Sept. 7, 1926. 1,599,165

H. H. CLARK

INTERMITTENTLY FIRED FURNACE

Filed May 6, 1922 5 Sheets-Sheet 1

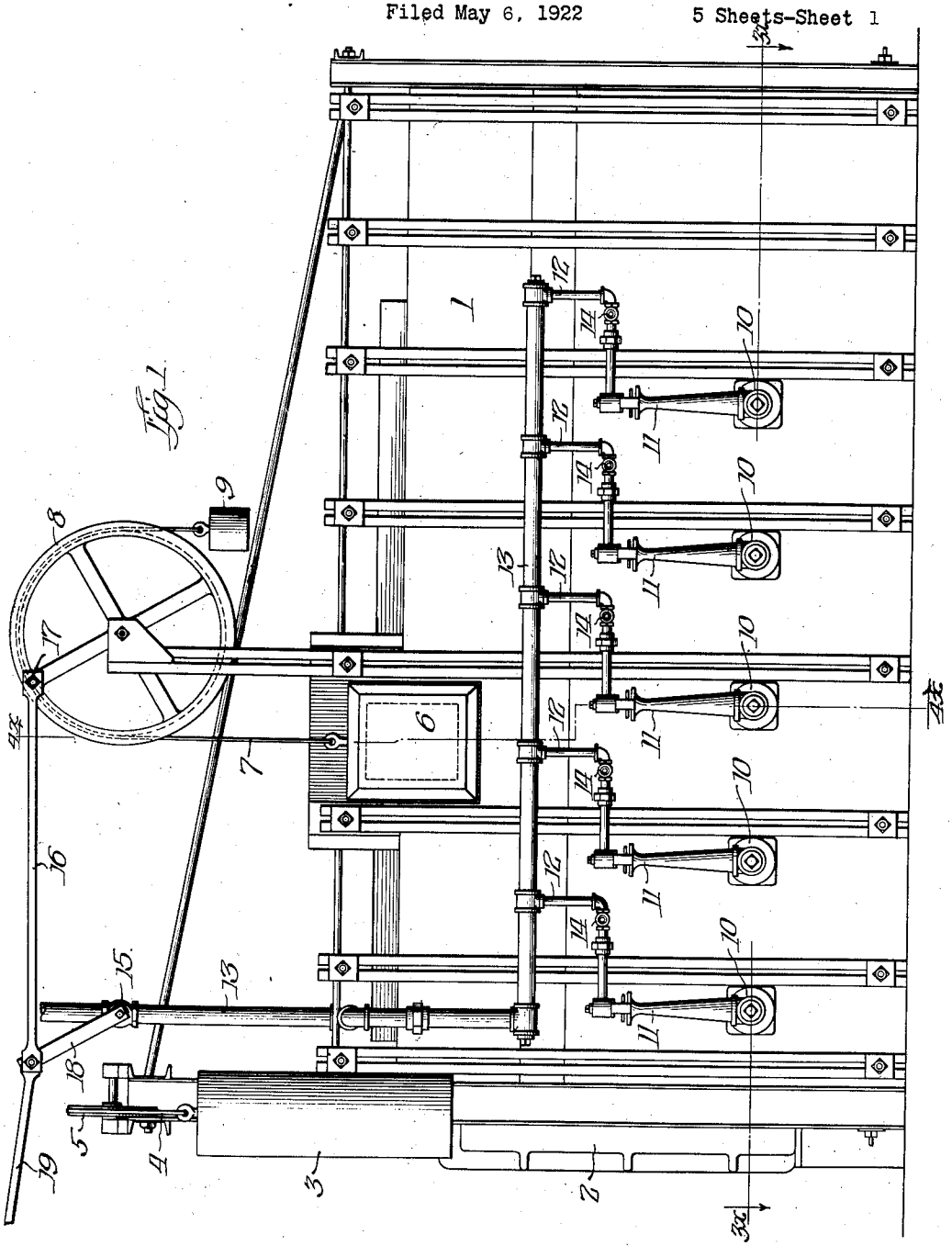


Fig. 1.

Witness:

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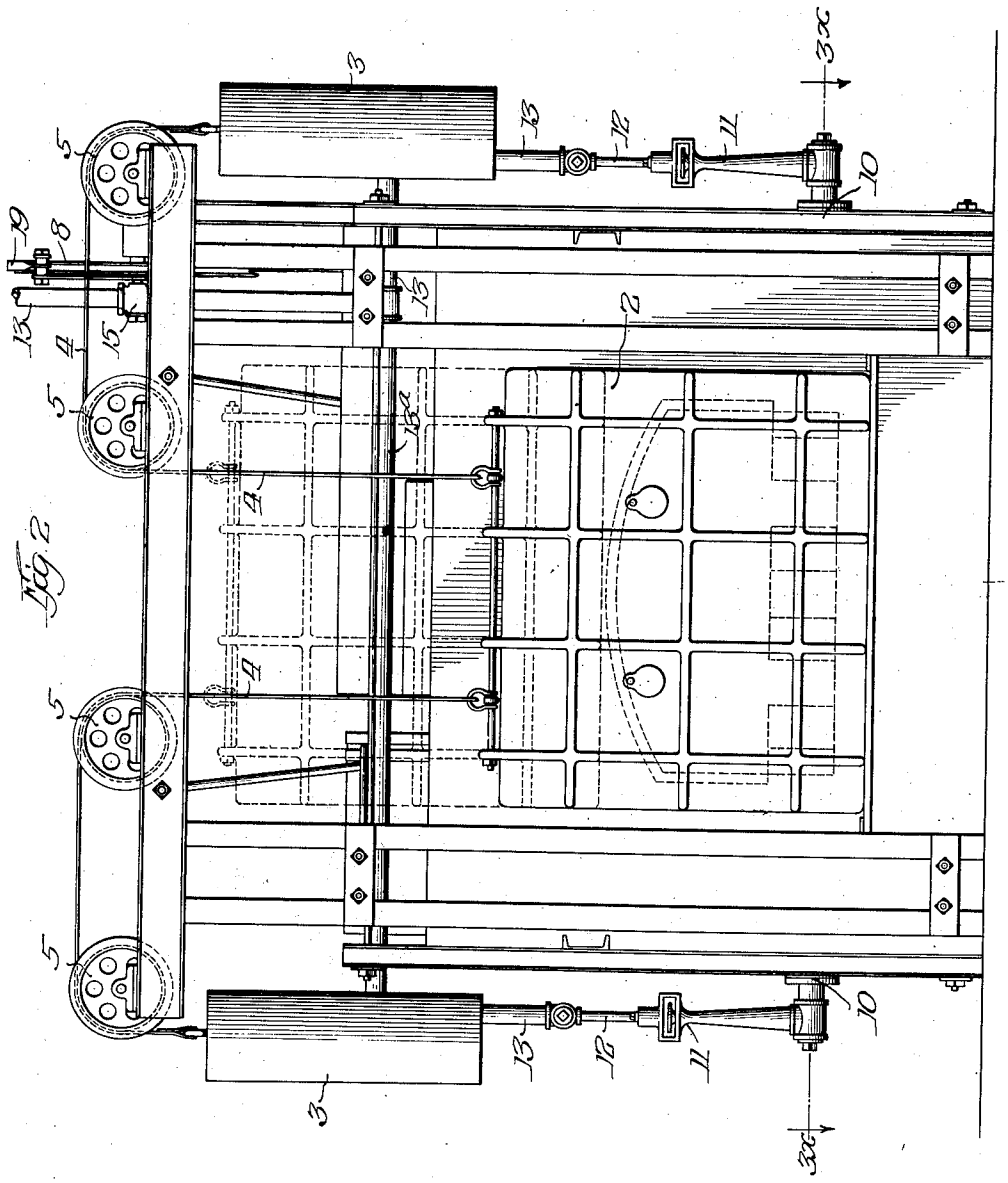


Fig. 2

Witness!

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Sept. 7, 1926. 1,599,165

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INTERMITTENTLY FIRED FURNACE

