be led, as by the mains 38, to points likewise convenient to the burners, and branch pipes 39, connected to the mains, as through regulating valves 40, may carry the gas to the gas inlet openings 17.

The air and gas inlet openings 16 and 17 may be disposed as shown in Fig. 2, so as to produce relatively slow mixing of gas and air and consequent gradual combustion.

In Fig. 4, I show a modified arrangement of burners, such as may be desired in a soaking-pit of relatively small size. In this arrangement I may use two burners, shown generally at 41, each of which may consist of entrances for gas and air and an ignition chamber, being substantially as already described.

These burners may be directed substantially parallel to the walls 42, thus producing, in combination with the openings 43 of the exit passages 44, a circulation of the character shown by the arrows in Fig. 4.

I claim:

1. A recuperative furnace having walls forming a vertically disposed working chamber, means for admitting gas and air for combustion to the working chamber through two opposite walls at points near both of the lateral extremities of each of said walls, and means for the escape of products of combustion from the working chamber, said escape means being located between the admitting means in each wall, both the admitting means and escape means being at substantially the same level and below the top of a normal charge.

2. A recuperative furnace provided with walls forming a vertically disposed working chamber and ignition chambers in two opposite walls and communicating with the working chamber, means for admitting gas and air to the said ignition chambers, the admitting means communicating with one ignition chamber in each wall being directed parallel to an adjacent wall, the admitting means communicating with another ignition chamber in each wall being directed generally toward the center of the working chamber, and escape means located through each of said two walls between the ignition chambers.

3. A recuperative furnace provided with walls forming a vertically disposed working chamber and ignition chambers in two opposite walls and communicating with the working chamber, means for admitting gas and air to the said ignition chambers, the admitting means communicating with one ignition chamber in each wall being directed parallel to an adjacent wall and diagonally opposite to a similar chamber in the opposite wall, the admitting means communicating with another ignition chamber in each

wall being directed generally toward the center of the working chamber, and escape means located through each of said two walls between the ignition chambers.

4. A recuperative furnace provided with walls forming a vertically disposed working chamber and ignition chambers in two opposite walls and communicating with the working chamber, means below the level of the top of a normal charge for admitting gas and air to said ignition chambers, the admitting means communicating with one ignition chamber in each wall being directed parallel to an adjacent wall, the admitting means communicating with another ignition chamber in each wall being directed generally toward the center of the working chamber, and escape means located through each of said two walls between the ignition chambers and at substantially the same level as the admitting means.

5. A recuperative furnace provided with walls forming a vertically disposed working chamber and ignition chambers in two opposite walls and communicating with the working chamber, means below the level of the top of a normal charge for admitting gas and air to the said ignition chambers, the admitting means communicating with one ignition chamber in each wall being directed parallel to an adjacent wall and diagonally opposite to a similar chamber in the opposite wall, the admitting means communicating with another ignition chamber in each wall being directed generally toward the center of the working chamber, and escape means located through each of said two walls between the ignition chambers and at substantially the same level as the admitting means.

6. The combination with a soaking pit of a plurality of fuel injecting means in each of two opposite side walls, said means being set back from the pit proper and firing into expansion combustion chambers which converge from the pit toward said means, the axes of said chambers being at such angle to the side walls of the pit that the heating gases on entering the pit will tend to rotate about the vertical axis of the pit, and additional fuel injecting means in said two opposite side walls at diagonally opposite corners of the pit firing thereinto in a manner to assist in imparting a rotary motion to the heating gases, and means in said two opposite side walls and between the fuel injecting means for the escape of products of combustion from the pit, both the fuel injecting means and escape means being at substantially the same level and below the top of a normal charge.

7. The combination with a soaking pit which is rectangular in plan, of fuel injecting means in two opposite side walls of the pit delivering into the pit from each corner of the pit, one set of diagonally opposite means firing toward each other and the other set firing in a common plane and parallel to the end walls of the pit, and means in said two opposite side walls and between the fuel injecting means for the escape of products of combustion from the pit, both the fuel injecting means and escape means being at substantially the same level and below the top of a normal charge.

In testimony that I claim the above, I have hereunto subscribed my name.

MATTHEW H. MAWHINNEY.