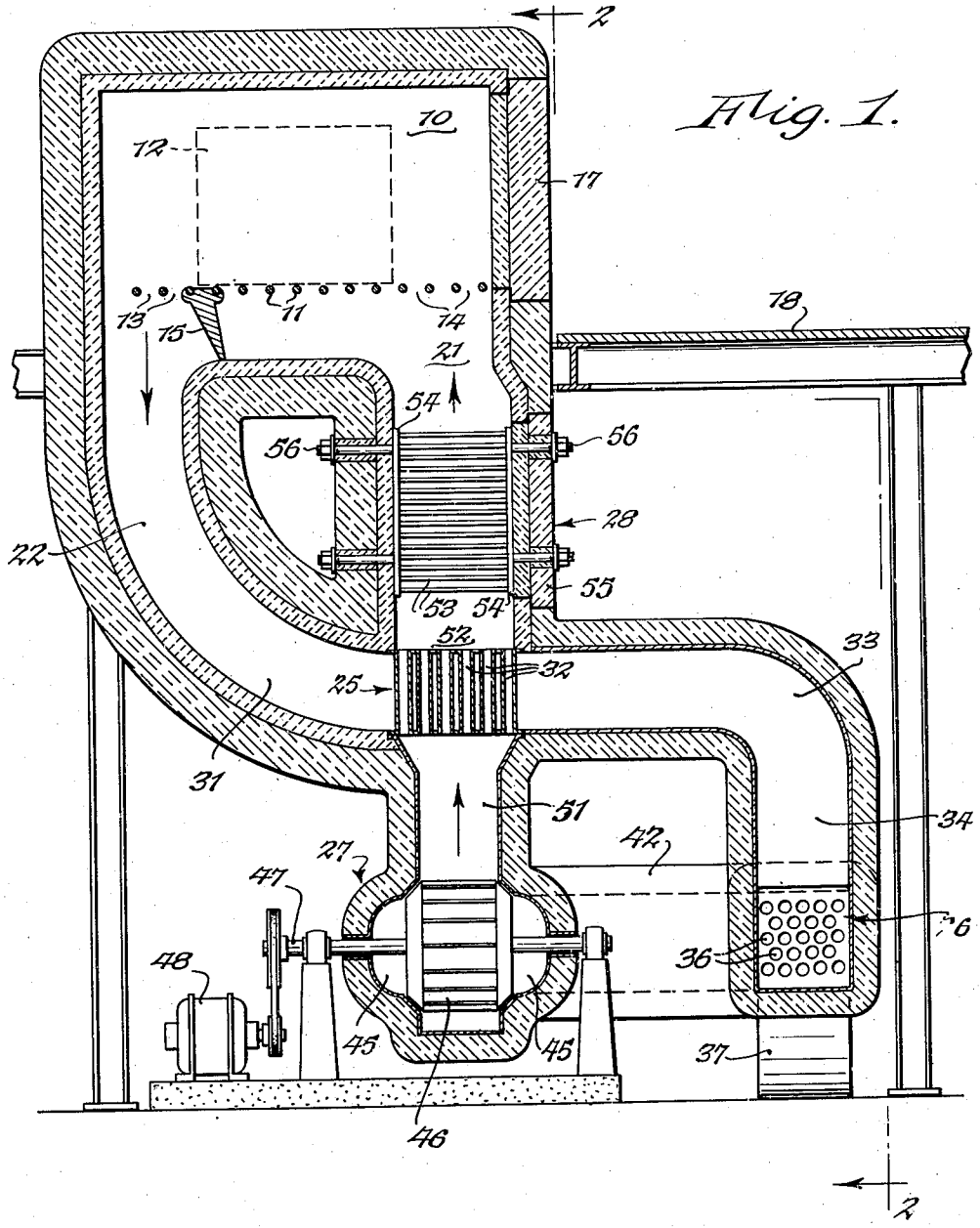
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HIGH TEMPERATURE HEAT TREATING FURNACE

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Fig. 1.



