Nov. 25, 1952 J. WALLERIUS 2,619,341

HEAT-TREATING FURNACE

Filed Sept. 26, 1947 3 Sheets-Sheet 1

Fig. 1.

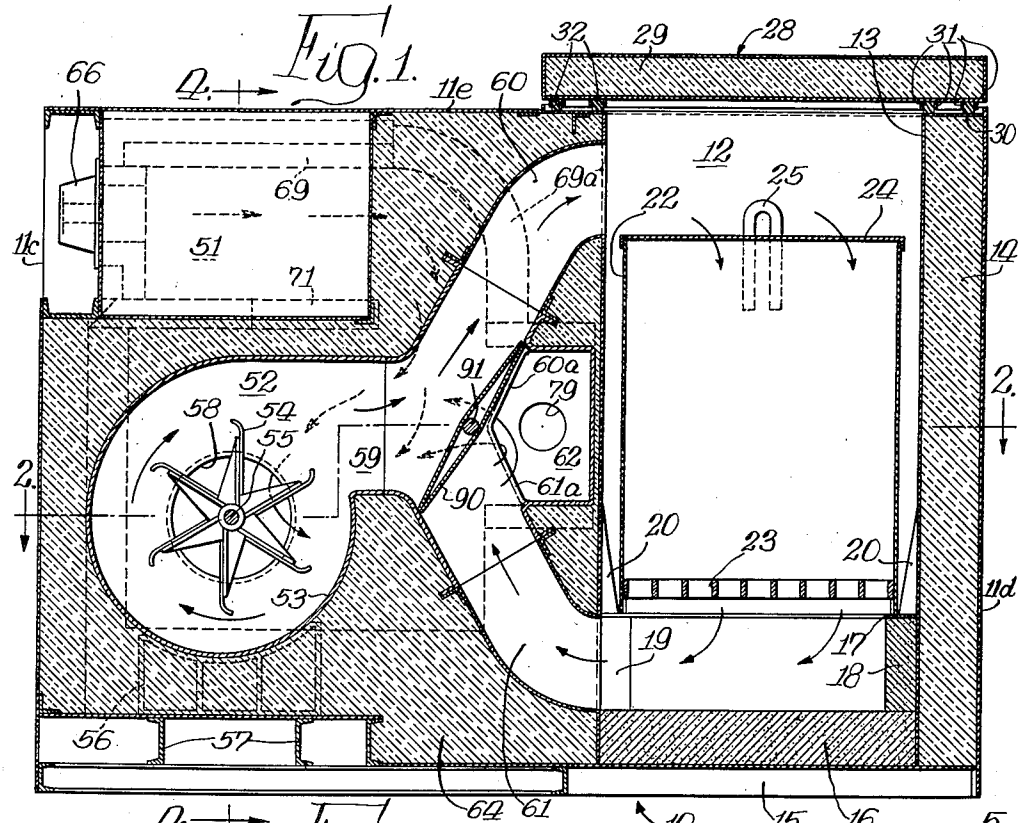
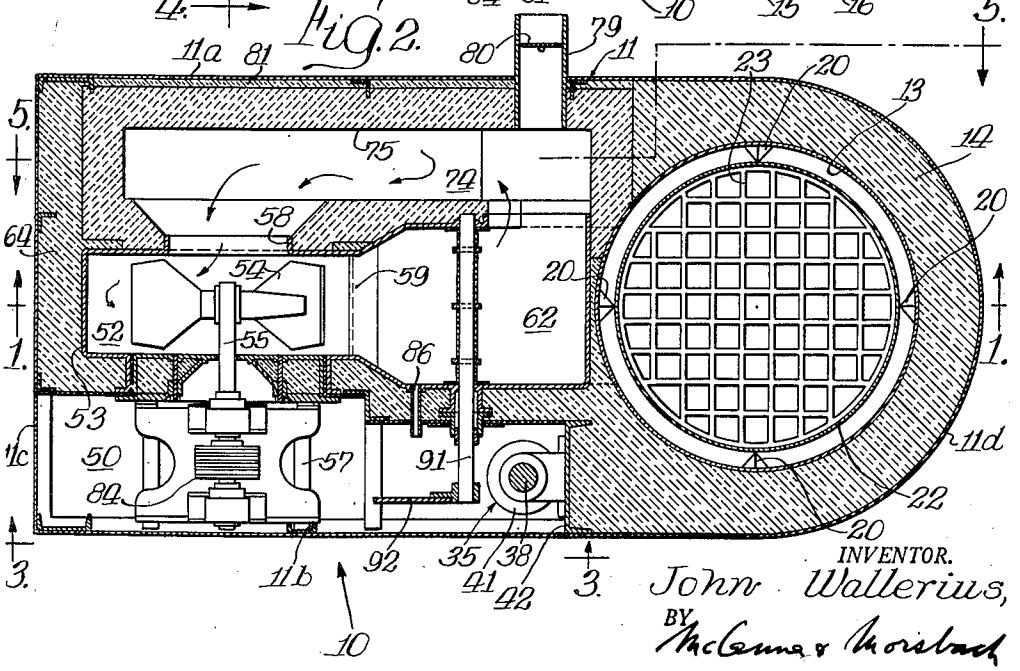


