Dec. 4, 1923. 1,476,142

G. D. BRADSHAW

FURNACE

Filed June 9, 1921 2 Sheets-Sheet 1

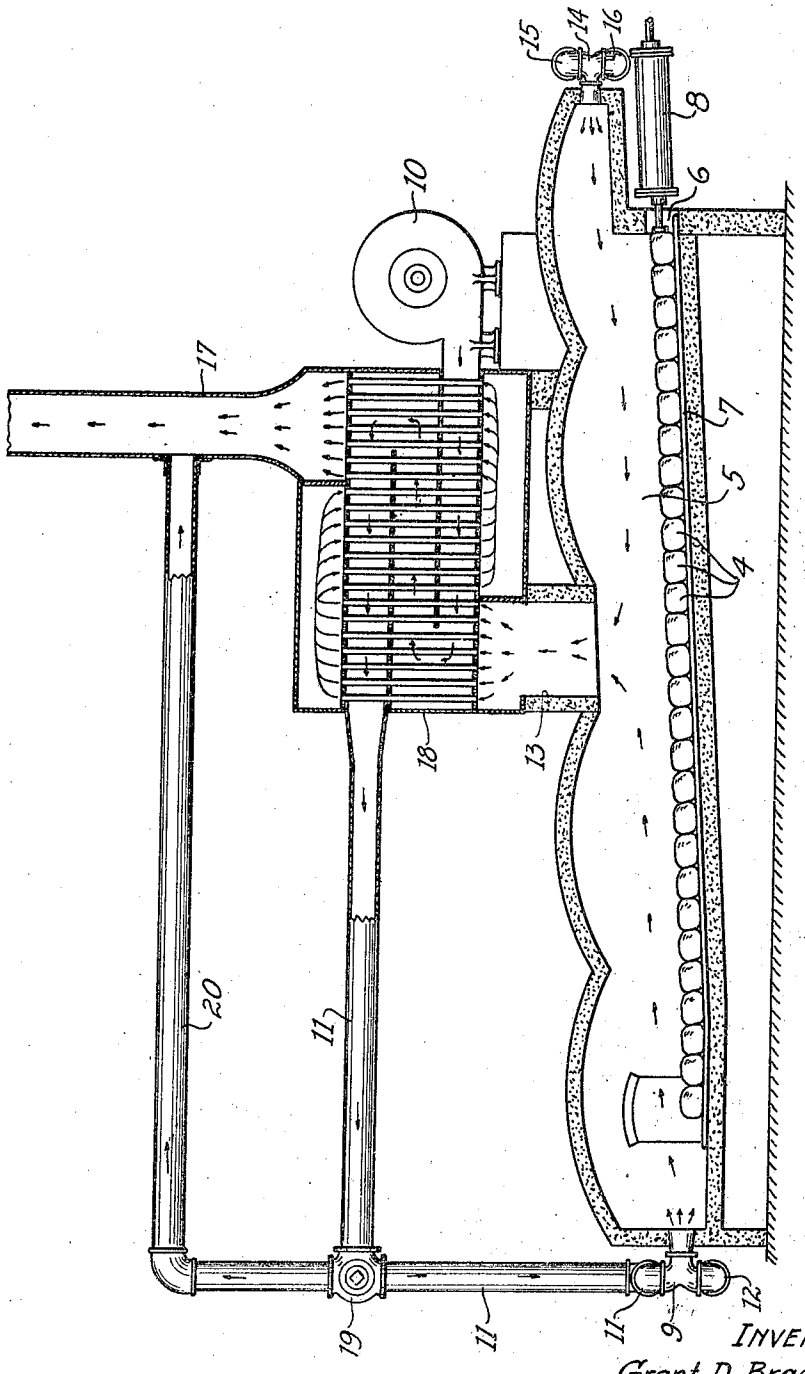


Fig. 1

INVENTOR:
Grant D. Bradshaw
By E. J. Andrews
Atty.