Filed May 6, 1922 5 Sheets-Sheet 3

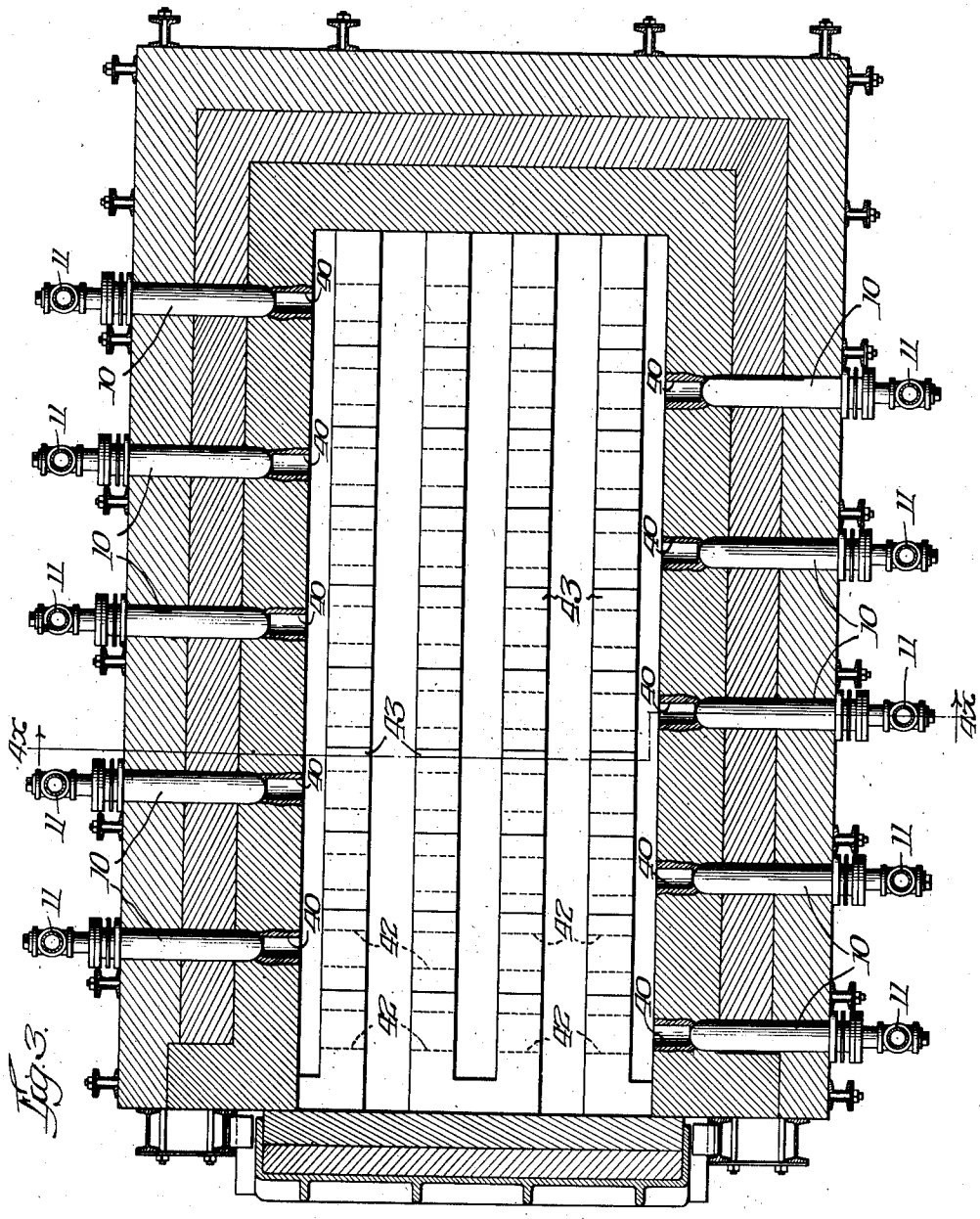


Fig. 3.

Witness:
Fred. C. Dorson.

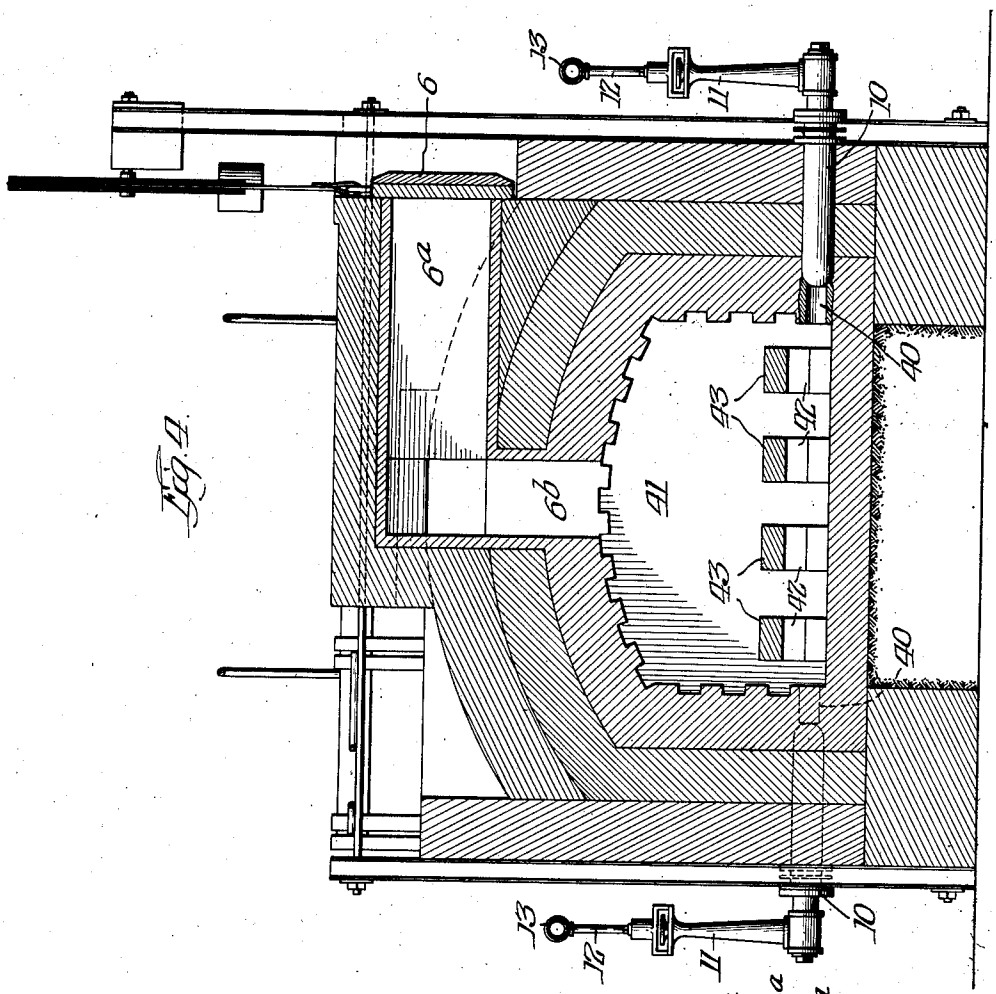
Inventor
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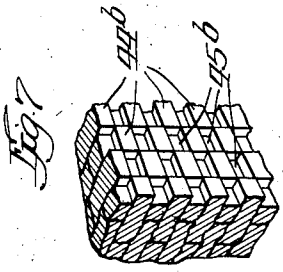
Sept. 7, 1926. 1,599,165

