

- [54] **BILLET HEATING**
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- [73] Assignee: **Granco Equipment, Inc.**, Grand Rapids, Mich.
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- [58] Field of Search ..... **432/8, 14, 18, 50, 234, 432/176, 153-154, 86, 120, 121, 128, 137, 143-146, 150**

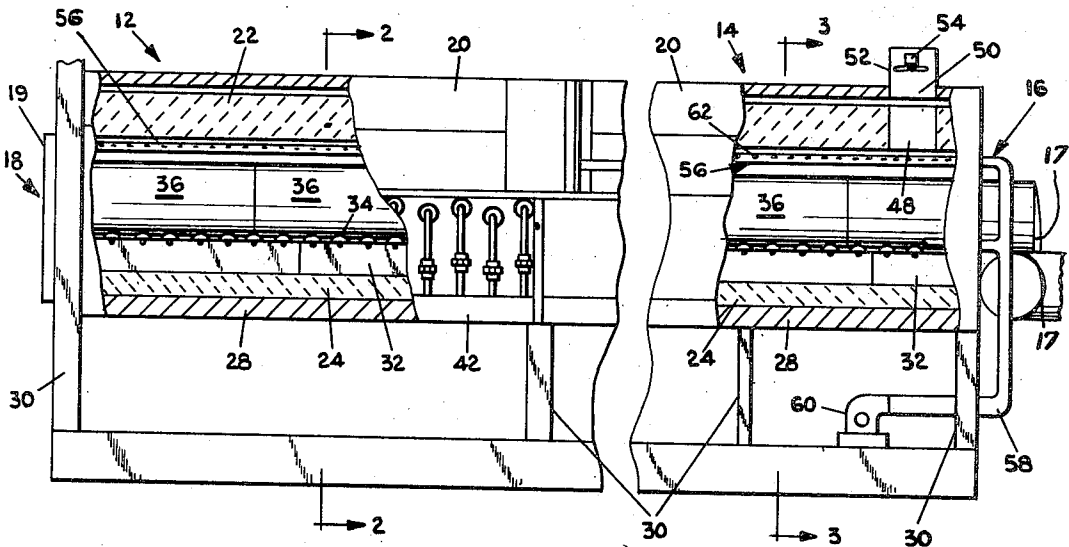
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 Attorney, Agent, or Firm—McGarry & Waters

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[57] **ABSTRACT**  
 A method and apparatus for heating articles such as billets wherein the articles are passed serially through a preheating zone and into a fired discharge zone of a furnace. A burning combustible mixture of gases is directed against the articles in the fired discharge zone and the hot gases are passed to the preheating zone for heat exchange with the articles therein. The heated gases are turbulated by blowing cooler air through holes in pipes positioned along the length of the preheat chamber. Desirably, the pipes extend into the fire discharge zone to further turbulate the gases therein.