Fig. 2.



INVENTOR.
John Wallerius,
BY McGeman & Morsbach
Atty's.

Nov. 25, 1952 J. WALLERIUS 2,619,341

HEAT-TREATING FURNACE

Filed Sept. 26, 1947 3 Sheets-Sheet 2

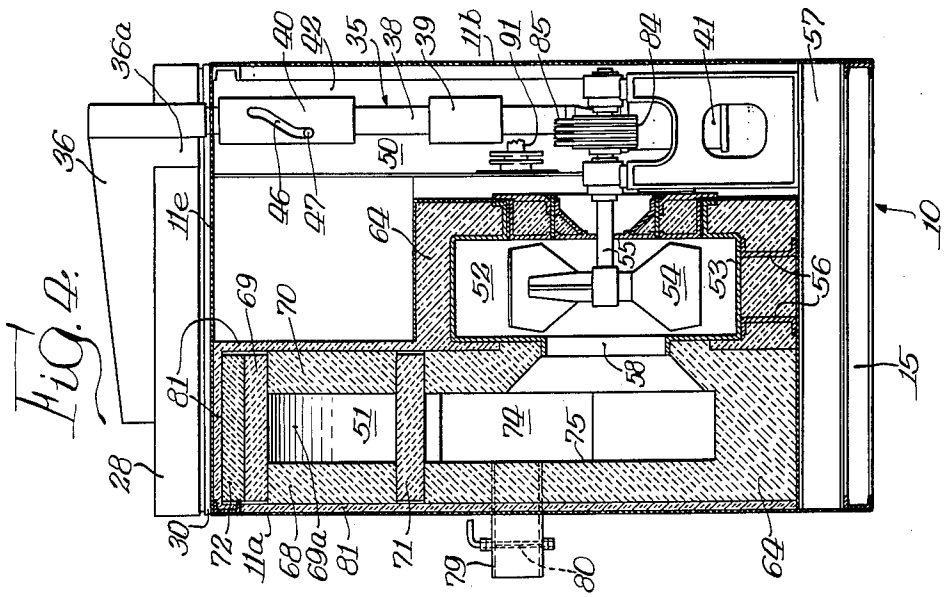


Fig. 4.

