Oct. 3, 1961 J. D. BARNES 3,002,733

HEAT TREATING FURNACE

Filed April 9, 1958 3 Sheets-Sheet 1

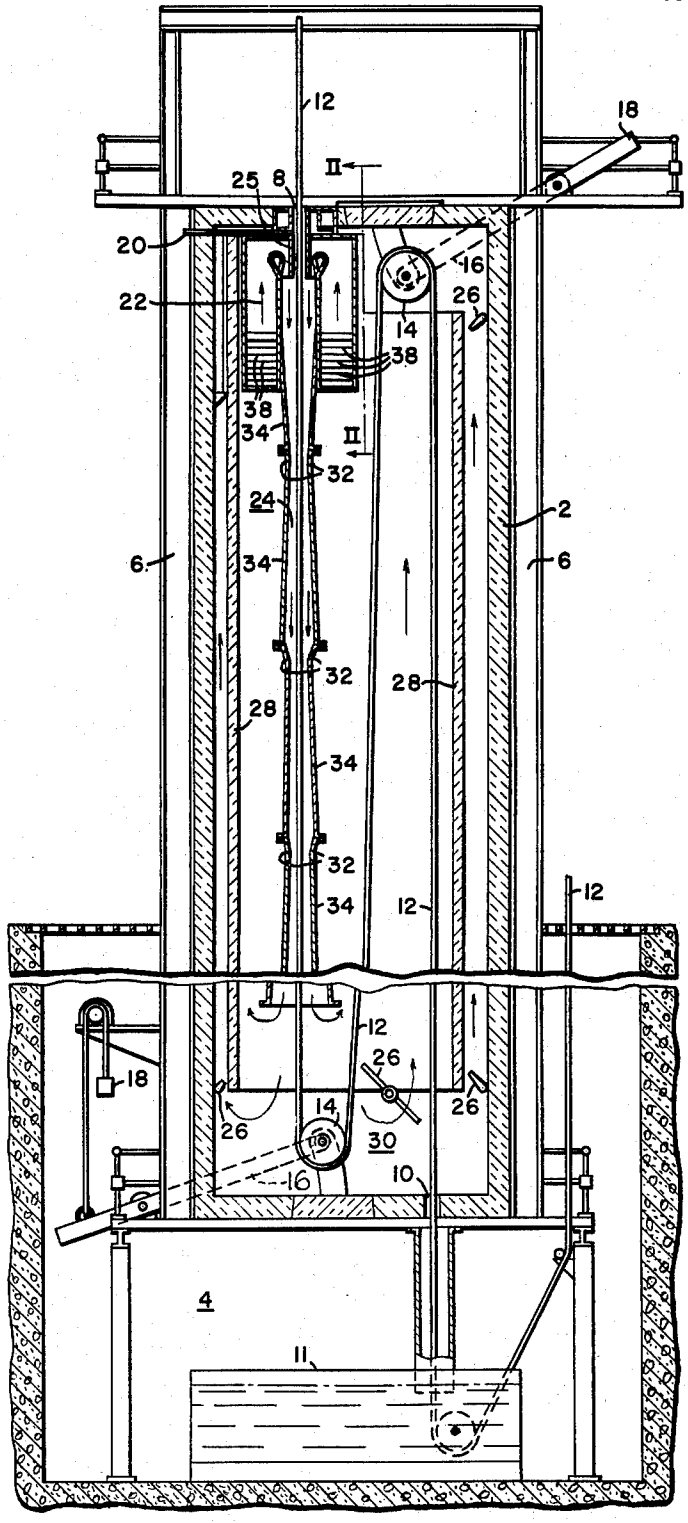


Fig. 1

Oct. 3, 1961 J. D. BARNES 3,002,733

HEAT TREATING FURNACE