Dec. 4, 1923. 1,476,142

G. D. BRADSHAW

FURNACE

Filed June 9, 1921 2 Sheets-Sheet 2

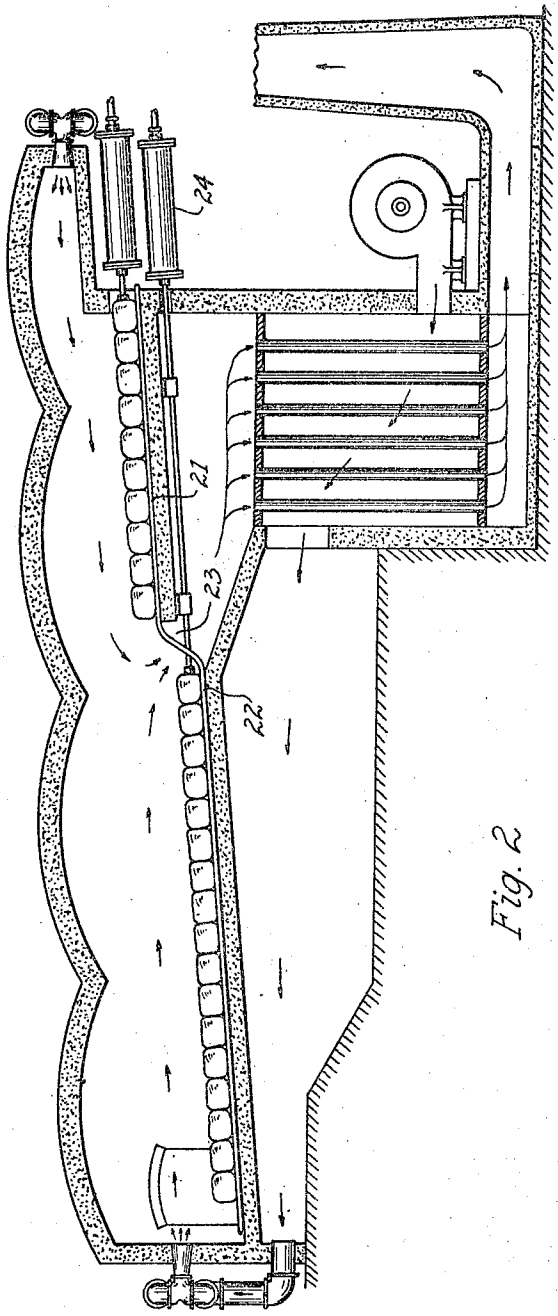


Fig. 2

INVENTOR:
Grant D. Bradshaw
By E. J. Andrews
Atty.

Patented Dec. 4, 1923. 1,476,142

UNITED STATES PATENT OFFICE.

GRANT D. BRADSHAW, OF PITTSBURGH, PENNSYLVANIA.

FURNACE.

Application filed June 9, 1921. Serial No. 476,148.

To all whom it may concern:

Be it known that I, GRANT D. BRADSHAW, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

This invention relates to furnaces which are used for heating metal billets or for other similar purposes, and it has for one object a method of operating such furnaces in order to increase the capacity and the efficiency of the furnaces, and a further object is to produce suitable apparatus for carrying out the improved method.

It has been customary in operating continuous billet furnaces to pass the billets in at one end of the furnace and take them out at the other end of the furnace, and also to pass the hot gases, which are intended to heat the billets, in at one end of the furnace and out at the other end, usually in a direction opposite to that of the movement of the billets. If the billets and gas move in the same direction from one end of the furnace to the other the hot gases will first come in contact with the cold billets and will impart heat rapidly thereto according to the law of the transference of heat by gases to solids, which is in furnace practice substantially as the fourth power of the differences in temperatures between the gases and the billets. But as the gases approach the other end of the furnace, much of the heat having been extracted from the gases and the temperature of the billets having been materially increased, the temperature of the two substances rapidly approximate each other, and the rate of heating is very materially reduced. Also in such a case, in order to heat the billets sufficiently it is necessary to pass the gas off from the furnace at an extremely high temperature and hence the capacity of the furnace is materially decreased and complex recuperating mechanism is necessary in order to maintain a reasonable efficiency. On the other hand if the gases and billets move in opposite directions from one end of the furnace to the other the hot gases entering the furnace come in contact with the hot billets, and as the temperature of the gases decreases the temperature of the billets likewise decreases, and the difference in temperatures, although increasing somewhat towards the gas exit, does not become very great. Hence, as a consequence of the law of heating, the heat is not transmitted from the gases to the billets at a very high rate, and the capacity of the furnace is in this way limited.