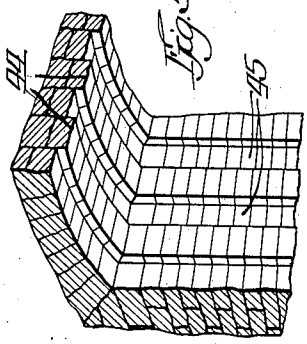
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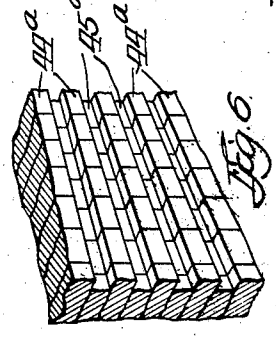
INTERMITTENTLY FIRED FURNACE

Filed May 6, 1922 5 Sheets-Sheet 4









Witness:
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Sept. 7, 1926. 1,599,165

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INTERMITTENTLY FIRED FURNACE

Filed May 6, 1922 5 Sheets-Sheet 5

Fig. 10

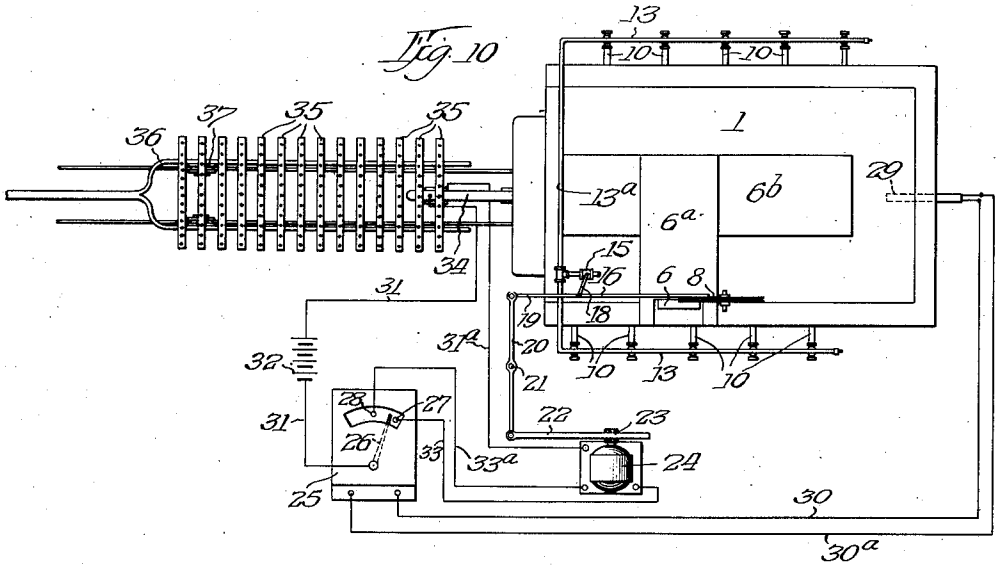


Fig. 8

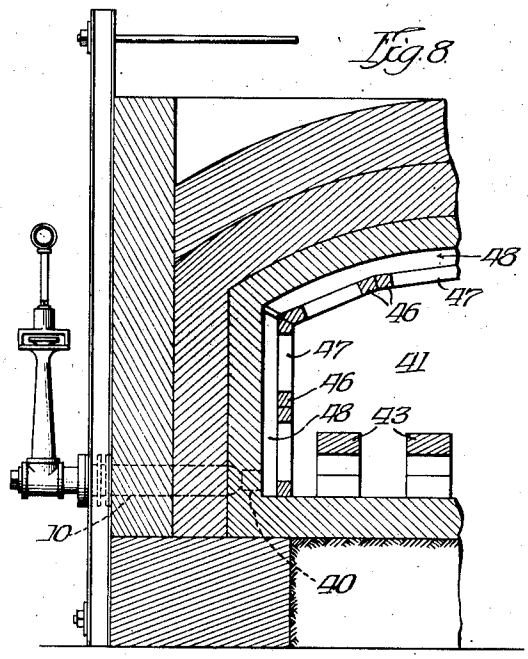


Fig. 11

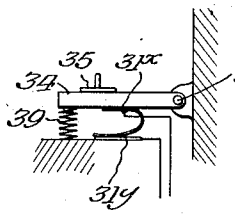
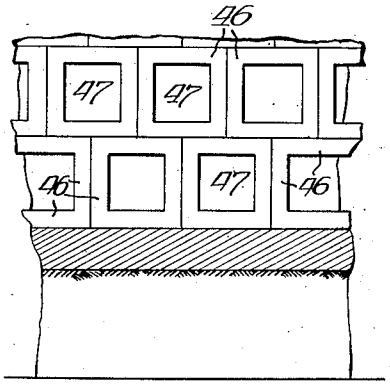


Fig. 9



Witness:

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Patented Sept. 7, 1926. 1,599,165

UNITED STATES PATENT OFFICE.

HORACE H. CLARK, OF OAK PARK, ILLINOIS.

INTERMITTENTLY-FIRED FURNACE.

Application filed May 6, 1922. Serial No. 559,108.

This invention relates to furnaces for subjecting materials and articles of manufacture to high temperatures in a relatively inert environment, and particularly to that class of such furnaces in which the products of combustion are delivered directly into the chamber which receives the goods to be heat treated, and, for the sake of avoiding ill effects of continued combustion during heat treatment, combustion is interrupted and the heating chamber is purged largely of products of combustion before each charge of goods is introduced, and heat stored in the walls of the chamber during the interval of combustion is given off to the goods during the interval of heat treatment, and the relatively immobile and inert furnace atmosphere can be maintained during the last-named intervals.

For the sake of economy in time and heat consumption in the operation of a furnace of this type, it is very desirable to be able to change from the heating interval to the charging interval with the utmost promptness, without residual combustion or unconsumed fuel mixture; also to return from the heat treatment interval to the combustion or heat storing interval with utmost promptness, either as an immediate sequence to the removal of the charge of goods, or preferably through automatic restoration of combustion whenever the temperature of the chamber falls to a predetermined degree, and provided the charge of goods is absent from the heating chamber; and one object of the present invention is to provide firing apparatus which will insure these conditions in the furnace operation.