17 Claims, 4 Drawing Figures



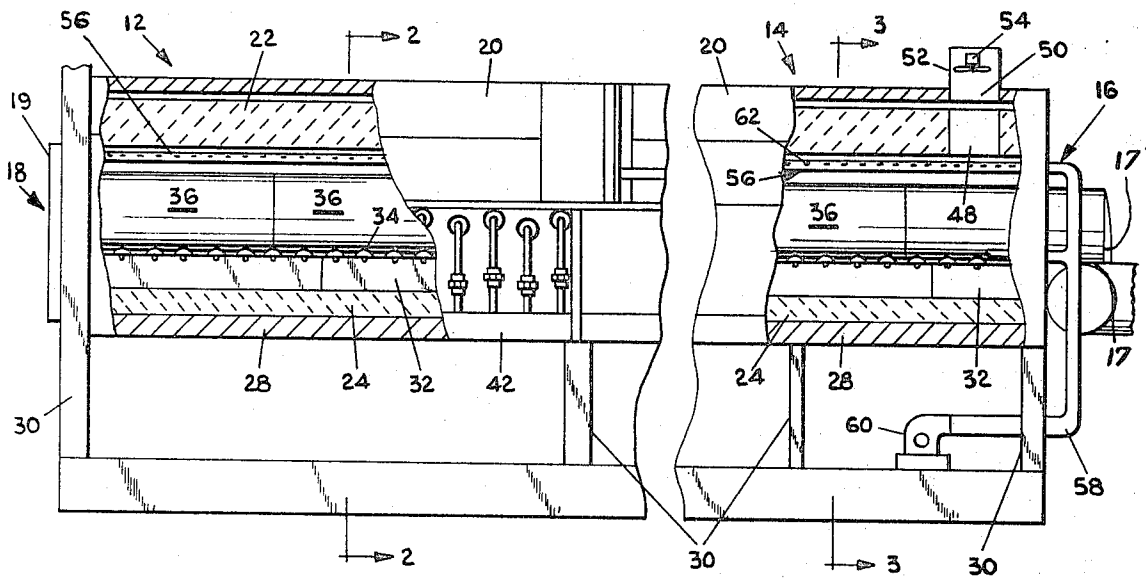


FIG. 1

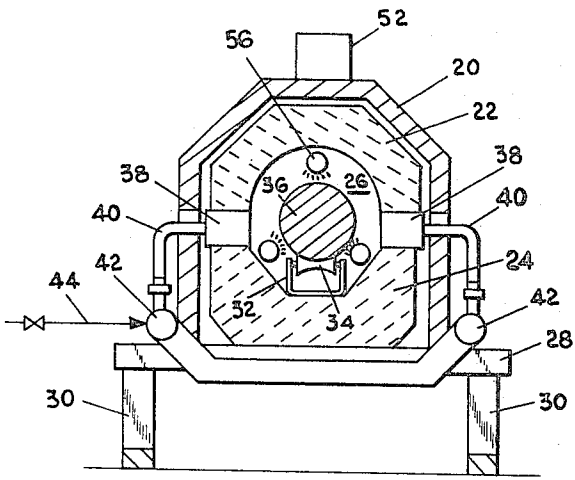


FIG. 2

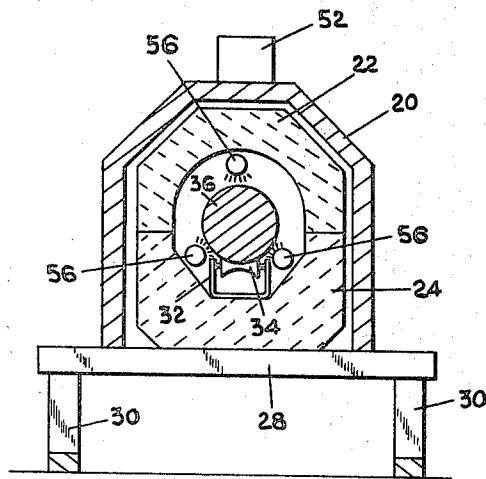


FIG. 3

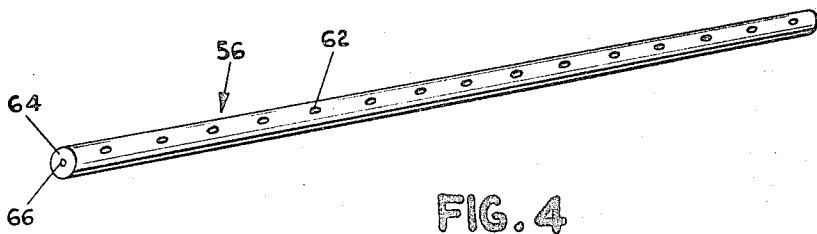


FIG. 4

# 1

## BILLET HEATING

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to article heating. In one of its aspects, the invention relates to a method and apparatus for heating articles such as billets to a predetermined elevated temperature within a relatively short period of time while minimizing fuel requirements.

#### 2. State of the Prior Art

Billet heating furnaces heat billets or slugs of metal to an elevated temperature for extrusion or other working purposes. One type of widely used billet heating furnace has an elongated heating chamber through which the billets are pushed in end-to-end relationship. Burners are disposed along the length of the furnace chamber and direct burning combustible gases against the billets as they move through the furnace chamber. Hot gases from each section are exhausted directly to the atmosphere through the top of the furnace.

This heating technique is known as "flame impingement" because the burner flame actually envelopes the billets within the furnace. The billets are generally within the reducing portion of the flame. This type of heating has been found to be very fast and quite satisfactory to supply billets at a desirable rate for extrusion presses.