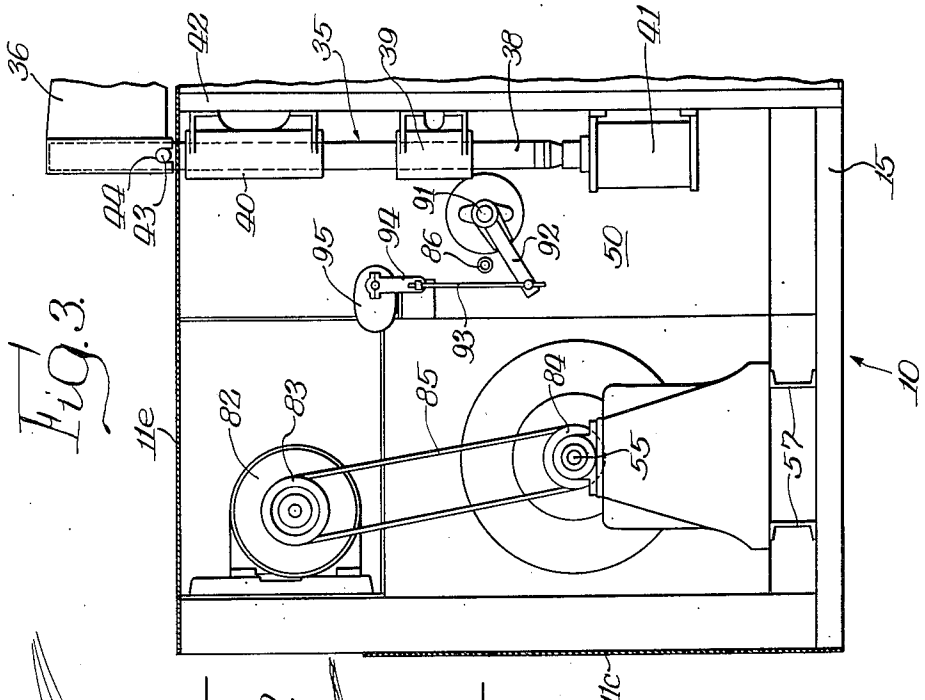


Fig. 3.

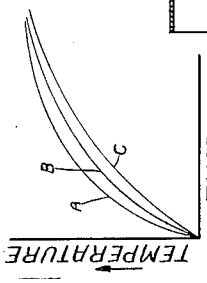


Fig. 7.

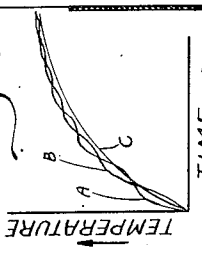


Fig. 8.

INVENTOR.
John Wallerius,
BY McCanna & Morsbach
Attys.

Nov. 25, 1952 J. WALLERIUS 2,619,341

HEAT-TREATING FURNACE

Filed Sept. 26, 1947 3 Sheets-Sheet 3

Fig. 5.