Accordingly, one feature of the present invention consists in providing a furnace of the class described with burners adapted to supply fuel in fluid form along with an oxidizing agent, in such close proportions as will insure complete combustion, together with means for initiating and arresting the flow of fuel mixture through the burners instantly as the conditions demand; means being provided for coordinating the fuel controlling means and the flue controlling damper of the furnace in a manner to open the latter simultaneously with the initiation of combustion, and to close the same as combustion is arrested. A feature incident to the preferred embodiment of this part of the invention consists in utilizing burners of such character that immediately the flow of fuel is arrested, residual fuel within the burner will be at once consumed, as, for instance, by so-called back firing, so that there is no residual combustion taking place in the chamber, and the latter can be opened immediately for purging and introduction of the goods. Another feature incident to the preferred embodiment of this part of the invention consists in the provision of combustion chambers between the discharge ends of the burners and the heating chamber so that ignition and oxidation are practically complete before the gases leave the combustion chambers, and products of combustion alone circulate in the heating chamber.

Another object of the present invention is to insure prompt and uniform distribution of heat throughout the walls of the heating chamber; and to this end, another feature of the invention consists in arranging the burners as a plurality of units distributed along the sides of the furnace and discharging their products of combustion across the bottom of the heating chamber through tunnels constructed transversely of the piers that support the goods, and into impingement against the walls of the chamber opposite the burner; the burners on opposite sides of the furnace and the tunnels through which they discharge, being alternated in position so that a burner on one side discharges its hot gases between the lines of two opposite burners, and the gases are thus distributed uniformly and in rising columns up along the opposite inner walls of the chamber and across the roof to the escape flue.

Another object of the present invention is to so construct the inner walls of the heating chamber in an intermittently fired furnace, that the area through which the walls alternately absorb and radiate heat will be greatly enlarged in proportion to the capacity of the heating chamber. Accordingly, another feature of the present invention consists in constructing the inner wall of the heating chamber with recesses, pockets, grooves, channels, or the like, all with an internal chamber that develops inner superficial heat absorbing areas communicating with the heating chamber through the medium of such recesses, apertures, or the like,

and causing hot products of combustion to escape into and traverse the inter-wall space thus provided, in escaping to the flue.

