

Nov. 11, 1941.

J. D. KELLER

2,262,609

FURNACE FOR COATING BATHS

Filed June 27, 1940

5 Sheets-Sheet 1

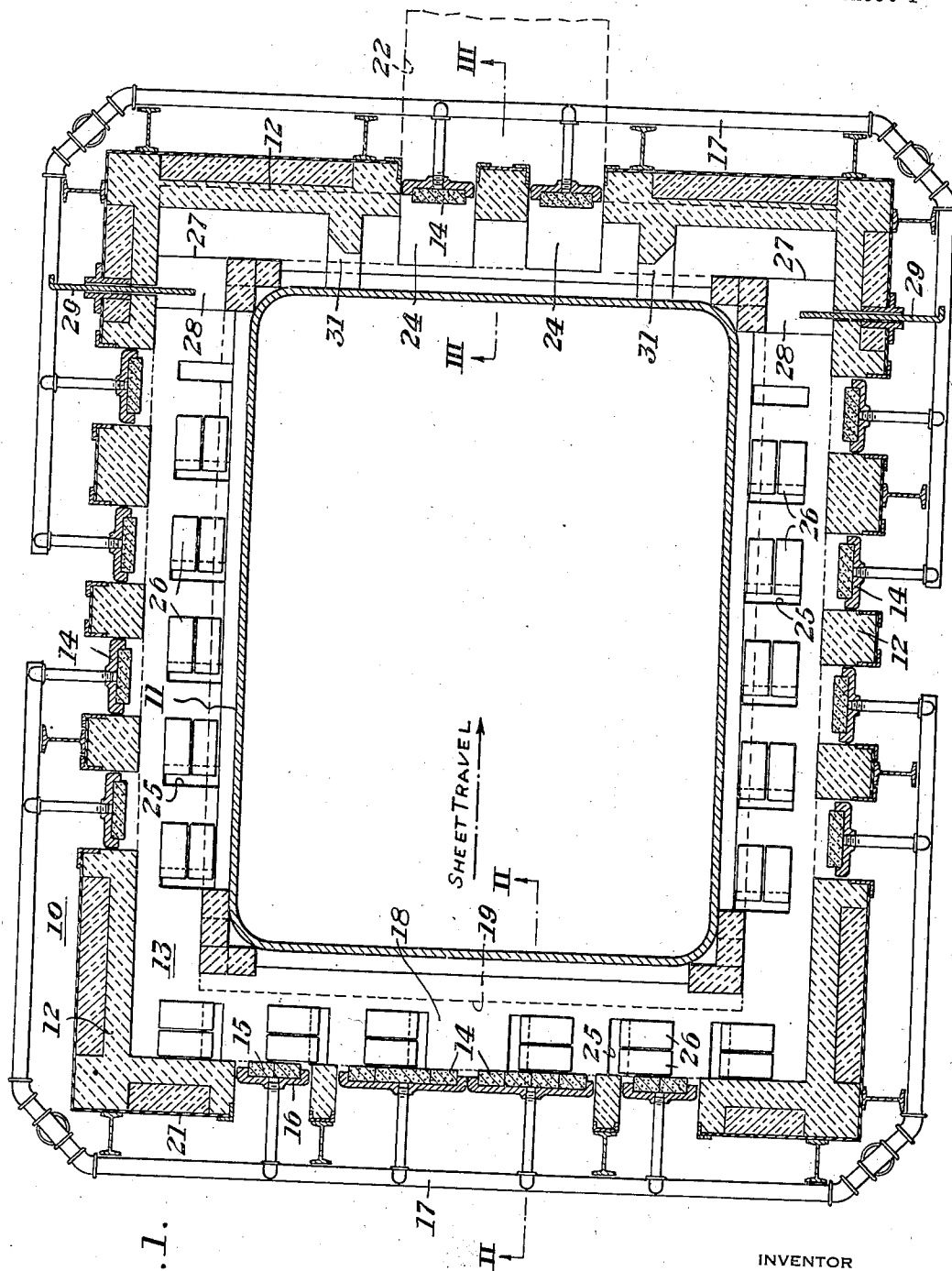


Fig. 1.

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Fig. 5.

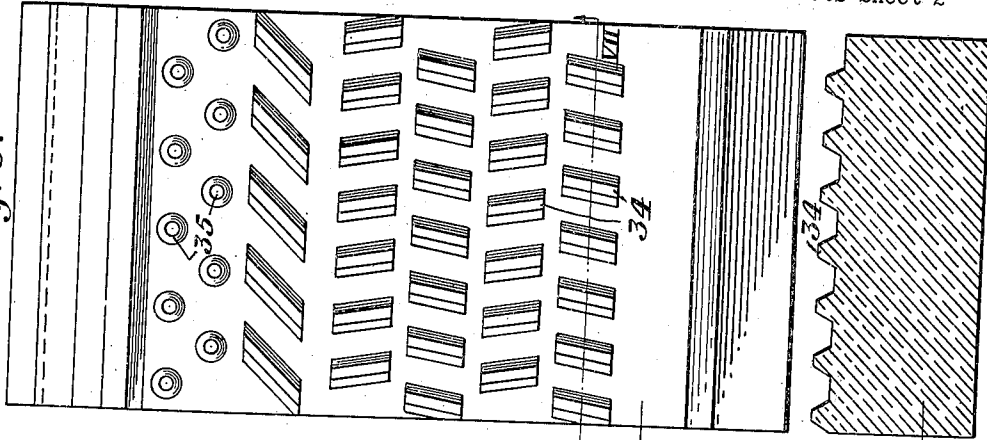


Fig. 6.