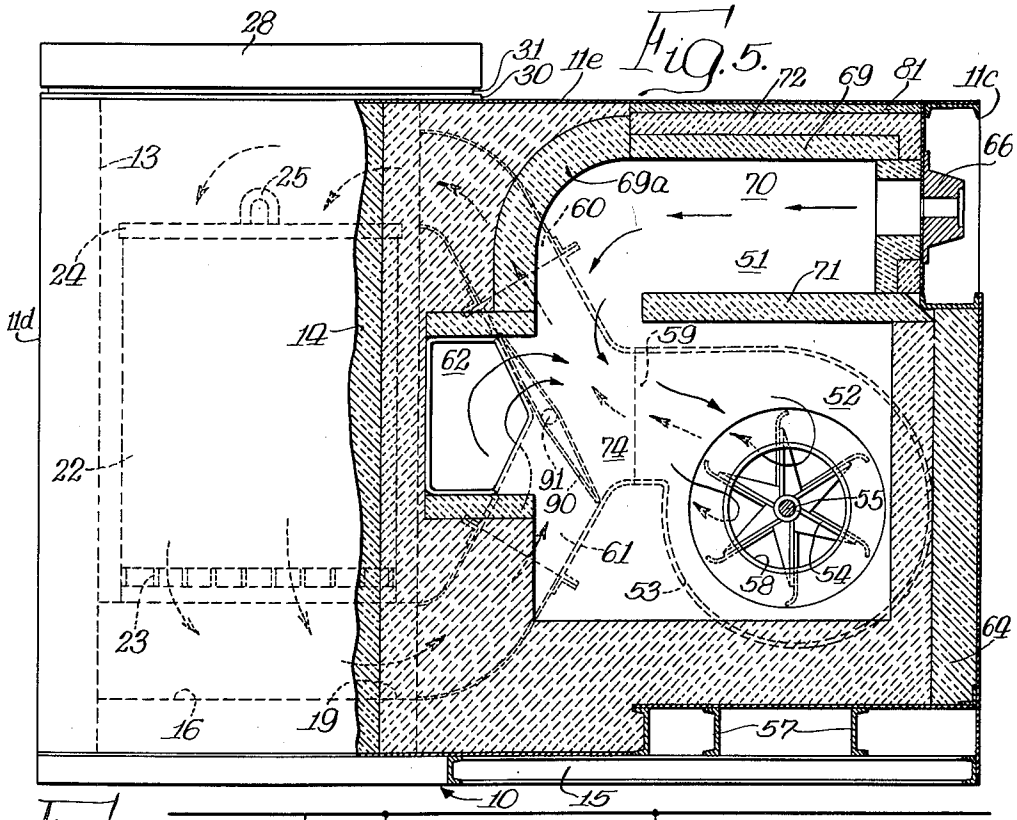
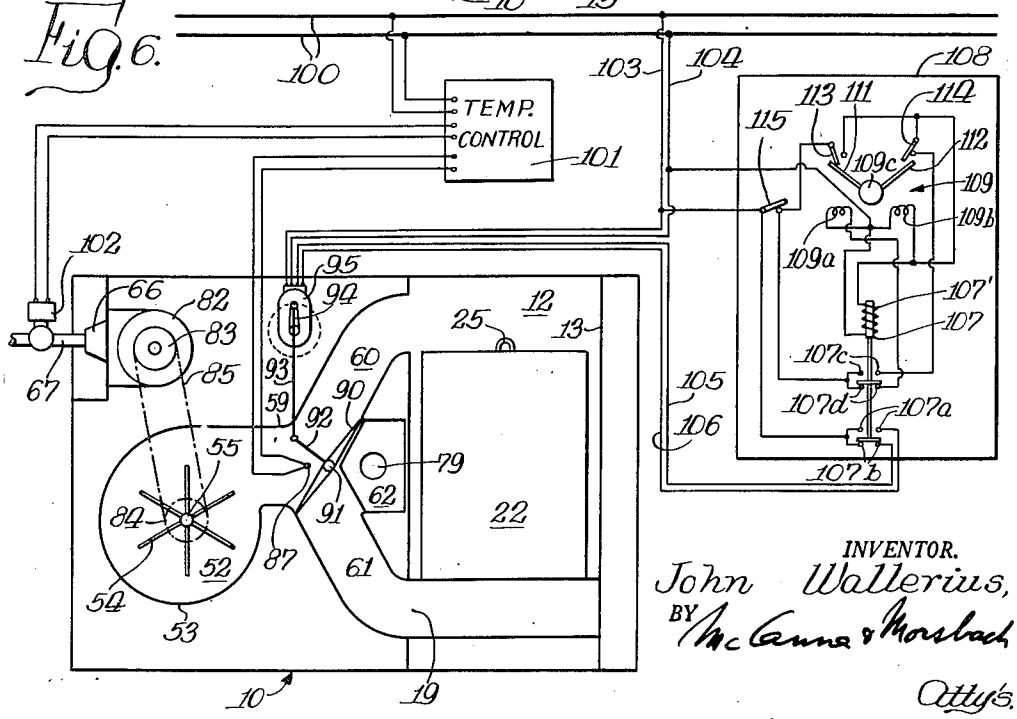


Fig. 6.



INVENTOR.
John Wallerius,
BY McCanna & Morsbach
Atty's.

Patented Nov. 25, 1952

2,619,341

UNITED STATES PATENT OFFICE

2,619,341

HEAT-TREATING FURNACE

John Wallerius, Glen Ellyn, Ill., assignor to Sunbeam Corporation, Chicago, Ill., a corporation of Illinois

Application September 26, 1947, Serial No. 776,213

3 Claims. (Cl. 263—15)

1

The present invention relates to heat treating furnaces and more particularly to recirculating hot air or gas furnaces particularly useful for low temperature heating in many types of work. Such furnaces are very satisfactory for tempering carbon and alloy steels, for annealing brass between drawing operations, for stress relieving castings, welding structures and cold worked metals, and for aging all types of castings. In addition almost all aluminum heating or heat treating and all heating operations and heat treating of magnesium can be carried out in such furnaces.

The recirculating heat treating furnace has been extensively used in recent years due to its efficient and high speed operation. With the advent of high temperature alloys it was possible to build fans which were trouble free and which could produce the large capacity for satisfactory heating. It is a well-known fact that in a recirculating furnace perhaps the most important factor is fan capacity. It is necessary to get high velocities of circulation to take full advantage of the convection principle for rapid uniform heating. The second important requirement of well-designed recirculating furnaces is an even distribution of the flow of gases or air through the work. The widespread use of recirculating furnaces has resulted in the following accepted advantages; uniformity of temperature throughout the furnace, high speed heating at relatively low temperatures, high speed heating through considerable depths of work, ability to maintain low temperatures without difficulty, operation through wide temperature ranges, capability of using oil as a fuel as well as gas or electricity, greater efficiency due to recirculation, and increased tonnage per furnace.