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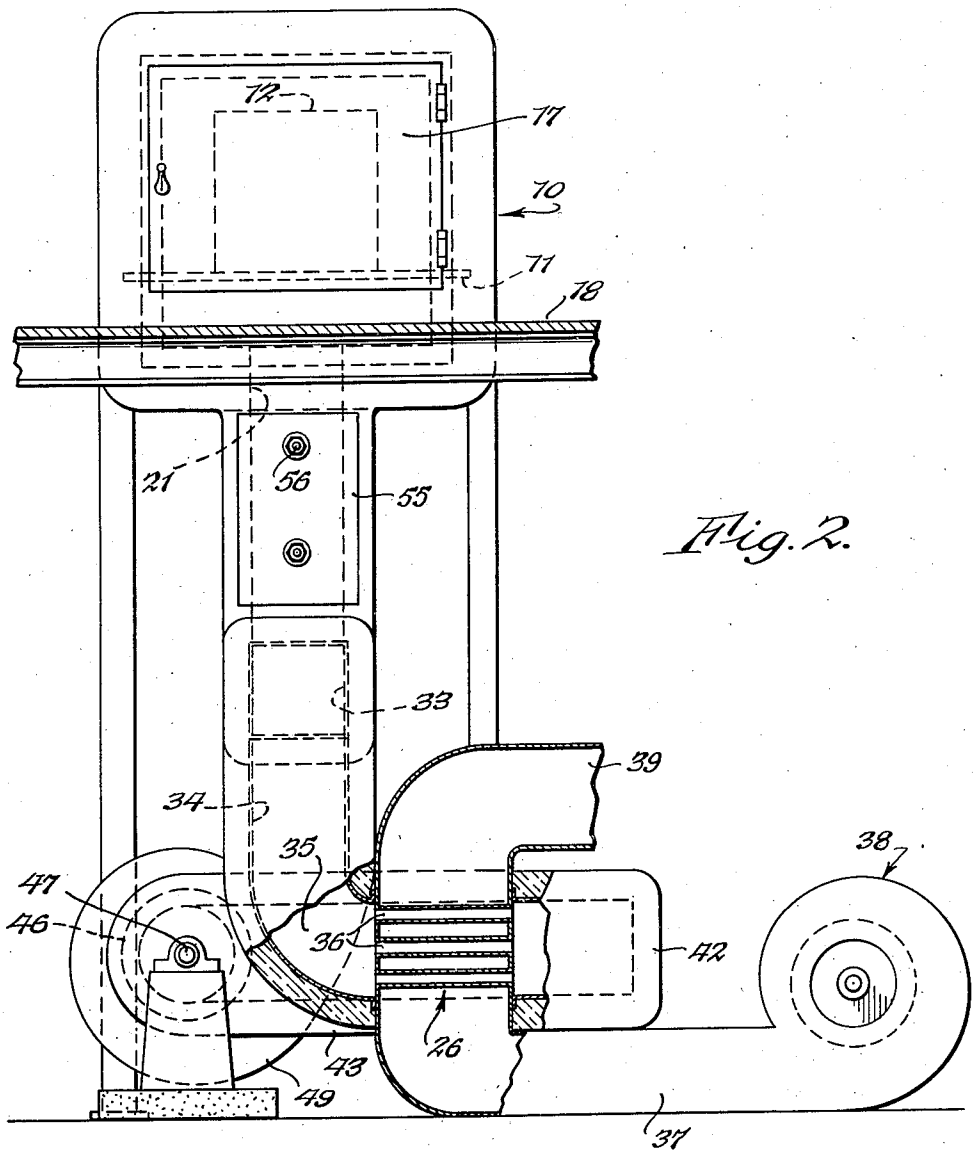


Fig. 2.

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HIGH-TEMPERATURE HEAT-TREATING FURNACE

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7 Claims. (Cl. 263—15)

This invention relates to a furnace for heat treating various articles by means of a blast of hot air or other gases, and it is concerned particularly with the provision of means for heating with a circulating stream of air at relatively high temperatures.

There are various articles, such as heat interchanger cores which are made of thin metallic tubes and plates, which can be integrated into their final form by the application of heat, provided, however, that the heat so applied is sufficient to effect the desired fusion without melting or warping or otherwise spoiling the work. Of the various types of furnaces heretofore available, and to which the art has turned for this and other delicate operations, two may be mentioned. In one, the work is placed on the hearth and is heated, usually by radiant heat, in a stagnant atmosphere, natural convection being relied upon to bring the articles up to temperature. In such a furnace, the upper temperature limit depends, of course, primarily on the quantity of heat supplied by the heating elements and the efficacy of the insulation. The trouble with this type is that while high temperatures can be attained, the heating cycle is too long, and the outer portions of the articles will be overheated and be burned before the inner portions have been brought up to temperature.