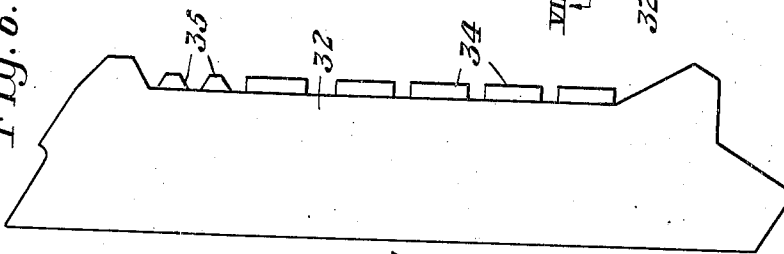


Fig. 7.

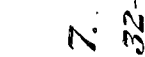
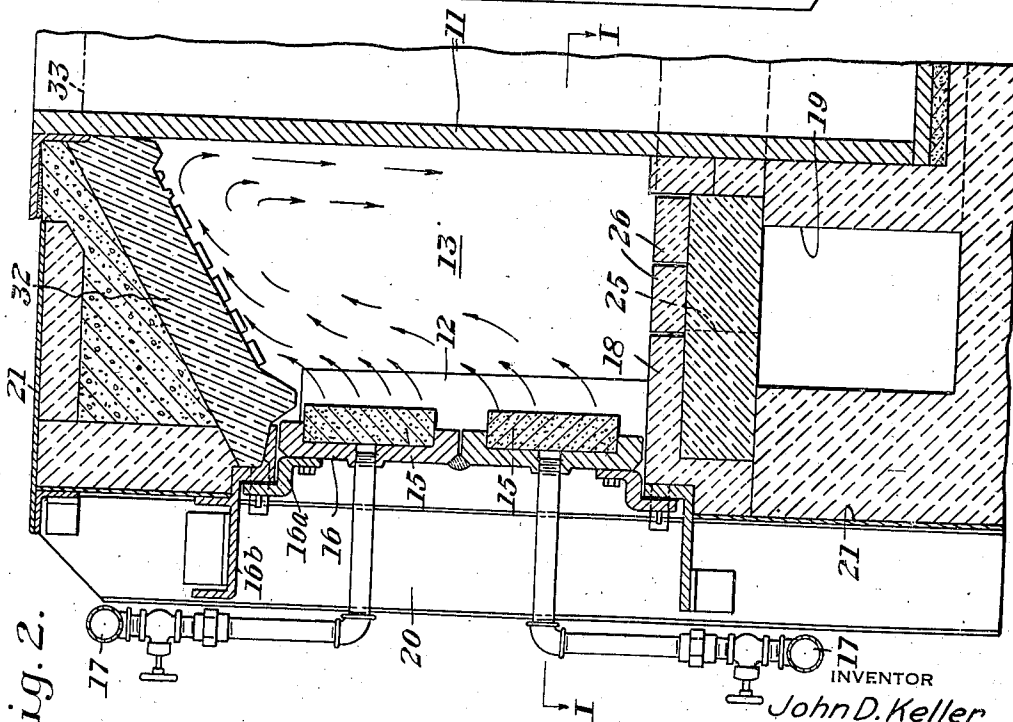


Fig. 2.



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Fig. 4.