Still another object of the invention is to provide means whereby the previously mentioned automatic initiation and arrest of combustion can be effected through the medium of a pyrometer or thermo-couple, and only when the goods are removed from the furnace. Accordingly, another feature of the invention consists in providing a reversible motor for turning on and off the fuel and simultaneously actuating the flue damper, controlling the circuits of this motor by a limiting pyrometer, and introducing into the controlling circuit a circuit closer that is responsive to the presence, on the outside of the furnace, of a rack-bar or other means through which the goods are conveyed into and out of the furnace.

In order that the invention may be fully understood, the preferred embodiment of the several features thereof is shown in the accompanying drawings, in which—

Figure 1 is a side elevation of a furnace equipped with certain of the features of the invention.

Figure 2 is a front elevation of the same.

Figure 3 is a horizontal section of the same on the line 3^x—3^x of Figures 1 and 2.

Figure 4 is a vertical transverse section on the line 4^x—4^x of Figures 1 and 3.

Figures 5, 6, and 7 are detail perspective views showing different constructions of channelled, grooved, or recessed inner walls of a heating chamber.

Figures 8 and 9 are fragmentary views showing, respectively, in vertical transverse section and in elevation, a construction of false inner wall adapted to develop with the main inner wall of the heating chamber an interior space connected with the heating chamber through means of recesses, apertures, or the like, in order to still further enlarge the heat-absorbing areas.

Figure 10 is a schematic view showing an electrical installation suitable for controlling the combustion by a pyrometer, and subjecting such control to the location of the vehicle which accompanies the goods into and out of the heating chamber.

Figure 11 is a detail view of a circuit closing switch suitable for use in the installation illustrated in Figure 10.

1 represents a furnace which may be of known construction, 2 the door thereof, and 3 counterbalances controlling the door through the medium of flexible connectors 4 passing over pulleys 5. 6 represents a damper adapted to control the escape flue 6^a which communicates with the uptake 6^b through which products of combustion escape; and this damper 6 is controlled by flexible connector 7 passing over pulley 8 to a counterbalance 9. 10 represents burners introduced horizontally through the sides of the furnace at a level slightly above the bottom of the heating chamber, as hereinafter explained, and in such positions on the opposite sides of the furnace that the burners on one side alternate the lines of their discharge with the burners on the other side. Each burner 10 is provided with a known construction of fuel mixing attachment 11 which has the function of intermingling with the gaseous fuel with substantial exactness the quantity of oxidizing medium (in the present instance air) required for complete oxidation of the fuel, so that ignition can be rendered substantially complete within a very short distance of the end of the burner and substantially before the gases enter the heating chamber, as hereinafter explained. Each fuel conditioning device 11 is supplied with fuel through a branch pipe 12 leading from a gas main 13; and each branch pipe 12 has a controlling valve 14 through means of which to regulate the fuel apportioned to the respective burners, so that by opening and closing the supply of fuel through the main 13, and through a single instrumentality, the burners may be collectively controlled, and each will perform in exact accordance with its individual adjustment. The burners collectively will thus insure proper distribution of heat units throughout the heating chamber.

As will be seen upon reference to Figure 2, the mains 13 on the respective sides of the furnace, are connected through a cross-over pipe 13^a so that a single fuel control may serve for both groups of burners. As a means for supplying and arresting fuel in the main 13, a valve 15 is employed, and this valve is controlled in common with the damper 6 through the medium of an arm 16 which is connected with the sheave 8 at 17, and with the valve 15 through the medium of an arm 18. 19 represents a connecting element intended to lead to any point of control which may be manual, as when the operatives watch a reading pyrometer and turn on and off the gas at the proper intervals, or automatic in case of use of the electrical system hereinafter described. In either case, longitudinal reciprocation of rod 19 will simultaneously open the damper 6 and valve 15, or simultaneously close said elements. Ignition of the fuel mixture discharged from the burners 10 follows automatically the release of the fuel, in consequence of the presence of hot surfaces with which the fuel mixture contacts, as hereinafter described.