Another type of furnace is the forced draft air or gas furnace, wherein the atmosphere is circulated by a fan, the theory being that the relatively rapid movement of the air curtails the heating-up portion of the cycle, and thus permits saturation of the inner portions before surface overheating occurs. This type may be embodied in successful forms for low temperature applications, but has not heretofore been applicable to high temperature work.

One reason for such failure is due to the destructive effect of blasts of high temperature atmospheres on most materials of construction. Thus, a hot air or hydrogen blast at a temperature much above 1500° Fahr. will corrode or embrittle steel or the common alloys of which fans and blowers are made, with the result that the equipment soon fails. The quest for more resistant metals as materials of construction has not been successful. Accordingly, the common practice today is to turn over articles requiring high temperature treatment to skilled workmen for hand processing during the course of assembly—a method which adds tremendously to manufacturing costs and curtails the output of vitally needed equipment.

The present invention provides a solution for these problems by means which effect the propulsion and circulation of the air as though the furnace were operating in a safe low temperature range, together with means for supplying heat to the moving atmosphere to bring its temperature into the high temperature range. The furnace accordingly operates without the destructive effect just noted, and also takes advantage of the benefits of a forced draft type, thereby permitting delicate work to be heat treated on a production basis. Such furnace, as will be appreciated by those skilled in the art, moreover provides a tool or instrumentality for the extension of hydrogen brazing to applications not previously deemed feasible.

One form or embodiment of the principles of the invention is illustrated in the accompanying drawings, wherein:

Fig. 1 is a vertical section through a typical installation, showing the components thereof; and

Fig. 2 is an end view, partially in section and partially in elevation, taken substantially along the line 2—2 of Fig. 1.

Referring first to Fig. 1, the numeral 10 designates a heat treating furnace including a hearth or work-receiving platform 11 upon which may be placed one or more articles 12 to be heat treated. The platform 11 preferably is perforated at least at its end portions 13 and 14 for the admission and withdrawal of a hot gas blast, and it may be provided on its under side with one or more adjustable baffles 15 so that a portion of the entrant air may be diverted through portions of the work—a provision enabling more rapid saturation of such articles as heat exchange cores wherein dual flow through and around the tubes may be effected. Access to the platform 11 is had through a door 17 conveniently located with respect to the floor or handling platform 18, so that the work 12 can be inserted and removed as desired.

The furnace 10 and its contents are heated by means of a forced draft of gas, such as air, hydrogen, or nitrogen, which enters through a flue 21 for flow through the platform 11 and around the work, and which is removed through a flue 22. As thus far described, the furnace corresponds generally to known types of apparatus, and therefore a more extended discussion of the materials of construction and fabrication is believed to be superfluous. It may simply be noted here that, as will appear from the following portions of the description, it is intended that the entering gas may be at a relatively high temperature, say 2000° to 2400° Fahr., which is appreciably above the temperatures heretofore tolerated, and therefore the brickwork and lining should be chosen to withstand such temperatures for a long time. The platform 11 and baffles 15, being simple bar and plate forms, may be permitted to suffer deterioration, since they are cheap and are designed for ready replacement. Under such entrance conditions, and

depending upon the velocity of the draft and the heat absorbing nature of the work 12, the returning atmosphere may be at any temperature from say 100 to 400 degrees lower than the entrance temperature.

Upon inspection of Fig. 1, it will be seen that air leaving the furnace 10 through the flue 22 travels in a figure eight path en route to the entrance flue 21. In successive order from the flue 22, the returning atmosphere passes through one pass of a heat interchanger 25, flows thence to a cooler 26, is then inducted into a blower 27 for discharge through the other pass of the interchanger 25, is heated by the heater 28, and is then admitted into the entrance 21 for recirculation through the furnace 10. This cycle therefore contemplates successive temperature reductions in the return gas in the heater interchanger and the cooler, whereby the blower handles relatively cold gas, and successive heatings of the forced draft in the interchanger and heater. The blower accordingly operates at permissible low temperatures, while the furnace operates at high temperatures on the forced draft, closed cycle principle, a result which, as it is believed, has not heretofore been attained

The heat interchanger 25, which is connected to the flue 22 by the elbow 31, consists of a conventional form of spaced tube core, and is so installed that the returns flow in the spaces around the tubes. The returns thus correspond to the hot gases in a water tube type of boiler, the blower discharge passing through the tubes 32. A certain amount of the sensible heat of the returns is accordingly extracted with the result that the temperature will drop (depending, always, of course, on particular operating conditions) to say 1800° Fahr. from 2000°–2100°. The partially cooled returns then flow through the elbow 33 into a downcomer 34, and thence, through a lateral elbow 35 (see Fig. 2) through the tubes 36 of the cooler 26. Here, it will be noted, the flow of the returns through the cooler 26 is in fire tube fashion.