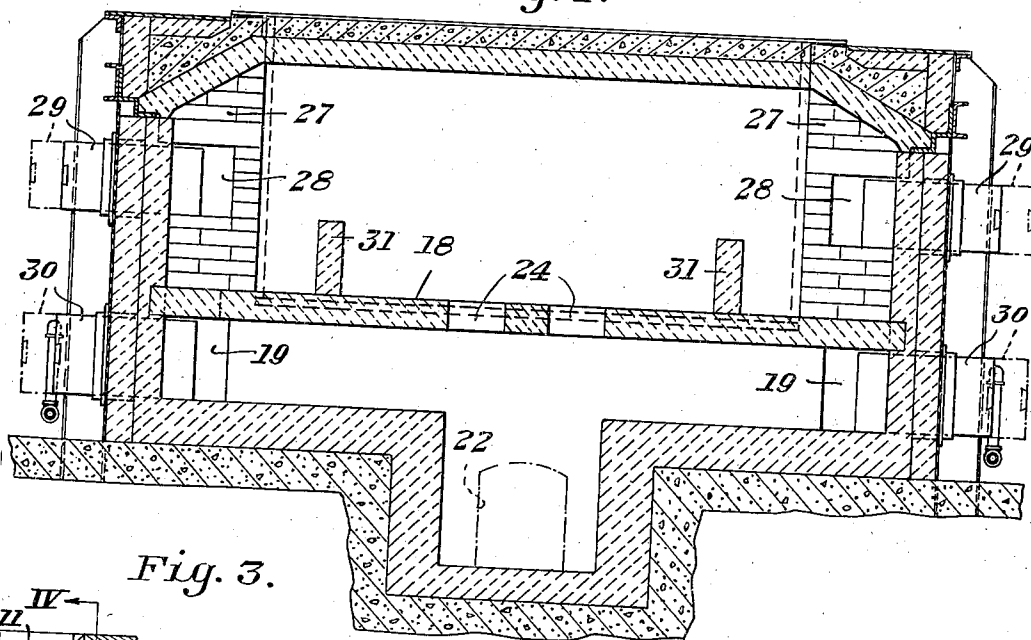


Fig. 3.

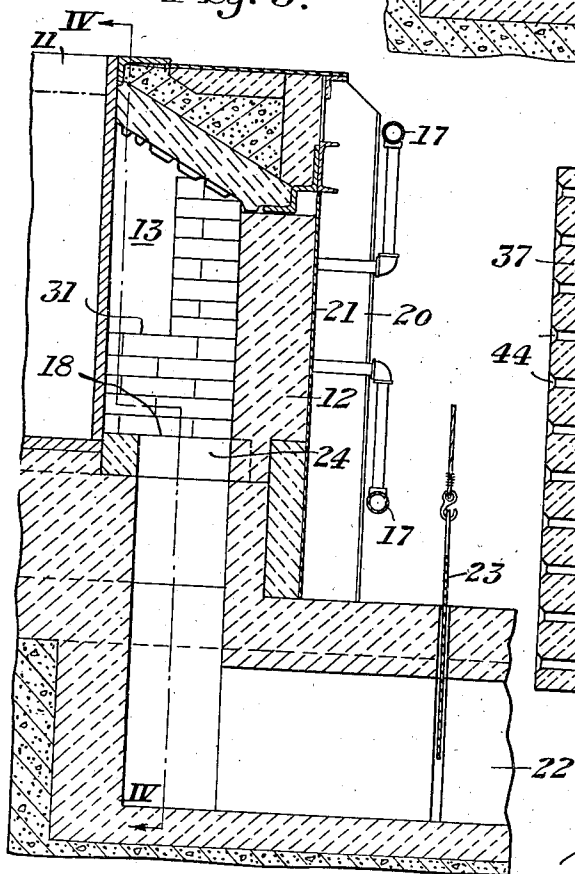


Fig. 10.

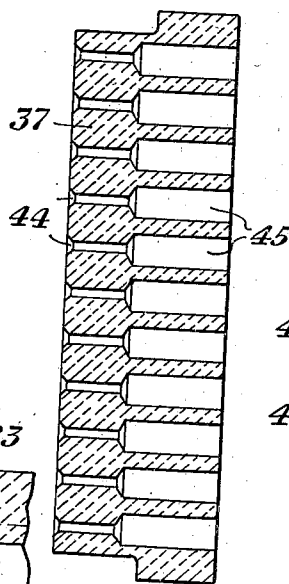
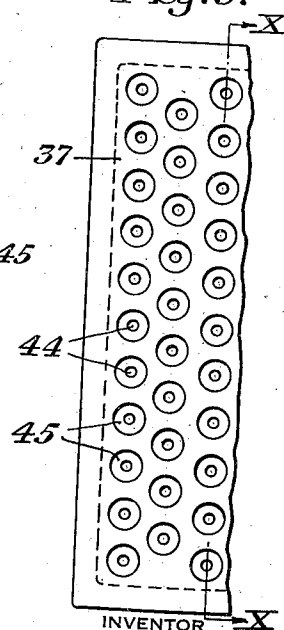


Fig. 9.



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Fig. 11.