In the recirculating furnaces now in extensive use it has been found that the work which is being heated at the air or gas entrance to the heating chamber initially attains a much higher temperature than the work at the air or gas exit and a substantial length of time is required until the temperatures of the work at each end of the heating chamber are substantially the same. It has been discovered by extensive tests that the fastest and most uniform heating is achieved when the temperature drop of the gases through the work is a minimum. It is obvious that the temperature drop will be a minimum when the gases take the shortest and most direct path through the work. The greater the number of particles of work with which each particle of air or gas comes in contact the cooler the gas becomes and therefore the less heat can be imparted to each succeeding particle of work. The greater the amount of turbulence, or stirring action, of the gases, the more

2

the air or gas is cooled and the greater the variation of temperature of the work itself. The reduction of turbulence to a minimum has resulted in improvement of all types of recirculating furnaces. Additional tests have shown that when a load of work was heated in one of these furnaces the parts next to the inlet of the hot gases heated much faster than those near the outlet. This caused an ever increasing temperature variation through the work until a maximum point with respect to temperature variation was reached. Then, as the differential of temperature between the incoming hot gases and the nearest parts became less, more heat was left in the gases resulting in a relatively faster heating rate for the parts near the outlet. This gradually reduced the temperature variation through the load to an amount considered satisfactory for most work by the end of a reasonable heating period. It would be desirable to provide means for substantially reducing the temperature variation with the consequent reduction in heating time and the resulting increase in furnace capacity.

Accordingly it is an object of the present invention to provide a new and improved recirculating type of furnace with greatly reduced heating time for the same satisfactory service and with a substantial increase in furnace capacity.

It is another object of the present invention to provide a new and improved recirculating furnace for heat treating purposes including means for periodically reversing the direction of flow of gas or air through the work.

Still another object of the present invention is to provide a new and improved recirculating furnace including numerous improved features from the standpoint of accessibility, speed of operation, simplicity, ease of operation and the like.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this application.

For a better understanding of the present invention reference may be had to the accompanying drawings in which:

Fig. 1 is a sectional elevational view of a furnace embodying the present invention, the sectional view being taken substantially on line 1—1 of Fig. 2, assuming Fig. 2 shows a complete structure;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1, assuming Fig. 1 shows a complete structure;

Fig. 3 is a side elevational view of a portion of the furnace taken in the direction of the arrows 3—3 of Fig. 2, with the front wall removed to

show certain control and operating mechanism of the furnace;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 1 assuming Fig. 1 shows a complete construction;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 2 assuming Fig. 2 shows a complete structure;

Fig. 6 is a schematic diagram of the furnace of the present invention illustrating the electrical control circuits therefor; and

Figs. 7 and 8 are curve diagrams to aid in understanding the operation of the recirculating furnace of the present invention.

Referring now to the drawings there is illustrated a recirculating furnace generally designated at 10 comprising a unitary structure formed of a frame of angle and channel members and provided with an exterior wall generally designated at 11 comprising parallel side walls 11*a* and 11*b*, a straight end wall 11*c*, a curved end wall 11*d*, and a top wall 11*e*. The furnace 10 is specifically illustrated as a so-called batch or basket type of furnace comprising a heating chamber generally designated at 12 which is defined by a suitable enclosing wall structure 13 preferably formed of an alloy steel or the like to withstand the high temperatures prevalent in the heating chamber 12. As illustrated the wall structure 13 is of circular configuration and is spaced from the curved outer wall 11*d* of the furnace 10 by a substantial amount to define a space which is filled with suitable heat insulating material generally designated at 14 which heat insulating material may comprise rock wool or any other suitable similar material, many varieties of which are available on the market today.

For the purpose of providing a furnace unit which is movable as a unitary structure a base generally designated at 15 defined by suitable channel irons and the like is provided which supports the furnace structure. The bottom of the heating chamber 12 is defined by a substantial layer of an insulating cement generally designated at 16, which insulating cement provides a hard surface. This insulating cement bottom 16 is also supported by the base 15.