Fuel, especially natural gas, which is used in the furnaces is becoming more scarce and it is increasing in price. It is therefore necessary to heat the billets as efficiently as possible.

It might be possible to conserve fuel by heating the billets at slower rates with other types of furnaces. However, the efficiency of fuel consumption must be weighed against the speed of operation and the availability of heated billets. These billets must be heated with sufficient speed to keep up with the more expensive extrusion equipment. Less efficiency in the operation of the extrusion equipment quickly outweighs any savings in fuel costs for a slower heating process.

### SUMMARY OF THE INVENTION

According to the invention, a highly efficient yet rapid heating furnace and method have been devised for heating articles such as billets. The articles are passed serially through a preheating zone and a fire discharge zone in a furnace. A burning combustible mixture of gases is directed against the articles in the fired discharge zone to directly heat the articles in the fired discharge zone. The hot gases in the discharge zone are then passed directly to the preheat zone for heat exchange contact with the billets in the preheating zone. The heated gases are turbulated in the preheating zone and, if desirable, in the fired discharge zone, to increase the heat transfer capabilities of the heated gases in the preheating and fired discharge zones.

Desirably, the preheating and fired discharge zones or sections of the furnace are in open communication with each other so that the billets pass continuously from one section to the other. The turbulating step for the heated gases is accomplished by directing jets of cooler gases against or toward the billets in the furnace zones.

The billets are heated in the preheating zone solely by contact with the heated gases from the fired discharge zone. The preheat zone preferably contains no burners.

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The turbulating means comprises one or more pipes which extend through the preheating zone or section adjacent to the articles or billets passing therethrough. The pipes have openings which direct jets of air at the billets, thus turbulating the gases flowing through the preheat zone or section. A cooler gas, such as atmospheric air is supplied to the pipes under pressure to provide the source of gases for turbulating the heated gases within the furnace. The hot gases are thereafter exhausted from the preheating section of the furnace near the entrance end thereof.

### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a side elevational view, partially broken away, of a billet heated furnace according to the invention;

FIG. 2 is a sectional view taken along lines 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along lines 3—3 of FIG. 1; and

FIG. 4 is a perspective view of an air supply pipe used in the invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and to FIGS. 1—3 in particular, there is shown a billet heating furnace having a fired discharge section 12 and an unfired preheating section 14. Generally, the fired discharge section is of smaller length than the unfired preheat section 14, for example, in the ratio of 1:2. The unfired preheat section 14 forms an open entrance end 16 through which the billets enter the furnace and the fired discharge section 12 forms an open exit end 18 at which the billets are removed from the furnace.

Generally, the billets are pushed through the furnace by a suitable pushing mechanism, such as a chain 17 having a billet engaging dog 17, as is conventional in these types of billet heaters.

Each portion of the furnace has a housing 20 which encloses upper refractory blocks 22 and lower refractory blocks 24. An elongated heat treating chamber 26 is formed longitudinally through the furnace by the upper refractory blocks 22 and the lower refractory blocks 24. Cross plates 28 on upright supports 30 support the furnace above the floor level.

At the bottom of the heat treating chamber 26, a plurality of U-shaped channels 32 are positioned. Rollers 24 are journaled in the sides of the channels 32. The billets 36 are supported on the rollers 34 as the billets are pushed through the furnace.

In the fired discharge section 12, a plurality of burners 38 are positioned at the sides of the heat treating chamber 26. Fuel and air mixture is supplied through pipes 40, header 42, and supply pipe 44 to the burners 38. Such burners are desirably of the direct flame impingement type so that when the burners are fired, the flame therefrom impinges upon and envelopes the billets 36. Such burners are well known in the billet heating art. A door 19 normally closes the exit end of the furnace until the billets are removed.

The unfired preheat section 14 has no burners. An exhaust for hot furnace gases is formed near the entrance end 16 of the preheat section 14 by exhaust openings 48 in an upper refractory block 22, an ex-

haust opening 50 in the housing 20 and by exhaust conduit 52 which extends above the housing 20. Desirably, a fan 54 is provided in the exhaust conduit 52 to draw the hot gases from the furnace. The hot gases are thus drawn from the fired discharge section through the entire length of the preheat section 14 in counter-current heat exchange with the billets passing therethrough.