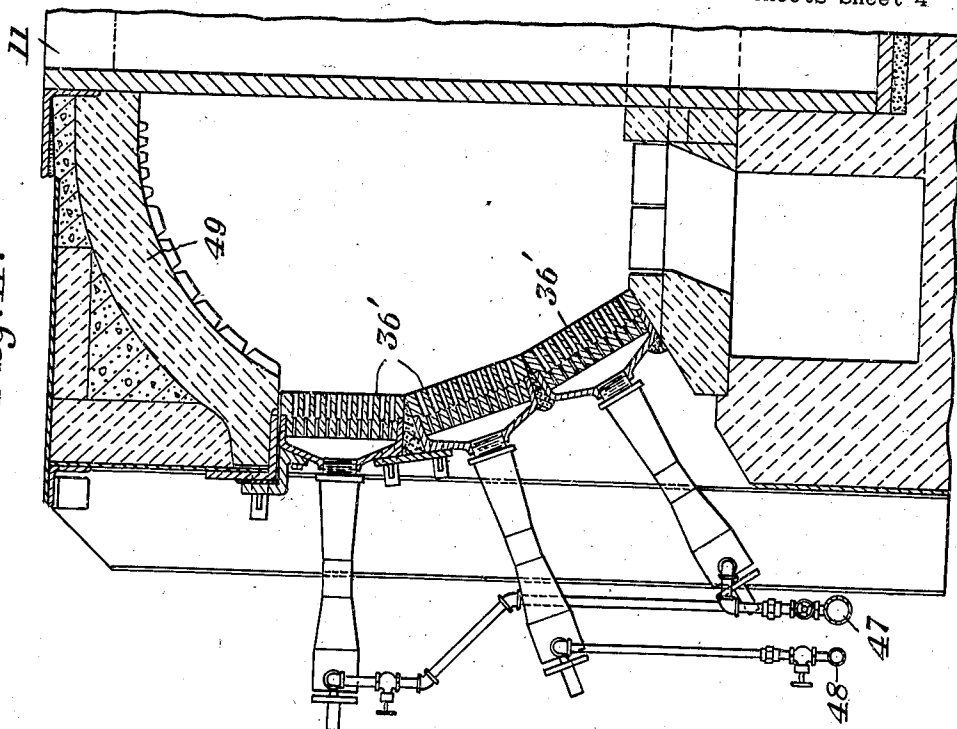
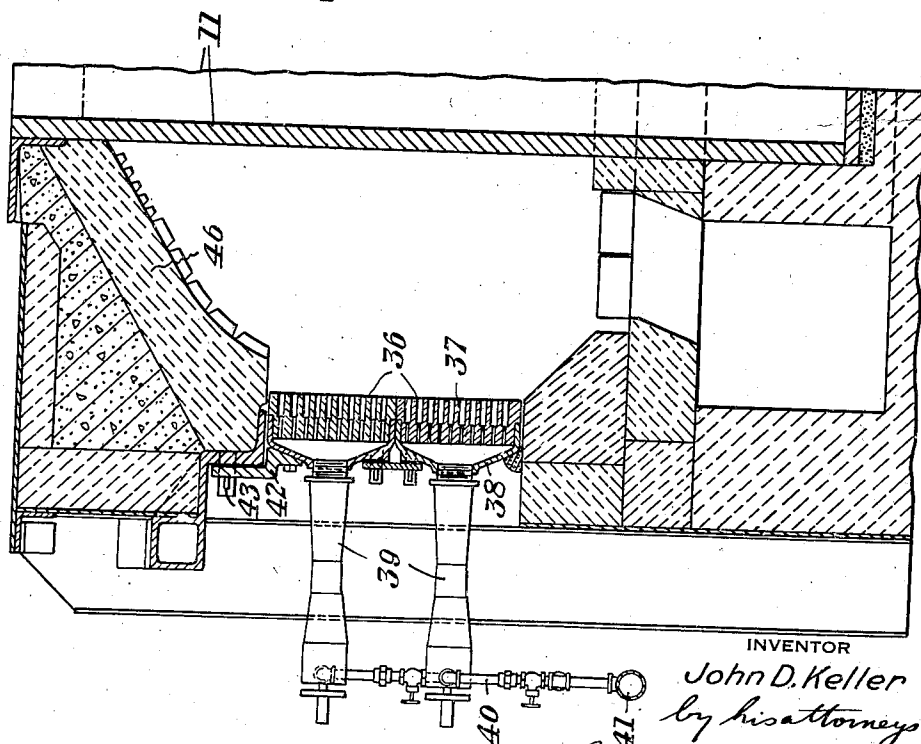


Fig. 8.