Filed April 9, 1958 3 Sheets-Sheet 2

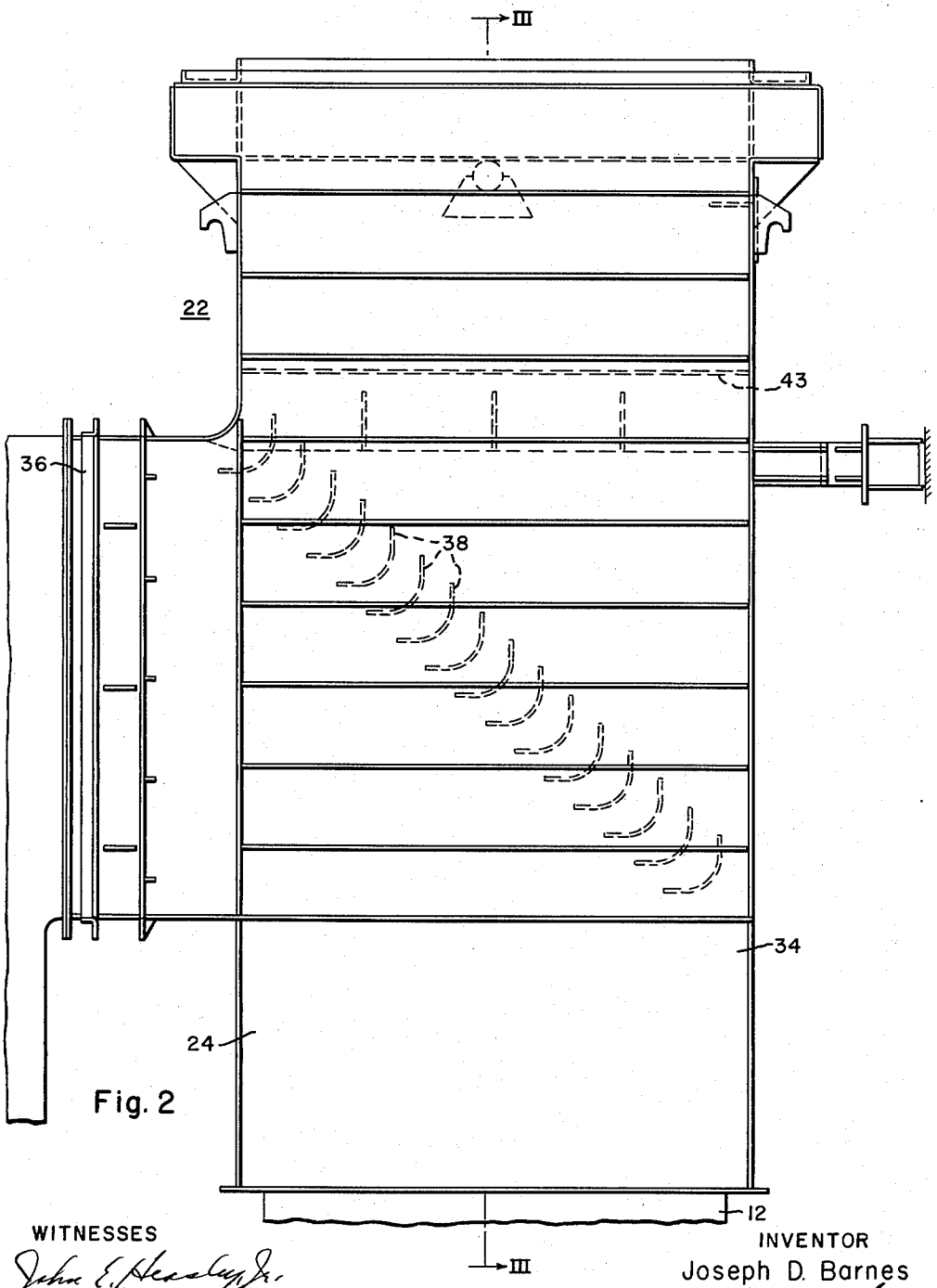


Fig. 2

WITNESSES

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Oct. 3, 1961 J. D. BARNES 3,002,733