The cooler 26 is herein illustrated as a forced draft air cooled type, although it will be understood that water cooled types may be used if provision is made to take care of the steam volumes which tend to form at the temperatures just indicated. The cooler 26 is connected by a duct 37 to the discharge side of an auxiliary blower 38, operated by a motor or other source of power, not shown, and which serves to force a blast of cold air around the tubes 36. The opposite face of the cooler 26 is connected to a waste duct 39, by means of which the heated air may be sent to waste, or conveyed to a combustion type boiler or other equipment where the heat of the air blast may be used to advantage. In the present embodiment of the invention, it may be assumed that the cooler 26 is of such size as to reduce the atmosphere from the furnace 10 to about 1400° Fahr., which is a safe temperature for the blower and other parts of the installation. Obviously, greater cooling may be effected if operating conditions so warrant.

Upon emerging from the cooler 26, the returns enter a U bend 42 which connects to a duct 43 terminating in the suction chambers 45 of the blower 27. This unit is of the squirrel cage type, having a rotor 46 mounted on a shaft 47 which is belt-driven by the motor 48. The snail 49, or discharge side of the blower, is connected to a riser 51 which is lined up with the entrance flue 21, as best shown in Fig. 1.

As previously noted, the blower discharge flows through the tubes 32 of the heat interchanger 25, wherein it was assumed, for example's sake, that the hot returns had been reduced in temperature some two or three hundred degrees. The heat lost by the returns is taken up by the blower discharge, so that the gases entering the riser 51, and which were considered to be at about 1400°, are now reheated to say 1700°. This, however, is below the desired entrance temperature for the furnace 10.

Accordingly, an electric resistance heater 28 is positioned in advance of the platform 11. The gases leaving the interchanger 25 at the region marked 52 flow around a number of heating elements 53 supported on end plates 54, and which are accessible through a removable panel section 55 of the flue wall. These elements are advantageously made of a highly resistant material such as silicon carbide, which will withstand temperatures in excess of 2400°, and to which the electric current is supplied by means of bus bars 56. Obviously, the selection of the materials here will depend upon the desired temperature for the furnace atmosphere, and under some conditions it may be found preferable to use flame heat. Temperature regulation may be obtained by the usual forms of thermostatic control. In any event, the re-heated furnace atmosphere now enters the furnace 10 through the flue 21, thus completing the cycle.

It will thus be seen that, while in the common form of hot blast furnace, it is the custom to supply make-up heat to the circulating gases equal to the amount of heat lost to the work, the present invention contemplates the wilful extraction of much greater quantities of heat from the returns, although, of course, such extracted amounts must later be replenished. This, of course, appears to be a futile waste of energy, since whatever is lost to the cooler 26 must be compensated by additions from the reheater 28. This effect does exist, but it is reduced to a minimum by providing the heat exchanger 25 which restores to the circulating gases some of the energy taken from the returns.

As hereinabove pointed out, however, this energy loss, or rather, the cost of extracting and replenishing the heat, becomes an economical price to pay for the results which may be obtained in heat treating. There are many applications for the hydrogen brazing or welding method if the time cycle could be curtailed by using forced draft, and such applications are now made possible. Again, the destructive effect of high temperature gases has precluded successful use of forced draft, which may now be applied. The case of the thin walled heat interchanger initially noted is but one such application. It is believed unnecessary to multiply the examples, since those skilled in the art can utilize the present invention for various conditions and processes.

It is also to be understood that while certain simple forms of heat interchangers and coolers have been described, no novelty is claimed for them in detail, and the particular forms discussed have been chosen because of their simplicity and the facility with which they lend themselves to rapid installation. Each of the various elements of the system may obviously be substituted by such other form as the user may deem preferable. Likewise, the temperatures set forth herein are merely for exemplary purposes, and will naturally vary with conditions. It is therefore intended that the foregoing description shall be

considered as illustrative of the principles of the invention, and that no limitations shall be imposed thereon except as are set forth in the following claims.