I have found that a materially greater capacity and efficiency is arrived at and maintained by a combination of these two methods of associating the gases and billets. In order to transmit to the billets the heat of the gases at a maximum rate I pass a portion of the hot gases in at the end of the furnace where the billets enter, the gases and the billets moving thus in the same direction. At the same time, in order to raise the temperature of the billets to the required amount most efficiently, I also pass hot gases into the end of the furnace from which the billets are removed, so that the heated billets come in contact with gases at the highest temperature. I then pass the hot gases, coming from both ends of the furnace, out of the furnace at some point intermediate the two ends. By this method heat is passed to the billets at a much greater rate from the gases moving in the same direction as the billets than is the case with the gases moving in the opposite direction, and at the same time, by passing some gas in at the end where the hot billets are removed, the temperature of the billets is raised to the desired point with less gas and more efficiently than when all of the gas and the billets pass continuously in the same direction.

Of the accompanying drawings Fig. 1 is a central sectional view, more or less diagrammatic, of a furnace and its attachments, which embodies the features of my invention; and Fig. 2 is a similar view of a modified form of apparatus which may be used in carrying out my method.

Referring to Fig. 1 the billets 4 to be heated are passed into the heating chamber 5 of the furnace, through an opening 6, at, what may be called for convenience, the rear end thereof; being mounted on skid pipes 7 which are kept sufficiently cool in any suitable or ordinary manner. The billets are passed into the furnace in any suitable or ordinary manner and are pushed towards the forward end of the furnace by means of suitable mechanism such as the ordinary pusher 8. The billets are then taken out of the forward end of the furnace in the usual manner. The manipulation of the

billets in this instance may be in all respects substantially similar to the ordinary manipulation of billets in an ordinary continuous furnace, except that the rate of movement of the billets may vary somewhat materially from the ordinary rate with furnaces of a similar size.

A gas burner 9 is mounted in the forward end of the furnace receiving air from any suitable source of supply and also combustible gas, the air being supplied by means of a blower 10, and passing into the burner through a pipe 11, and the gas through the pipe 12 which is connected with any suitable source of gas supply. The burned gases from the burner pass into the furnace and over the billets moving counter to the billets for a material distance, and they are then passed out of the furnace in any suitable manner such as by means of the conduit 13, which is intermediate the two ends of the furnace. At the same time hot gases are generated in the gas burner 14, in the rear of the furnace, the burner being supplied by air and combustible gases from the respective pipes 15 and 16. The hot gases from the burner 14 pass in the same direction as the billets for a material distance and then are also passed out of the furnace in any suitable manner. In this instance I have indicated the exit for these gases also as the conduit 13, the flow of the gases throughout the system being indicated by the arrows. It is to be understood that the exact location of the conduit 13 is not a necessary feature of my invention, nor is it necessary that the two streams of hot gases coming from opposite directions shall pass out of the same conduit.

The hot gases after leaving the heating chamber of the furnace may be transmitted to any suitable heat utilizing device, or directly to the chimney 17 of the furnace as is ordinary, or as may be desired. I prefer to pass the gases to some form of recuperator 18, or to some other heat economizing apparatus, so that more heat may be extracted from the gases before they are passed to the chimney. By means of the recuperator the air for the burners may be heated; and, if desired at times, a portion of the hot air may be passed directly to the chimney through the valve 19 and the pipe 20.