Three air supply pipes 56 are disposed throughout the length of the unfired preheat section 14 of the furnace and extend from the entrance end 16 thereof. The air supply pipes 56 are connected to an air supply conduit 58 and to fan 60. Each of the air supply pipes 56 contains a plurality of spaced openings 62 for dispersing air from the fan 60 into the preheat end 14 of the furnace. As illustrated in FIG. 4, each air supply pipe has a closed end 64 which may have an opening 66 in the end thereof to equalize the flow through the pipe 56 and permit an even distribution of air through each of the holes 62. The opening 66 will further keep the air flowing through the pipe so that the end 64 does not get too hot. As illustrated in FIGS. 1 and 2, the pipes 56 extend into the discharge end of the furnace to further turbulate the gases therein.

In operation, the billets are fed one at a time in end-to-end relationship through the entrance end 16 of the furnace and passed through the unfired preheat section 14 and through the fired discharge section 12. The heated billets are removed from the exit end 18 of the furnace when they reach the proper temperature. The billets are heated in the fired discharge end of the furnace by direct flame impingement from the burners 38 and are preheated in the unfired preheat section 14 by the hot gases from the burners 38 in the heating sections 12. The hot gases from the burners 38 are drawn into and through the entire length of the preheat section and escape from the furnace through opening 48, opening 50, and exhaust conduit 52. Cool or ambient air is supplied from fan 60 through line 58 and into the air supply pipes 56 in the unfired preheat section 14 of the furnace. The air is discharged through the spaced openings 62 and opening 66 in the air supply pipes into the preheat section 14 of the furnace. The openings 62 serve as nozzles for the air and the air is thus discharged under pressure-like jets toward the billets in the furnace. For each of the air supply pipes 56, the spaced openings 62 are directed radially inwardly directly at the billets 36. The air discharged from the openings 62 toward the billets 36 has a turbulating effect on the hot gases passing through the preheat section 14 to substantially increase the heat transfer characteristics thereof in the preheat end of the furnace. It has been found that the supply of cooler air actually increases the efficiency of the furnace by creating a turbulating effect on the hot gases in the preheat section of the furnace. Thus, greater amounts of heat are transferred to the billets from the hot gases and the furnace operates much more efficiently with the supply of cool turbulating air.

Desirably, the speed of the fan 60 is controlled by a conventional controller (not shown) which correlates the speed of the fan with the flow of fuel to the fired discharge section of the furnace so that the flow of turbulating gases will be coordinated with the flow of heated gases to the furnace.

The holes 62 in the air supply pipes 56 are of suitable size and distribution to discharge jets of air into the heating chamber so as to sufficiently turbulate the hot

gases therein for maximum heat exchange with the billets. The size of the air pipes can also be selected to give the proper flow of air into the furnace for proper turbulating effect.

In a test operation, a 15 foot billet heater had a 5 foot fired discharge end and a 10 foot unfired preheat end. Three 1 1/4 inch I.P.S. pipes, 12 feet in length, were positioned substantially as illustrated in FIG. 3 in the 10 foot unfired preheat end of the furnace. Each of the three air supply pipes had openings of seven sixty-fourths of an inch spaced 5 inches apart along the length of the pipe. Air, mixed with fuel, was supplied to burners in the fired discharge end of the furnace at the rate of 350 to 360 CFM to produce gases at a temperature of about 2,400°F. The flames from these gases envelope the billets and thereby heated the same. Ambient air was supplied at the rate of 75 CFM to the three air supply pipes for turbulating the heated air within the preheat section of the furnace. The temperature of the gases being removed from the exhaust conduit 52 was in the range of 500° to 550°F. Aluminum billets, 5 inches in diameter and 30 inches in length, were pushed intermittently through the furnace. The Billets were removed from the end of the furnace when they reached a temperature of about 850°F.

During the test, the billets heated quickly and evenly to a temperature of about 850°F at the rate of about 1.81 minutes per billet. This yielded 3.12 pounds of heated billets at 850°F per cubic foot of gas.

In the conventional method and apparatus where the billets are fired along the entire length of the furnace, the billets are heated to about 850°F at the rate of about 1.74 minutes per billet. However, the gas consumption is about twice as high with the yield of billets being about 1.25 pounds of heated billet per cubic foot of gas.