Referring to the automatic pyrometer control for the valve 15 and damper 6, as shown in Figure 10, 20 represents a lever pivoted at 21, connected at one end to the rod 19 and at its other end to a rack-bar 22

which receives the pinion 23 of a reversible electric motor 24. 25 represents a pyrometer of standard commercial construction, the arm 26 of which is adapted to contact with terminal 27 on the attainment of a predetermined upper limit of temperature, and with a terminal 28 on the attainment of a lower limit; and this pyrometer is controlled by the thermo-couple 29 of any standard construction through the medium of a circuit 30, 30^a. Pyrometer arm 26 controls circuit 31, 31^a which includes a source 32 of electric current that supplies the motor 24. Contacts 27, 28 constitute terminals in the reversing circuit 33, 33^a of the motor 24, so that current is supplied to the motor in one direction or the other as the arm 26 reaches a contact, and according to the particular contact which it reaches. To render the circuit 31, 31^a inoperative so long as goods are in the heating chamber of furnace 1, the conductors of said circuit are so involved with the circuit closer 34, lying in the path of the rack-bars 35 which serve as a vehicle for the introduction of the goods into the furnace, that so long as the rack-bars are in the furnace, whither they are introduced by the conventional charging fork 36 pivotally mounted on truck wheels 37, the circuit closer 34 will be open and motor 24 cannot act to shift the lever 19 of the heating apparatus. But whenever the rack-bars 35 are out of the furnace and resting upon the circuit closers 34, the circuit 31, 31^a will be operative to energize the motor 24 whenever the thermo-couple 29 moves the contact 26 to either of the terminals 27, 28.

Any suitable construction may be employed for the circuit closer 34. According to Figure 11, this may consist of a frame-like member 34 pivoted at 38, held normally elevated by spring 39 to a plane above that to which it will be depressed by the rack-bars 35, and having resilient terminal 31^x depressed upon contact 31^y whenever the rack-bars rest upon the frame 34.

In order to control combustion and insure ignition upon release of fuel mixture from the burners 10, and discharge the gases into the heating chamber as completely oxidized products of combustion, combustion chambers 40 are arranged between the discharge ends of the burners 10 and the heating chamber 41 of the furnace. These combustion chambers consist of thimbles or flue liners of highly refractory material adapted to store sufficient heat from one period of combustion to ignite the fuel mixture when it is released for an ensuing period of combustion. In alignment with each combustion chamber 40 is a tunnel 42 formed through a series of piers 43 upon which the rack-bars 35 rest while supporting the goods within the chamber 41, and these tunnels extend preferably to the opposite wall of the heating chamber, the burners and their aligned tunnels as already described being located on alternating lines so that the main body of hot gas or products of combustion from each burner passes across the opposite wall and arises thence in close impingement against the walls and against the roof of the chamber until it escapes through the uptake 6^b into the flue 6^a and past the damper 6, as already described. Of course, appreciable portions of the hot gases by reason of their expansion will rise between the piers and circulate in the main space of the chamber 41, but the directing and impinging action of the burners described will insure high efficiency in heat transferring contact between the gases and the walls of the chamber.

In order to enlarge the absorption capacity of the walls of the chamber 41, they are, as already stated, provided with some form of channel, groove, recess, pocket, or the like which greatly increases the superficial heat absorbing area. One form of wall construction having this result is shown in Figure 5, wherein 44 represents vertical ribs or pilasters merged into sealing ribs or arches and develop between them vertical flue like channels 45 through which the gases will flow in reaching the uptake 6^b. These structural members 44 obviously increase the superficial heat absorbing area of the heating chamber walls to an extent represented by their dimension perpendicular to the wall, multiplied by their total length, which obviously will provide a very substantial increment in the heat absorbing surface.

According to Figure 6, horizontal ribs or ledges 44^a are provided in a manner to form horizontal grooves 45^a which will trap the upwardly flowing impinging sheet of gases, and by eddy currents cause impingement thereof against the increased superficial areas provided.

According to Figure 7, the protruding portions of the wall are in the form of limited rectangular members 44^b in the nature of checker-work, leaving segregated pockets 45^b among them in a manner to afford an increment of superficial area at least equal to that attained by the constructions of Figures 5 and 6.

When it is desired to get a very large increase in heat absorbing and radiating surface, as, for instance, where the furnace is used for heating bodies of relatively large mass, for instance, in the enameling of bath tubs, and the heating interval has to be continued for a proportionately longer time, I prefer to employ a lining or false wall 46 in the chamber 41, with its area largely apertured, as, for instance, by openings 47, thereby providing a recess 48, the walls of which, as well as the surfaces which define the openings 47, constitute heat absorbing

surfaces, impingement against which by the hot gases is induced by the communication of the recess 48 with the escape flue 6^a, 6^b. The liner or false wall 46 may be constructed of frame-like tile, such, for instance, as the tile commonly used to build muffles in enameling or annealing furnaces, but with the thin panels of such tile wholly removed in order to provide the openings 47.