For the purpose of providing a support for a work enclosing container structure there is provided at the bottom of the heating chamber 12 a ring 18 preferably formed of an insulating concrete similar to the material 16 which is circumferentially disposed around the heating chamber 12 so as to define a ledge 17. This ledge 17 has a discontinuous portion indicated at the lower left hand part of the heating chamber 12 so as to define an air or gas passageway 19 which interconnects the bottom of the heating chamber 12 with the other parts of the furnace to be described hereinafter.

In order that a suitable work containing structure may be centrally supported in the heating chamber 12, the walls 13 of the heating chamber are provided near the ledge 17 with suitable guide members 20 arranged in spaced relationship around the heating chamber just above the ledge 17. These guides 20 provide a centering arrangement so as to tend to center a work containing structure inserted into the heating chamber 12.

It will be understood that any suitable work containing structure may be employed for insertion and removal from the heating chamber 12. As a matter of fact if large pieces are to be heat treated they might be inserted directly into the heating chamber 12. However since the type of furnace illustrated is particularly adapted to heating batches of small parts there is illustrated a work containing structure 22 in the form of a cylindrical container preferably formed of an alloy steel or the like to withstand the high temperatures in the heating chamber 12. The bottom of the cylindrical work containing structure 22 is designed to permit the passageway of gas or air therethrough and is comprised of a grid structure generally designated at 23 or any other grill work capable of supporting the work pieces in the container 22 and still permitting substantially unimpeded flow of gas or air in either direction. The work enclosing structure 22 may be open at the top or it may be provided with a suitable cover 24 having the necessary passageways therethrough for air or gas. If a cover 22 is employed it is generally employed for the purpose of insuring the even distribution of such air or gas throughout the area defined by the cover 24. Also, in order that the work containing structure 22, particularly when filled with work for heat treating purposes, may readily be removed or inserted with reference to the heating chamber 12 it is provided with suitable handles 25 engageable by a crane or other suitable manipulating equipment. With this arrangement the basket 22 may readily be loaded with work to be heat treated which of course may subsequently be unloaded to permit other batches of material to be treated. Preferably a single heat treating furnace such as 10 would employ several work containing structures 22 so that the furnace may be employed to its maximum capacity without delays due to loading or unloading new batches or permitting relatively slow cooling of treated batches.

It will be apparent that to permit insertion and removal of the work containing structure 22 from the heating chamber 12 that access to the heating chamber from the exterior must readily be afforded. In addition the closure means provided for any opening to the heating chamber for the removal and insertion of the work containing structure 22 must be an insulating cover structure. As illustrated the heating chamber 12 is closed by a suitable cover 28 which is of generally hollow wall construction so that the hollow space may be filled with a suitable heat insulating material designated at 29 and preferably comprising rock wool or the like. For the purpose of providing a sealing surface around the opening to heating chamber 12 there is preferably provided a metal plate such as 30. In order to make a proper seal between the cover 28 and the metal plate 30 the lower surface of the cover 28 is illustrated as being provided with four rings 31 arranged in spaced concentric relationship. These rings are fastened to the bottom of the cover as by welding or the like and are arranged in pairs so as to define a relatively narrow space between each pair of rings. This space is filled with a suitable high temperature packing material generally designated at 32 so as to provide two spaced concentric seals between the cover 28 and the plate 30 surrounding the entrance to the heating chamber 12 in a manner which is clearly apparent from an examination of Fig. 1 of the drawings.

It will be apparent that the cover structure described above to provide the desired insulating features and the like has substantial mass. In order that this cover may readily be removed or replaced when access to the heating chamber 12 is desired there is provided in accordance with the present invention a suitable cover ma-