Therefore, it can be seen that the method and apparatus of the present invention heats the billets uniformly to the desired temperature in approximately the same time but with a savings of 50 percent on fuel costs. This savings of fuel costs is quite surprising in view of the fact that cool air is supplied to the furnace to turbulate the hot gases.

If desired, heated gases can be supplied to the furnace through the air supply pipes 56 instead of the ambient gases, thereby still further increasing the efficiency of the furnace. For example, a portion of the exhaust gases from the exhaust conduit 52 can be fed directly to the intake for the fan 60 so that the turbulating gases entering the furnace through the supply pipes 56 will be at an elevated temperature.

Reasonable variation and modification are possible within the scope of the foregoing disclosure, drawings, and the appended claims without departing from the spirit of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for heating articles to an elevated temperature comprising the steps of:
  - passing said article serially through a preheating zone and a fired discharge zone;
  - directing a burning combustible mixture of gases against said articles in said fired discharge zone to directly heat said articles in said fired discharge zone;

passing the heated gases from said fired discharge zone through said preheat zone in contact with said articles therein for preheating the same; and turbulating said heated gases in said preheating zone at the surface of the articles by directing additional gases against the articles uniformly throughout the length of the preheating zone to increase the heat transfer capabilities of said heated gases in said preheating zone.

2. A method of heating articles according to claim 1 wherein said preheating and fired discharge zones are in open communication with each other.

3. A method for heating articles according to claim 1 wherein said turbulating step comprises directing jets of a cooler gas uniformly along the length of said preheating zone, against said articles in said preheating zone.

4. A method for heating articles according to claim 1 wherein said articles are heated in said preheating zone solely by contact with said heated gases from said fired discharge zone.

5. A method for heating articles according to claim 1 where said heated gases pass through the length of said preheat zone in counter-current heat exchange relationship with the movement of said articles through said preheating zone.

6. An apparatus for heating articles to an elevated temperature, wherein the articles are moved serially from an entrance end to an exit end thereof, said apparatus comprising:

a furnace having a preheating section at said entrance end and a fired discharge section at said exit end;

means in said discharge section for directing burning combustible gases against said articles in said fired discharge section to directly heat said articles therein;

means for passing heated gases from said fired discharge section to said preheating section for contact with said articles in said preheating section; and

means for turbulating said heated gases in said preheating section at the surface of said articles, said turbulating means including means extending along the length of said preheating section for directing additional gases uniformly against the articles throughout the length of said preheating section to increase the heat transferability of said heated gases in said preheated section.

7. An apparatus for heating article according to claim 6 wherein said preheating section is in open communi-

cation with said fired discharge section.

8. An apparatus for heating articles according to claim 6 wherein said passing means includes an exhaust conduit near to an entrance end of said preheating section.

9. An apparatus for heating articles according to claim 8 wherein said fired discharge section has as its only opening to the atmosphere a discharge opening wherein heated articles can be removed from said furnace.

10. An apparatus for heating articles according to claim 8 wherein said heated gases from said fired discharge section are the sole source of heat for said articles in said preheating section.

11. An apparatus for heating articles according to claim 10 wherein said turbulating means comprises at least one pipe disposed longitudinally along the length of said preheating section, said pipe having a plurality of holes for directing gases against said articles, and means for supplying gases under pressure to said pipe.

12. An apparatus for heating articles according to claim 11 wherein said holes in said pipe form nozzles to discharge the gases toward said articles.

13. An apparatus for heating articles according to claim 11 wherein there are a plurality of said pipes disposed uniformly with respect to said articles in said preheating section.

14. An apparatus for heating articles according to claim 11 and further comprising means for correlating the flow of combustible gases to said directing means with the flow of gases from said gas supplying means for said pipe so that the flow of turbulating gases is a function of the flow of heated gases into said fired discharge section.

15. An apparatus for heating articles according to claim 11, wherein said pipe extends into said fired discharge section and includes means for turbulating gases in said fired discharge section.

16. A method for heating articles according to claim 1 wherein the additional gases are directed substantially uniformly about the articles throughout said preheating zone.

17. A method for heating articles according to claim 1 wherein the flow of the additional gases is correlated with the flow of the combustible mixture of gases so that the flow of the turbulating gases is a function of the flow of combustible gases to the fired discharge zone of the furnace.

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