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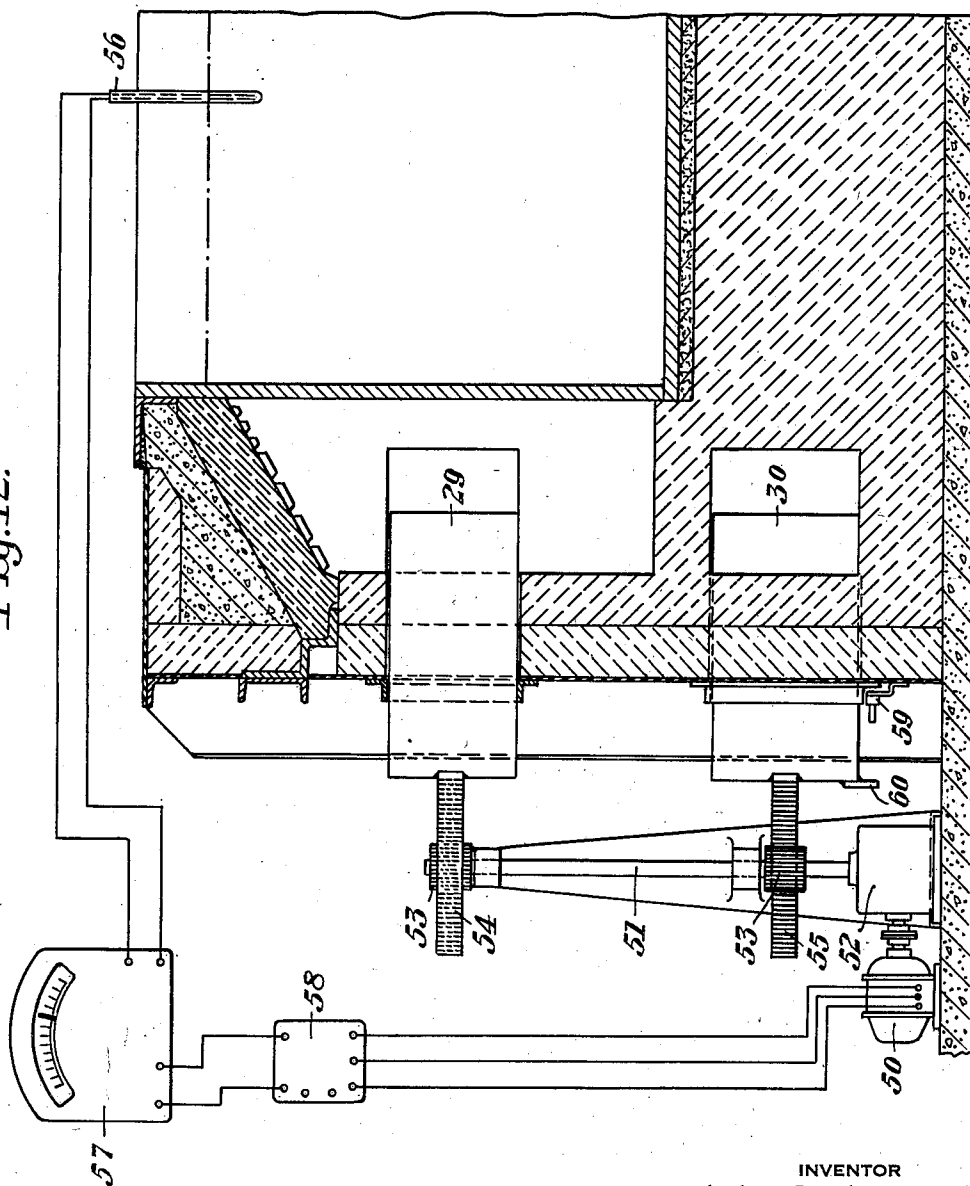
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Fig.12.



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2,262,609

FURNACE FOR COATING BATHS

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Application June 27, 1940, Serial No. 342,681

10 Claims. (Cl. 263—14)

This invention relates to the application of a protective metal coating to base metal such as ferrous sheets and, in particular, to a setting for the pot containing the bath of molten coating metal such as zinc.

It has been customary heretofore to enclose the pot containing a bath of molten coating metal used in coating sheets by the hot-dip process, in a brick setting and to heat it by means of nozzle-type burners extending through the wall of the setting adjacent the entrance end of the pot. This construction, however, has been characterized by numerous objections. In the first place, the pot, usually cast iron or steel, is subject to rapid corrosion by zinc, one of the metals most widely used in coating sheets, and the rate of corrosion is roughly proportional to the temperature existing at the contacting surfaces. The burners used in conventional settings for galvanizing pots set up hot spots as a result of intense, localized radiation or high-velocity vortices of combustion gases. Such concentration of the applied heat involves local corrosion of the pot wall at an excessive rate.

I have invented a novel furnace or setting for a pot containing a bath of molten coating metal, whereby the aforementioned objections are largely overcome. In a preferred embodiment, the pot is enclosed by a wall spaced therefrom, the wall having porous block burners distributed more or less uniformly thereover, the burners being of such character as to deliver a substantial proportion of the heat produced, by mild radiation. The setting also has a group of radiating tiles sloping upwardly from the wall toward the pot, whereby combustion gases discharged by the burners have intimate contact with the tiles and heat them to radiant temperature. I also provide means for controlling the flow of combustion gases around the pot to an outlet adjacent the discharge end thereof. Exhaust ducts extend along the sides of the pot so that more or less of the combustion gases may be diverted to the outlet without passing entirely around the pot.

Other novel features and advantages of the invention will be explained in the following detailed description referring to the accompanying drawings illustrating the preferred embodiment. In the drawings:

Fig. 1 is a sectional view through a setting for heating the bath of a metal coating apparatus, on a horizontal plane near the bottom;

Fig. 2 is a transverse section through the wall of the setting, taken along the plane of line II—II of Fig. 1 showing a construction suitable for a zinc coating bath; line I—I of Fig. 2 indicates the plane on which the section of Fig. 1 is taken;

Fig. 3 is a sectional view taken along the plane of line III—III of Fig. 1 showing a setting for a pot suitable for a lead-zinc coating bath;

Fig. 4 is a transverse section through the setting taken along the plane of line IV—IV of Fig. 3;

Fig. 5 is an elevation of one of the roof tiles;

Fig. 6 is an end view thereof;

Fig. 7 is a transverse section taken along the plane of line VII—VII of Fig. 5;

Fig. 8 is a view similar to Fig. 2 showing a modified construction;

Fig. 9 is a partial elevation of the radiant member of the burners illustrated in Fig. 8;

Fig. 10 is a sectional view along the line X—X of Fig. 9;

Fig. 11 is a view similar to Fig. 2 showing a further modified construction; and

Fig. 12 is a diagrammatic view illustrating an automatic control system for regulating the out-flowing combustion gases.