nipulating mechanism generally designated at 35 and best shown in Figs. 3 and 4. This mechanism includes a suitable cover support 36 which is fastened in any suitable manner to the cover 28 and includes a portion 36a which extends beyond the circumferential edge of the cover 28. The portion 36a includes a vertically disposed opening for receiving a vertically movable piston rod 38 which has its lower end connected to a suitable piston not shown, disposed within the cylinder 41. To insure straight line motion, the piston rod 38 passes through a pair of aligned sleeves 39 and 40 suitably and rigidly supported from a vertically disposed channel member 42 positioned for also supporting the wall 11b. The rod 38 is removably related to the support 36 as by the pin 43 and the notch 44 best shown in Fig. 3 of the drawings. It will be apparent that if air under pressure is supplied to the cylinder 41 below the piston fastened to the piston rod 38, upward movement of the piston rod 38 results with the consequent upward movement of the cover 28. Such opening movement of the cover 28 still does not provide satisfactory access to the opening to the heating chamber 12. In accordance with the present invention means are provided to produce subsequent pivotal movement of the cover 28 about the axis of the connecting rod 38 following initial upward movement thereof. As illustrated the sleeve 40 which is provided with a suitable opening for the piston rod 38 so as to permit both axial and rotational movement thereof relative thereto, includes a cam-like slot 46 for receiving a pin 47 fastened to the piston rod 38. The slot 46 is so shaped that upward movement of the piston rod 38 and consequently the pin 47 causes rotation of the shaft or piston rod 38 and consequently pivotal movement of the cover 28 away from the opening to the heating chamber 12.

The remainder of the space defined by the walls 11 is divided into several chambers including a control and mechanism chamber 50, a heat source chamber 51, a fan or blower generally designated at 52 and various ducts and mixing chambers to be described hereinafter. The fan or blower 52 preferably comprises a suitable fan housing 53 and is illustrated in Fig. 2 of the drawings, as substantially disposed on the longitudinal central axis of the furnace 10. Mounted for rotation in the fan housing 53 is the fan or impeller 54 mounted on a suitable shaft 55 which extends out of the fan housing 53 into the mechanism or control chamber 50. As is best shown in Figs. 2 and 4 of the drawings, the fan housing 53 is supported by a suitable support 56 from channel members 57 in turn supported by the base 15. The fan chamber or fan housing 53 is provided with an air or gas intake opening generally designated at 58 which causes the gas to flow into the housing in the direction of the axis of the shaft 55 so as to provide an axial inlet 58. On the other hand the fan has a circumferential outlet generally designated at 59 which outlet is connected to ducts 60 and 61 arranged in the form of a Y with the juncture between the ducts 60 and 61 connected to the circumferential outlet 59. Each of the ducts 60 and 61 is connected by means of openings 60a and 61a respectively with a return gas chamber 62 which is defined in the space within the Y portion of the ducts 60 and 61 and the wall 13 of the heating chamber 12. The return gas chamber 62 as is best shown in Fig. 2 of the drawings extends in the horizontal direction between the Y duct arrangement comprising the ducts 60 and 61 and a mixing chamber to be described hereinafter. It will be understood that the fan parts are constructed of suitable high temperature alloys to withstand the high temperature air or gases to which they are subjected. It might be mentioned at this time that in many heat treating operations air is employed as the heating medium. However the present invention is equally applicable where some gas other than air is employed and it should be understood that the term gas as employed in this specification and claims includes air or any other gases which might be employed in the heat treating operation.

For the purpose of preventing substantial loss of heat from the fan housing 53 or the air or gas ducts 60 or 61, the space surrounding these members is filled with a suitable heat insulating material generally designated at 64 which heat insulating material may be rock wool or the like.

Although the source of heat employed in the furnace 10 of the present invention might comprise a gas burner, an oil burner, or electric heater the invention has been specifically illustrated as comprising a gas burner generally designated at 66 which is connected to a suitable source of air and gas by a conduit means generally designated at 67. (See Fig. 6 of the drawings.) The gas burner is adapted to extend into the heat source chamber 51 which, as is best shown in Fig. 4 of the drawings, is defined by walls 68, 69 and 70 of an insulating fire brick and wall 71 of fire brick not insulating in character. Preferably also a layer of ordinary insulating brick 72 is provided above the insulating fire brick layer 69. Upon operation of the gas burner 66 a gas flame is produced in the heat source chamber 51 which causes hot gases to be supplied at the exit of the heat source chamber 51. As is best shown in Fig. 1 of the drawings the wall 69 terminates in a curved portion 69a so as to direct the hot gases from the heat source chamber 51 in a downward direction into a mixing chamber generally designated at 74. This mixing chamber 74 is defined by the duct 75 which extends between the axial fan inlet 58 and the return gas chamber 62, the term mixing chamber 74 being appended thereto since it provides the chamber where the return gases from the chamber 62 are mixed with the hot gases from the heat source chamber 51 which are guided into the mixing chamber 74 by the curved wall portion 69a.