HEAT TREATING FURNACE

Filed April 9, 1958 3 Sheets-Sheet 3

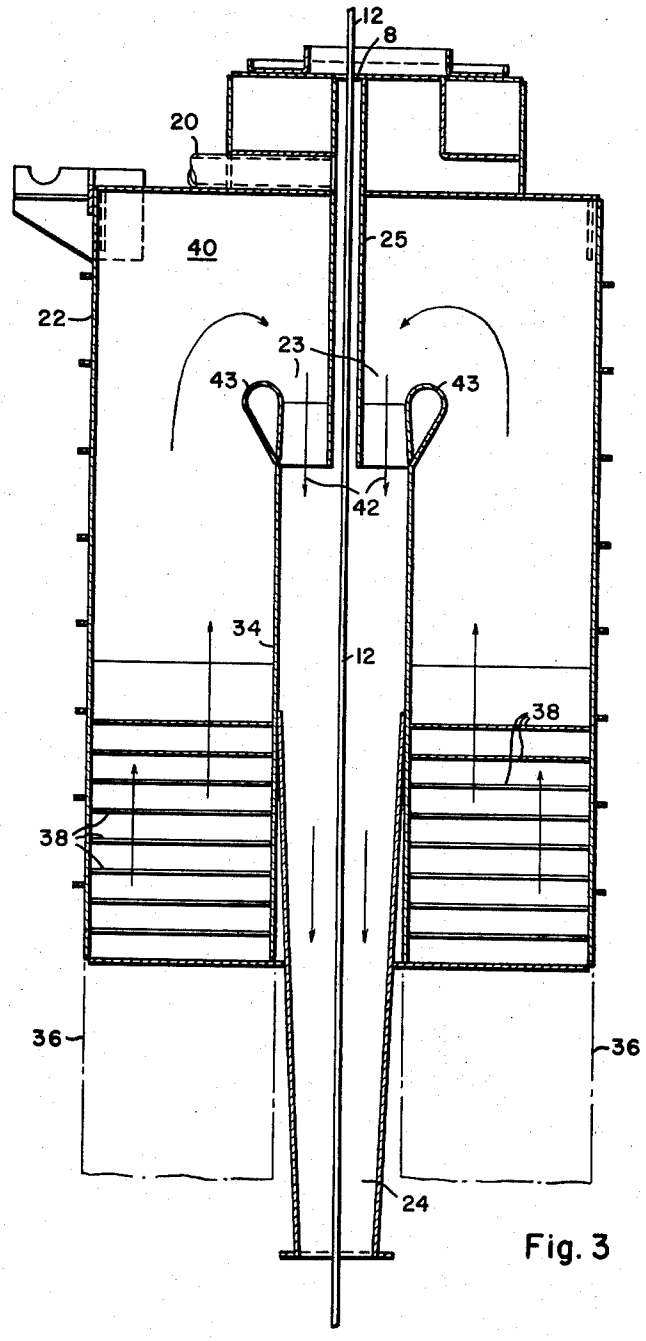


Fig. 3

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HEAT TREATING FURNACE

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4 Claims. (Cl. 263—3)

The present invention relates to a heat treating furnace, and more particularly relates to a heat treating furnace for continuously moving strip.

The continuous handling and annealing of strip metal at greater and greater production speeds has required the lengthening of the heating paths through which the continuously moving strip must pass for adequate and satisfactory heat treating. Lengthening of the heating paths has, of course, increased the size of heat treating furnaces. The complexity of containing and directing the heat to best advantage has become greater with the increased size of the furnaces. The heat treating of continuously moving strip in large vertical heat treating furnaces has given rise to another major problem, namely, control of the lateral movement to and fro of long unsupported vertical lengths of strip as it passes through the furnace. In furnaces of seventy to ninety feet tall, which are coming into use, the metal strip can easily rub the sides of the heating chamber with possible resultant damage both to the strip and the heating chamber.

At the same time, the strip entering the furnace at high production speeds, is sought to be brought up to furnace temperature as quickly as possible so that the strip, moving quickly through the furnace, will be at the desired soaking temperature for as long a period as is required. For this reason, the furnace is provided with a special heating section wherein the temperature of the strip is raised as quickly as possible to the desired soaking temperature.

The object of my invention is to provide a continuously moving strip heat treating furnace with an initial heating passage capable of stabilizing and centering the moving strip as it enters and travels through the passage.

Another object of my invention is to provide a heat treating furnace for continuously moving strip with a means for rapid heat transfer to the moving strip entering the furnace.

Another object of my invention is to provide a heat treating furnace whereby the continuous strip may enter with a minimum of heat loss from the furnace.

Other objects and advantages of my invention will be readily apparent from the following detailed description, taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a vertical longitudinal sectional view of a vertical three-pass strip furnace embodying the invention;

FIG. 2 is a side elevation view of part of the furnace as seen from the line II—II in FIG. 1; and

FIG. 3 is a sectional view substantially on the plane indicated by the line III—III in FIG. 2.

The general furnace construction is similar to that described and claimed in the copending application of Willard Roth et al., Serial No. 561,780, filed January 27, 1956, now United States Patent No. 2,926,902, granted March 1, 1960. The furnace has a tall heat insulated furnace housing 2 which is supported on a base framework 4, and which is free to expand and contract vertically along suitable vertical guide bars 6. The housing 2 has an entry slit 8 which is located at the top, and an exit slit 10 which is located at the bottom, although entrance and exit to the furnace may be had in any desired arrangement. The exit slit 10 is provided with suitable sealing means, such as a water tank 11 presenting a barrier against gas leakage from the furnace. Heated gas is exhausted from the furnace in any suitable manner and redirected to heating means for return to the furnace through a plenum chamber 22. The housing 2 is otherwise as gas tight as it can conveniently be made.