Referring now in detail to the drawings and, for the present, to Figs. 1 through 7, the setting of my invention, indicated generally at 10, encloses a coating-metal pot 11 and comprises principally a wall 12 spaced therefrom defining a combustion chamber 13 extending entirely around the pot adjacent the sides and ends thereof. Burners 14 are disposed in the wall 12, being distributed over the sides and ends thereof as illustrated.

The burners are of the porous-block type, each including a gas-permeable, refractory block 15 through which a combustible mixture is supplied. In this type of burner, combustion is initiated within the interstices of the block and continues as the gases flow outwardly therefrom but is completed within a very short distance outward from the surface. The blocks 15 are positioned in holders 16 and fuel is supplied thereto from any suitable source through manifolds 17. As best shown in Fig. 2, the holders 16 are secured in the wall by brackets 16a attached to a part of the structural frame such as 16b by wedges.

The combustion chamber 13 has a floor 18, and an exhaust duct 19 extends entirely around the pot 11 beneath the floor 18. The entire setting, as indicated in the drawings, is built up from suitable fire-brick and insulating material assembled within structural frame members 20 and sheathing plates 21. The duct 19 communicates with an outlet 22 at the discharge end of the pot, the outlet being provided with a damper 23. Ports 24 in the floor 18 also afford communication from the combustion chamber 13 to the outlet 22. Ports 25, distributed along the side and entering end of the pot, provide communication between the combustion chamber 13 and the exhaust duct 19. Suitable closures, such as refractory brick 26, may be laid over the ports 25 to partially restrict or completely obstruct the flow of combustion gases therethrough.

Cross walls 27 are provided in the combustion

chamber adjacent the discharge end thereof. Ports 28, formed in these walls, are provided with adjustable valves 29 adapted to control the flow of combustion gases around the discharge end of the pot and downwardly through the ports 24 to the outlet. Similar valves 30 are provided in the duct 19 adjacent the discharge end of the setting. By manipulation of these valves, the division of the combustion gases between the path around the discharge end of the pot and downwardly through the ports 25 may be readily controlled.

It is evident that this construction may be modified, without departing from the spirit of the invention, for example by doing away with cross walls 27 and upper valves 29, and substituting adjustable horizontal slide valves placed over openings 24.

Baffles 31 extend inwardly from the wall of the setting at the discharge end for the purpose of deflecting combustion gases flowing through the ports 28 against the end wall of the pot before they flow downwardly through the ports 24.

The roof of the combustion chamber 13 is formed by radiant tiles 32 which slope upwardly from the wall 12 to the pot 11. These tiles absorb heat from the combustion gases discharged from the burners 14 and radiate the heat absorbed to the pot wall. After passing upwardly over the exposed surface of the tiles 32, the gases flow downwardly through the ports 25 or sweep along the side walls of the pot, through the ports 28 and 24 to the outlet 22, the distribution of the gases between these two alternate paths being determined by the adjustment of the valves 29 and 30 and of the closures 26, as already explained. In passing downwardly along the walls of the pot 11 or horizontally therealong, the combustion gases furnish additional heat to the pot wall by convection.

By providing these two parallel paths for the flow of the gases, namely either downward through ports 25 and along the lower duct 19 to outlet 22, or horizontally along the upper duct or chamber 13 between wall 12 and the side wall of the pot through downtakes 24 to the same outlet 22, I am able to obtain the desired distribution of temperature in, and of heat input to, the metal within the pot while at the same time extracting from the gases as much of their sensible heat as is consistent with obtaining said distribution, thereby effecting best possible fuel economy. The closures 26 and valves 29 and 30 make it possible to vary the proportion of the gases flowing through either path as required to obtain the desired results under various conditions of operation. Thus it is found that when running sheets of certain gages or thicknesses, heat is absorbed very rapidly at the front or entrance end of the pot and very much less rapidly at the exit end of the pot. Gas must therefore be burned at a high rate at the front of the pot in order to furnish the required heat there, but if the resulting burned gases were all permitted to flow around the pot through the upper passage 13 they would overheat the metal at the exit end of the pot where, under the conditions stated, very little heat is required. The gases are, therefore, largely taken down through ports 25.

On the other hand when running sheets of a different gage or thickness, it is found that the rate of heat absorption by the sheets is less than in the previous case at the front end of the pot and greater at the exit end, so that the metal

at the exit end tends to freeze up. Under these conditions, most of the burned gases from the burners are caused to flow horizontally along and around the pot through the upper passage 13 in contact with the walls of the pot to downtakes 24, thereby supplying heat to the rear part of the pot where it is needed and at the same time affording the best possible extraction of heat from the gases, with corresponding saving of fuel. For intermediate conditions the closures and valves are set to divide the gases between the upper and lower passages in such proportion as is most suitable for effecting desired results.