Without desiring to enter into any strict mathematical demonstration of the differences between the results obtained by my method and those ordinarily obtained, attention is called to the following suggestions as a basis for the alleged differences:

Assuming the law of heating involved to be as the fourth power of the differences in the temperatures it is evident that a slight increase in this difference will produce a material increase in the rate of heating, so that a slight increase only will substantially increase the capacity of the furnace. If, for instance, the difference is only two per cent, the increased rate will be over eight per cent. This, however, is assuming that the difference is uniform throughout. In practice this will not be true and the increased heating will be equal to the mean of the fourth powers of all of the differences, which may be less than the fourth power of the mean of all the differences. But, a consideration will show that, with proper arrangements, the mean of the fourth power of all of the differences with my method will be much greater than with the old methods.

Assuming the initial and final temperatures of the billets and also the temperatures of the gases to be unchanged, it is evident that the hot gases entering in the rear and coming in contact with the cold billets will have an enormously greater temperature than the billets, and the differences in temperatures will be enormously greater than the differences with the old method, as with the old method the coolest gas is in contact with the coldest billets. At the same time the differences in the front of the furnace will be substantially the same in the two cases. The counter currents of gases, a distance away from the front end, will be even nearer the temperature of the billets by my method than by the old method, as the temperature of the billets necessarily will be higher due to the effect of the gases entering from the rear, so that in this regard there is a slight loss by my method. That this is true is evidenced by the fact that, with equal amounts of gases in the two cases, the stream from the front must be much slower than by the old method, as only a portion of the gases enters at this point; and, hence, by my method the gases which enter at the front will be materially longer in contact with the billets, thus necessarily more nearly approaching the temperature of the billets. But the difference in temperature between the billets and the gases entering at the rear end, and until the gas outlet is reached, is so much greater than by the old method that the decrease in difference near the other end is much more than offset. Also it is evident that the amount of increase in difference will depend upon the position of the outlet or inlet, the relative amount of gases entering the inlets, the total amount of gases entering, and the rate of movement of the billets as well as the maximum temperatures of the gases and the billets if changes therein are made. Hence it is to be understood that the exact proportions or arrangements in these regards are not to be considered as essential to the invention in general which I have made.

In reference to the relative results of the old method and my method we may consider

the following: If the rate of outflow of the gases and the rate of movement of the billets are unchanged, by my method, as more heat is imparted to the billets in the same time, the maximum temperature of the billets will be increased and the temperature of the outgoing gases decreased. However, by increasing the rate of movement of the billets, and thus increasing the capacity of the furnace, the maximum temperature of the billets may be reduced to the normal amount. But it will be found that the outlet temperature of the gases will then be decreased still more, as the difference in temperatures will be increased due to the cooler billets. As a consequence the rate of flow of the gases may be increased and this allows a further increase in the movement of the billets, so that with a given size of furnace the capacity thereof may be, for these reasons, materially increased. Or if it is desired, the gases may be passed from the furnace at a lower temperature and the complications of the recuperating system may be simplified.

In the modified form of apparatus indicated by Fig. 2, the billets are moved along the upper skids 21 towards the center of the furnace, and, at some suitable point, are dropped on to the lower skids 22, and the gases pass out from the heating chamber through the space 23 between the adjacent ends of the rows of billets, as indicated. In this case a second pusher 24 may be used in order to move forwardly the billets on the lower skids. The general method carried out by this apparatus is substantially the same as the method carried out by the apparatus indicated by Fig. 1.

I claim as my invention:

1. A method of heating articles consisting in passing articles through an elongated heating chamber by moving them from one end to the other, by passing hot gases in at both ends of said chamber at points adjacent the entrance and the exit of said articles, and in passing said gases out of said chamber intermediate the points of entrance thereof.

2. In a continuous heating furnace a heating chamber, means for passing articles to be heated in one end of said chamber and out of the other end thereof, means for passing hot gases into said chamber at both ends thereof, and means for passing the said hot gases out of said chamber at some point intermediate the ends of said chamber.

3. A method of heating articles consisting in moving a row of articles in contact with streams of hot gases, the streams passing from both ends of the row of articles towards the central portion of the row.

4. A method of heating articles consisting in moving them in contact with a stream of hot gases moving in the same direction as the articles, and then in moving the articles in contact with a stream of hot gases moving in a direction opposite to the direction of movement of the articles.

In testimony whereof, I hereunto set my hand.

GRANT D. BRADSHAW.