Means are provided for directing the continuously moving strip 12 through the furnace in one or more long, substantially unsupported, vertical passes as the strip moves through the furnace. Rollers 14, suitably located at the top and bottom of the furnace and driven by suitable means, move the strip through the furnace. Pivoted arms 16 which are counterweighted at 18 provide means for swinging the rollers 14 in or out of the furnace for maintenance and replacement purposes. Means for regulating strip tension either inside or external to the furnace may also be had in any suitable known manner.

The longitudinally moving strip 12 enters by means of the entry slit 8 and, if desired, may have been preliminarily heated in a preheating chamber, not shown, located above the furnace. A port 20 leads to a point outside of the top of the furnace. The purpose of the port 20 is to provide a means of indicating whether furnace gases are leaking out of the furnace through the entry slit 8, or whether air is being drawn in through the entry slit 8. Suitable apparatus, either in the form of pressure sensitive dampers or temperature sensitive instruments, can be used to detect whether air is blowing in or furnace gases are escaping from the slit 8. These devices would serve as a criterion for adjusting exhaust valves, not shown, that expel the furnace products of combustion.

The heated gas introduced into the furnace by the plenum chamber 22 flows through a heat exchange passage 24, the flow being generally indicated by the arrows shown in the figure. Dampers 26 divide the flow of heated gas in any selected or desirable direction and quantity so as distribute the heated gas to best advantage within a long open-ended, tubular, heat insulated baffle 28 within the heat insulated furnace housing 2, and the bottom space 30. By proper adjustment of the dampers 26 it is possible to maintain the temperature within the baffle 28 within very close limits as more fully explained in the aforementioned copending application. If desired, additional space heaters may be inserted between the furnace housing 2 and the baffle 28 to make up any heat loss through the furnace housing 2, and when such heaters are used it may be possible to omit the dampers in some cases.

As mentioned previously, the long vertical unsupported length of strip entering the furnace through the heat exchange passage 24 is subject to the possibility of fluttering or lateral movement which may damage the strip or the heat exchange passage 24. At the same time, upon the initial entry of the moving strip 12 into the furnace, it is desirable to increase the temperature of the strip to the soaking temperature of the furnace as quickly as possible so that the fast moving strip may have the benefit of proper soaking temperature for the greatest length of time.

In accordance with the present invention, the heat exchange passage 24 is made of a plurality of hollow sections 34 whose walls, enclosing the flat sides of the strip, are divergent in the direction of the moving strip and turn outward at the upper end thereof to provide a throat or constriction 32 at the top of each section 34. In effect, the passage 24 consists of convergent-divergent sections 34 secured end-to-end in series, and capable of creating sufficient turbulence of the heated gas over the moving strip 12 so as to increase the heat transfer from the heated gas to the strip. More importantly, the spaced constrictions within the passage 24 (a constriction 32 for each section 34) provide for increased strip stability by directing the heated gas with equal pressure against each side of the strip 12. The static pressure build-up on either side of the moving strip 12 just downstream from the apex of the node formed by each constriction 32 will be equal on each side and will tend to center the strip as it moves through the heat exchange passage 24. In other words, the depressions or constrictions 32 furnish venturi sections with nodes creating a static pressure build-up just downstream from the constrictions 32 so as to center the moving strip 12. The portion of the section 34 beyond each constriction 32 flares out slowly so that the velocity of the gas can be reduced to minimize the fluid friction total pressure loss in the passage 24. Thus, the passage 24 allows the maximum volume of heated gases to pass through into the furnace with minimum loss while creating sufficient turbulence for effective heat transfer to the moving strip 12.

FIGS. 2 and 3 show an enlarged view of the plenum chamber 22 which provides means for admitting the heated gas into the heat exchange passage 24 and hence into the heat insulated baffle 28 and the other areas of the furnace. Twin inlet ducts 36, located on opposite sides of the heat exchange passage 24, allow entry of the heated gases into the chamber 22 from external heating and propelling means, not shown, which may be generally as described in the aforementioned copending application. An exit passage 23 from the plenum chamber 22 is provided for the gases to enter the heat exchange passage 24.

It is necessary that the plenum chamber 22 admit the heated gas into the furnace in equal proportions on both sides of the longitudinally moving strip 12. The twin inlet ducts 36 initially divide the heated gases entering the plenum chamber 22. Two sets of crescent shaped vanes 38, each vane spaced equidistant from the adjacent vanes in its set, turn the heated gas towards the upper space 40 of the plenum chamber 22. The vanes 38 are diagonally disposed within the plenum chamber 22 in the direction of gas flow, as shown in FIG. 2, and each set is located to receive the heated gas entering from one of the twin inlet ducts 36.