The blocks 15 of the burners radiate heat directly to the portions of the pot wall opposite to them. The tiles 32 radiate heat generally to substantially the entire area of the pot wall exposed in the combustion chamber 13. The construction of the setting is such that the pot wall is not subject to direct heating adjacent the surface of the zinc bath indicated at 33. This protects the pot wall from the accelerated corrosion which usually occurs at the surface of the bath. The pot 11 illustrated in Fig. 2 is of sufficient depth to provide space for the accumulation of zinc cross below the area of the pot wall through which heat is delivered. Fig. 3 shows the use of a shallower pot suitable for lead-zinc coating in which the cross floats on the lead.

The tiles 32 are shown in Figs. 5 through 7 and are shaped at the ends to cooperate with the adjacent structural frame members. On their exposed face, the tiles 32 have horizontal rows of ribs 34. These ribs extend generally up and down, but the ribs in adjacent rows are inclined in opposite directions, producing somewhat the effect of a continuous zig-zag rib. The tiles also have points 35. The ribs and points provide projections on which the burned gases impinge, thereby creating turbulence and insuring good contact between the gases and the tiles for efficient transfer of heat. This is further aided by the slope of the tiles which is such that the ascending gases strike the tiles and are thenceforth held in contact therewith by their buoyancy until deflected therefrom toward the pot wall.

Fig. 8 illustrates a modified form of setting similar in general to that already described but utilizing burners 36 of a type somewhat different from the burners 14. The burners 36 include a perforated refractory block 37 seated in a holder 38. An inspirator tube 39 of known construction communicates with the holder and is open to the atmosphere at its outer end. A fuel nozzle extends into the inspirator and is connected by piping 40 to a fuel-supply manifold 41. The holders 38 are secured to the structural frame members of the setting by brackets 42 and wedges 43, as in the case of the burners 14.

The refractory blocks 37 have a plurality of passages 44 extending thereinto from their rear faces through which a combustible, fuel-air mixture flows. These passages are enlarged to form combustion spaces 45 adjacent the front faces of the blocks. By this construction, combustion is initiated within the blocks 37, the same as in the blocks 15, and continues as the gases are discharged from the spaces 45.

In other respects, the setting shown in Fig. 8 is generally similar to that previously described. Roof tiles 46 differ somewhat in shape from the tiles 32 but function in the same general manner to heat the exposed wall of the pot by radiation. The specific shape of the tiles is not material, of course, so long as they function generally as

described, that is, to absorb heat from the ascending combustion gases and radiate it to the side walls of the pot.

Fig. 11 illustrates a further modification in which burners 36', similar to those shown at 36, are arranged in the setting wall on a downward and inward curve, the face of the refractory block of the uppermost burner being substantially vertical, while the faces of the blocks of the lower burners are inclined progressively, inwardly and downwardly.

As shown in Fig. 11, the top and bottom burners are supplied from a manifold 47, while the middle burners are supplied from a separate manifold 48. By this arrangement, all the burners can be used to heat the pot when starting up and when operating at full capacity. The top and bottom burners may be shut down and the middle burners only relied on to keep the bath molten during idle periods.

Fig. 11 also shows a still further form of roof tile 49, which differs from those previously described only in shape, having an exposed face with a more pronounced curvature than that of tiles 46.

Fig. 12 illustrates diagrammatically an automatic control system for actuating the valves 29 and 30. As shown in the drawings, these valves are operated by a motor 50 driving a pinion shaft 51 through reduction gearing 52. Pinions 53 on the shaft 51 mesh with racks 54 connected to the valves 29 and racks 55 connected to the valves 30. The racks 54 and 55 engage opposite sides of the pinions so that on rotation of the shaft 51, the valves 29 and 30 are shifted in opposite directions.

The motor 50 is controlled by a thermocouple 56 immersed in the bath, through a controller 57 and a contactor 58. The controller 57 and the contactor are of known construction and are, therefore, only illustrated diagrammatically. The controller is preferably of the so-called "corresponding" type which closes one or the other of two control circuits, depending on the direction of the change in the temperature of the bath. The contactor 58 is adapted to close a circuit to operate the motor 50 in one direction when the temperature of the bath exceeds that for which the controller 57 is set. Similarly, the contactor closes the reverse circuit for the motor when the temperature of the bath falls below that for which the controller is set.

Assuming the parts to be in the position in which they are illustrated, when the temperature of that part of the bath near the exit rolls falls to a point which makes it desirable to supply additional heat to the exit end of the pot, the controller 57 operates the relay to drive the motor 50 in such direction as to increase the extent to which the valves are opened and simultaneously move the valves 30 further toward closed position. This causes a greater portion of the waste gases to sweep around the pot and downwardly through the ports 24 as the result of which more heat is delivered to the pot. When the temperature of the bath at the exit end rises above the desired value, the controller 57 operates to effect the reverse adjustment, i. e., to increase the opening of the valves 30 and to adjust the valves 29 toward closed position.