We claim:

1. In a heat treating furnace having a platform for the work to be treated, an entrance flue for the admission of hot gas to the work, and a return flue for the withdrawal of the gas, a blower having an inlet connected to the return flue and an outlet connected to the entrance flue, means in the return flue in advance of the blower for cooling the return gases to a temperature at which they cause no material deterioration of the material of the blower, means in the entrance flue on the discharge side of the blower for heating the admitted gases to a selected temperature which would cause deterioration of the material of the blower, said cooling means and said heating means including at least one common element and each also having an undivided element whereby part of the cooling and heating is effected by heat interchange between the gas volumes in the respective flues.

2. A forced draft heat treating furnace comprising a closed furnace member having a work receiving platform, an entrance flue for admitting hot gas to the furnace member, a return flue for removing the gas from the furnace member, said flues and members forming a closed, endless loop in which the gas is circulated, a blower having an inlet connected to the return flue and an outlet connected to the entrance flue, heating means interposed in the entrance flue between the outlet of the blower and the furnace member for supplying heat to the gas, a heat interchanger with separate passages having one of the passages also interposed in series in the entrance flue between the outlet of the blower and the said heating means, said return flue also being connected through the other of said passages of said heat interchanger at a zone between said furnace member and the inlet of the blower.

3. A forced draft heat treating furnace comprising a furnace member having a work receiving platform, an entrance flue connected to the furnace member to supply hot gas to the work, a return flue connected to the furnace member for withdrawing the gas, said flues and member forming a closed, endless conduit in which the gas is circulated repeatedly, a blower for recirculating the gas from the return flue to the entrance flue, cooling means interposed in the return flue between the furnace member and the blower, said cooling means comprising a heat interchanger and a separate cooler, heating means interposed in the entrance flue between the blower and said furnace member, said heating means comprising the aforesaid heat interchanger and a further heating member.

4. A forced draft heat treating furnace comprising a furnace member having a work receiving platform, spaced entrance and return flues connected to the furnace member for admitting hot gas to and withdrawing spent gas from the platform, said flues and member together forming a closed, endless conduit through which the gas is circulated repeatedly, a blower having an inlet connected to the return flue and an outlet connected to the entrance flue, a heat interchanger with separate passes and having one pass interposed in the return flue to absorb from the returning gas a portion of the heat therein, a cooling member connected to said one pass to receive return gas from said interchanger for further removing heat from the return gas, said cooling member being positioned in advance of the inlet of the blower, said blower outlet being connected to the other pass of the heat interchanger, and a heating member interposed in the entrance flue between said last named pass and said furnace member.

5. A method of heating objects uniformly to a selected temperature which comprises placing an object to be heated in a closed chamber, circulating the same body of a gas as a confined, closed stream through said chamber in a continuous, closed circuit, crossing the portions of said stream moving towards said chamber with the portion leaving said chamber, in heat exchanging relation to each other, heating the gas entering said chamber in a zone between said crossing stream portions and said chamber, cooling the gas leaving said chamber in a zone after it passes said heat exchanging relation and before it returns to said heat exchanging relation, and applying a circulating force to said gas stream between said cooling zone and the heat exchanging relation.

6. In the heating of an object uniformly and rapidly by a circulating stream of gas in which it is placed, to a temperature which would be destructive to a blower used to circulate said gas as a stream, the improved method of forcibly circulating the gas as a confined stream in a closed major loop path in which path has spaced apart portions crossing in separate stream portions to form two minor loops, placing the object to be heated in the stream in one of said minor loops, effecting a heat exchange between the gas of the stream in the crossing portions thereof, heating the gas of said stream in said one loop between the crossing portions and said object in a zone in which the stream is moving from the crossing portion to said object, cooling the gas of said stream in a zone of the other of said minor loops, and applying the circulating force to said stream in a zone of said other minor loop between said cooling zone and the crossing portions in a direction of movement of said stream, whereby the cooling of the stream immediately before the circulating force is applied thereto will protect any mechanism in the stream used to apply that force, and the heat losses will be a minimum.

7. In the heating of an object uniformly and rapidly, by placing it in a heated stream of gas circulated in a closed path by a mechanical blower, to a critical temperature which would be unduly destructive upon said blower, that improvement therein which comprises the steps of cooling the gas of the stream passing the object before it reaches the blower, effecting a heat exchange between the gas of the stream in the portion leaving the blower and before it reaches said object, and the portion of the stream leaving said object and before it is cooled, and heating the portion of the stream approaching the object from the blower after its heat interchange with the portion of the stream leaving the object.

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