As can be seen from the drawing, the heat exchange passage 24, by which the heated gases enter the furnace proper, has its beginning centrally located with respect to the walls of the plenum chamber 22 and just below a narrow entrance channel 25, which abuts the entry slit 8 and through which the strip enters the furnace and passes into the passage 24. The heat exchange passage 24 has a mouth 42 extending laterally from the front wall to the back wall of the plenum chamber 22. The mouth 42 is formed by streamlined lips 43 for a smooth well-rounded inlet at the entrance of the heat exchange passage 24. The lips 43 are shaped to afford entrance of the heated gases into the heat exchange passage 24 with a minimum of fluid friction and are shaped to convert static pressure energy into velocity pressure energy with a minimum energy loss. A low static pressure at this point makes it possible to have an opening into the furnace through which the moving strip 12 may enter without appreciable loss of the heated gases from the furnace.

Thus, it can be seen that the hot gases are initially divided and enter the plenum chamber 22 via the twin inlet ducts 36. The sets of turning vanes 38 evenly divide the heated gas to distribute it across the plenum chamber and direct it upward to the upper area 40. From the upper area 40 the gas enters the mouth 42 of the heat exchange passage 24 where half flows longitudinally along one face of the moving strip 12 while the other half of the heated gas flows longitudinally along the other face of the moving strip. In this manner, equalized centering forces will act upon the moving strip 12 during its travel through the heat exchange passage 24 at points just below each constriction 32 of each section 34, as previously described.

It is now readily apparent that a continuously moving strip heat treating furnace has been provided which has means for centering the moving strip in its travel through the heat exchange passage 24 while being brought up to soaking temperature with a minimum of delay. Sufficient turbulence of the heated gases has been provided to insure an adequate transfer of heat from the gases to the moving strip, yet the fluid friction total pressure loss of the gas stream itself has been minimized by the convergent-divergent sections 34 which provide venturi surfaces which not only minimize the pressure loss but also center the strip. The plenum chamber 22 provides means for adequately controlling the heated gases upon entry into the furnace so that little heat loss occurs through the entry slit 8.

While this invention has been described with a certain degree of particularity, it is to be understood that all modifications, alterations and combinations within the spirit and scope of my invention are included.

I claim as my invention:

1. In a heat treating furnace, twin inlet ducts for the entrance of heated gases, a plenum chamber including vertically extending side walls and front and back walls for containing said gases, means defining a heat exchange passage equidistantly located from the side walls of the plenum chamber and having a mouth extending laterally between the front and back walls, a plurality of substantially crescent shaped vanes facing upward and disposed in two sets in the plenum chamber on opposite sides of said passage, each set diagonally disposed with each vane spaced equidistant from the adjacent vanes in its set, said passage extending into the main portion of the furnace, said passage defining means including a series of longitudinally aligned sections, each section having a constriction at the upper end thereof and slowly flaring out therefrom towards the next section, and means for directing gases through said passage in equal proportion on each side of the strip.

2. In a heat treating furnace, a tall insulated furnace housing, conduit means forming a thin heat exchange passage of substantial width extending vertically within said housing, means for directing a longitudinally moving strip vertically through said passage, a plenum chamber positioned on both sides of the upper end of said passage and extending across the width thereof, horizontally extending openings at the upper end of said passage providing fluid communication between said plenum chamber and said passage, inlet ducts for introducing heated gases into said plenum chamber, gas distribution means within said plenum chamber for producing a constant gas flow across the entire length of said horizontally extending openings.

3. A heat treating furnace comprising a furnace housing, walls defining an elongated heat exchange passageway within said housing, said passageway being narrow and of substantial width to closely enclose a strip of material moving longitudinally therethrough, means defining a plenum chamber at one end of said passageway extending across the width of said passageway on both sides thereof, elongated openings extending across the width of said passageway and communicating between said plenum chamber and said passageway, conduit means extending parallel to said elongated openings for supplying heated

gases to said plenum chamber, vanes in said plenum chamber for delivering equal quantities of gas across the lengths of said openings.

4. A heat treating furnace comprising a furnace housing walls defining an elongated heat exchange passageway within said housing, said passageway being narrow and of substantial width to closely enclose a strip of material moving longitudinally therethrough, means defining a plenum chamber extending across the width of said passageway on both sides thereof, elongated openings extending across the width of said passageway, conduit means extending parallel to the width of said passageway for supplying heated gases to said plenum chamber, a plurality of crescent shaped vanes facing said conduit means and said openings and grouped in two sets, the

vanes of each set positioned along a line extending from a point adjacent the end of each said opening closest to said conduit means angularly away from said openings and said conduits.

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