When operating the apparatus under manual control, it would ordinarily be unnecessary to open the valves controlling the supply of fuel to the burners 14 in the end wall of the setting at the exit end of the pot and the two burners on

the side walls nearest said end wall. These burners are turned on, however, when the temperature of the bath at the exit end is too low.

The control system of Fig. 12 incorporates means for accomplishing this result automatically. A contactor 59 is adapted to be actuated by a finger 60 depending from one of the valves 30 when the latter is in its fully closed position. The contactor 59 operates an electromagnetic valve controlling the supply of fuel to the burners just mentioned. Thus, when the valves 30 are actuated to their fully closed positions indicating an abnormally low temperature of the bath at the exit end, the burners 14 in the end wall at the discharge end of the pot and the two burners on each side wall nearest the said end wall are turned on to supply additional heat to restore the temperature of the bath to the desired value. These burners are ignited by the flame from the adjacent burners and are automatically turned off when the temperature rises to a point such that the dampers 30 are partly opened. This same operation could also be obtained through the controller 57, by providing the necessary contact on the latter to be closed when the temperature of the bath at the exit end falls a predetermined amount below the desired value.

It will be apparent from the foregoing description that the invention provides a setting for a pot containing a molten coating bath, which has numerous advantages over the construction used previously. Special advantages are obtained by the use of porous-block, radiant burners in that the heat radiated thereby is delivered directly to the point where it is needed. The invention also provides a setting having a high thermal efficiency by reason of the use of roof tiles to absorb heat from the combustion gases discharged by the burner and the fact that the gases also have direct contact with the pot walls. This construction also avoids local overheating. The kinetic energy of the gases is practically dissipated and their combustion is practically completed when they leave the burners, whether of the type shown at 15 or that shown at 36, and certainly at a plane a short distance beyond the face of the burners. Hence, there can be no high-velocity impingement of burning gases on the metal wall of the pot and no localized overheating due to high-velocity vortices in the gases.

By applying the heat to the pot on all sides, the temperature of the bath is maintained more nearly uniform at all points throughout. According to the invention, furthermore, the heat is applied to the pot wall in an area which does not extend up to the surface of the bath nor to the dross zone near the bottom. This prevents excessively rapid corrosion of the pot at the metal line and also avoids disturbing the dross near the bottom. The heat transferred per unit of area in any sheet-coating pot, especially of the hot-dip galvanizing type, must necessarily be much greater through the wall of the pot at the entrance end than through the wall of the pot along the sides, but by distributing the soft, radiated heat nearly uniformly over the entire area of the entering end wall and the side walls, the temperature gradient through the pot wall need not be so steep and this reduces the rate of corrosion of the pot wall by the molten zinc, in the case of a galvanizing bath.

Although I have illustrated but a preferred embodiment of the invention with certain modi-

fications, it will be recognized that changes in the construction disclosed may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners distributed over the interior of said wall, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts below said chamber and along each side of the pot communicating with said chamber and said outlet, cross walls in said chamber adjacent said end of the setting, ports in said cross walls, and valves controlling the flow of spent combustion gases through said ducts and said ports.
2. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, means for controlling the flow of combustion gases through said ducts and means controlling the flow of combustion gases around the pot to said outlet.
3. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot, cross walls in said chamber adjacent said end of the setting, ports in said cross walls, ports in the floor of said chamber opening into said ducts, and means controlling the division of outflowing combustion gases between said ducts and the cross-wall ports.
4. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, valves in said ducts for controlling the flow of combustion gases therethrough, and valves controlling the flow of gases directly from said chamber to said outlet.
5. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, valves in said ducts for controlling the flow of combustion gases therethrough, and a valve on each side of the pot for controlling the flow of gases around the end of the pot directly to said outlet.
6. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot, cross walls in said chamber adjacent said end of the setting, ports in said cross walls, ports in the floor of said chamber opening into said ducts, valves in said ducts for controlling the flow of combustion gases therethrough, and valves controlling the flow of gases directly from said chamber to said outlet.
7. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, means controlling the division of waste gases between a direct path around the pot and to said outlet, and a path through said ducts, and means responsive to the temperature of the bath for actuating said controlling means.
8. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, means for controlling the flow of combustion gases through said ducts, means controlling the flow of combustion gases around the pot to said outlet, and means responsive to the temperature of the bath for actuating said controlling means.
9. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, valves in said ducts for controlling the flow of combustion gases therethrough, valves controlling the flow of gases directly from said chamber to said outlet, and means responsive to the temperature of the bath for actuating said valves.
10. A setting for a pot adapted to contain a molten coating bath, said setting comprising a wall around the pot and spaced therefrom forming a combustion chamber adjacent the pot, burners delivering combustion gases to said chamber, a waste-gas outlet adjacent one end of the setting communicating with said chamber, exhaust ducts adjacent said chamber and along each side of the pot communicating with said chamber and said outlet, means for controlling the flow of combustion gases through said ducts and means controlling the flow of combustion gases around the pot to said outlet.

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