In the operation of the furnace, the valve 15 and the damper 6 will be first opened by hand, fuel mixture ignited at one or more of the burners, and the main door 2 closed. Combustion will then proceed at all the burners and will restrict itself to the combustion chambers 40 until the inner walls of the furnace have absorbed sufficient temperature, when the furnace can be left to automatic heat control, which will shut the valve 15 and damper 6. The goods are arranged upon the rack-bars 35 (Figure 10), the furnace door 2 is opened, the rack-bars containing the goods are introduced through means of conventional fork 36, the fork is withdrawn, and the door 2 is closed. The goods will be permitted to remain for a time interval predetermined by experience, when the door 2 is opened and the goods withdrawn. As soon as one or more of the racks 35 rest upon the frame 34 of the circuit closer, the motor circuit 31, 31^a will be closed so that if the arm 26 of the pyrometer 25 has in the meantime moved into contact with terminal 28, motor 24 will be actuated in the direction to open the valve 15 and flue 6 and restore combustion. Under ordinary conditions, with the efficiency of the burner and hot gas distribution herein described, temperature will be restored and arm 26 will move to contact 27 and close the circuit through the motor 24 in the direction to arrest the fuel and close the damper 6 while the charge of finished goods is being removed from the rack-bars 35 and a new charge of goods to be baked arranged thereon. In this way the furnace will be kept at proper temperature without attention on the part of the operatives.

If at any time the goods should be left in the furnace until the temperature drops below the point developing contact between arm 26 and low temperature terminal 28, the ignition cannot be restored because of the absence of the rack-bar 35 over the circuit closer 34; but as soon as the goods are removed and the circuit closer 34 is depressed by the presence of a rack-bar thereon, restoration of furnace temperature will automatically ensue.

Scavenging or purging the heating chamber 41 of products of combustion results automatically from raising of the door 2 which, as suggested by the dotted outline of the heating chamber in Figure 2, will arise above the crest of the crown of the arch and leave a free opening for the inrush of cold air between the piers 43 and the upward displacement and outflow of products of combustion. Cutting off of the fuel mixture in the burners 10 results in immediate arrest of combustion because oxidation is practically complete before the mixture leaves the combustion chambers 40. Re-ignition, however, will take place immediately upon restoration of the flow of fuel mixture because of the heat stored up in the refractory liners 40. Even the fuel mixture contained in the conditioning devices 11 will be consumed at the interruption of fuel supply, because the mixture is combustible at the upper ends of these devices and back firing will result as soon as the momentum of fuel mixture is arrested.

I claim:

1. A furnace for subjecting materials to heat under inert environment, comprising a closed chamber in which the materials are heated, a plurality of fuel burners having air-tight connection with and delivering products of combustion into said chamber, and a master control for all of said burners adapted to completely arrest and re-establish supply of fuel thereto; said burners being provided with ignition chambers adapted to re-ignite fuel when restored thereto.

2. In an intermittently fired furnace for subjecting materials to heat under inert environment, a plurality of burners, a closed heating chamber with which said burners have air-tight connection, connections for supplying said burners with a mixture of fuel and oxidizing medium for said fuel, said burners having ignition combustion chambers which deliver products of combustion to said furnace; and a furnace temperature actuated single master control adapted to completely arrest and release fuel to said burners.

3. In an intermittently fired furnace for subjecting materials to heat under inert environment a closed heating chamber, a plurality of burners fitted air tight into the wall of the furnace and having ignition chambers adapted to ignite fuel delivered thereto and through which the respective burners deliver into the interior of the heating chamber, means for delivering fuel to the burners, means for automatically mixing air with the fuel so delivered, in advance of its discharge into the ignition chambers, a furnace-temperature actuated master fuel supply valve opening and closing to supply and completely interrupt flow of fuel, a flue cutoff, and means connecting said flue cutoff and fuel supply valve to enforce opening and closing of the same in unison.

4. In an intermittently fired furnace for subjecting materials to heat under inert environment, a plurality of fuel burners hav-

ing ignition chambers with which said burners have air tight connection and through which they deliver burning gases, enclosed heating chamber receiving said gases from said ignition chambers, and a master fuel supply control for all of said burners adapted to completely arrest and restore supply of fuel thereto; said ignition chambers being constructed with ignition liners that store heat above the ignition point of the fuel and cause re-ignition of the fuel when restored to the burners by the master control.

5. In a furnace for subjecting materials to heat under inert environment, a heating chamber, a fuel supply for said heating chamber, an electric motor adapted to control said fuel supply, circuits for said motor, a pyrometer controlling said circuits, means for charging materials to be treated, into the furnace, and a circuit closer also controlling said circuits and which is in turn controlled by the furnace charging means.

6. In a heat treating furnace, furnace charging means adapted to assume positions either within or out of the furnace, burners for heating said furnace, means controlling the operation of said burners and means whereby the control of the burners is made dependent upon the position of the furnace charging means.

7. In an intermittently operated furnace for subjecting materials to heat under inert enviroment, burners for heating the furnace, fuel delivery controlling-means for said burners, and means whereby said controlling means is rendered ineffective to deliver fuel while a charge of material is in the furnace.

Signed at Chicago, Illinois, this 29th day of April, 1922.

HORACE H. CLARK.