It will be understood that due to the burning of hot gases which are introduced into the furnace, means must be provided for bleeding off an amount of gas equal to that continually being introduced by the gas burner 66, if one is employed. It will be understood that if the heat source is electrical then this problem is not the same. In accordance with the present invention a positive gas pressure exists in the return gas chamber 62 at the entrance to the mixing chamber 74 and at this point there is provided a conduit 79 connecting the return gas chamber 62 to atmosphere outside the furnace whereby a predetermined amount of returned gas from the mixing chamber 74 may be vented to the atmosphere and no loss of hot newly burned gas results, since the newly burned gases are supplied to the mixing chamber 74 between the fan inlet 58 and the portion of the return gas chamber 62 vented to atmosphere by the conduit 79. A suitably adjustable damper 80 may be provided

in the conduit 79 to control the amount of gas venting, which may be substantially zero when an electric heat source is employed.

To further insulate the working parts of the heating chamber there preferably is provided a layer of asbestos board 81 as is best shown in Fig. 4 of the drawings between the insulating material described above and the exterior walls 11 of the furnace 10.

The mechanism and control chamber 50 essentially comprises a space defined alongside the fan housing 53 between the channel member 42 and the enclosing portions of the walls 11b and 11c adjacent thereto. Disposed within this chamber 50 is the cover-manipulating mechanism 35 described above. Also a suitable motor 82 is suitably mounted within this chamber and drivingly connected with the fan shaft 55 as by means of cooperating pulleys 83 and 84 and a belt 85. Preferably a suitable opening 86 in the insulating wall structure is defined immediately adjacent the fan outlet 59 for the purpose of permitting connections to be made with a suitable temperature measuring device designated at 87, and schematically indicated as a suitable pyrometer or the like in Fig. 6 of the drawings.

As has been mentioned above if the heating chamber 12 is supplied with hot gases through operation of the fan 54, say for example in the direction of the arrows shown in Fig. 1 of the drawings, the heating of the work at three different points therein is represented by the three curves A, B, and C shown in Fig. 7 of the drawings where the temperature thereof is plotted with reference to time. The curve A represents the top of the work which is first engaged by the hot circulating gases indicating that it is clearly the hottest portion of the work until after a substantial time has elapsed. The curve C represents the point of the work adjacent the hot gas exit which heats at a much slower rate, while the curve B represents the work in the middle of the container 22 which heats at an intermediate rate. As sufficient time elapses the temperature differential between the top, bottom and middle of the work gradually disappears and substantially the same temperature is approached. If the flow of gases were in the opposite direction curve C would remain the same and curves A and B would be interchanged. In accordance wilth the present invention the gas circulation is periodically reversed throughout the heating cycle to reduce to a minimum the differential in temperature between various parts of the work, and in Fig. 8 there are illustrated curves A', B', and C', corresponding respectively to the curves A, B and C, of Fig. 7, for an arrangement where periodic reversal of the air flow through the work occurs. It is apparent from these curves that not only is the temperature differential reduced but the time required to arrive at the same end temperature is also greatly reduced.

For the purpose of providing a simple means for reversing the flow of air there is provided a damper 90 as shown in Fig. 1 of the drawings which is disposed at the junction point between the ducts 60 and 61. The damper 90 furthermore controls two paths of flow. When in the position shown in Fig. 1 of the drawings the damper 90 closes the opening 60a between the duct 60 and the return gas chamber 62 and also closes the opening between the fan outlet 59 and the duct 61 thereby requiring air or gas to flow through the work from the top to the bottom. If the damper 90 were rotated in a counterclockwise direction as viewed in Fig. 1 through an angle of substantially 90% the opening 61a would be closed and the passageway between the fan outlet 59 and the duct 60 would also be closed so that the flow of air through the heating chamber 12 would be from the bottom to the top. The flow of air in all other parts of the device would be unchanged, however, since the air would flow from the return gas chamber 62 to the mixing chamber 74 and from the heat source chamber 51 to the mixing chamber 74 in exactly the same manner regardless of the direction of flow through the heating chamber 12. Obviously the flow from the mixing chamber 74 through the axial fan inlet 58 is also unchanged regardless of the position of the damper 90.

For the purpose of manipulating the damper 90 it is mounted on a suitable shaft 91 connected by a crank 92, a link 93, and a crank 94 to a unidirectional control motor 95. As illustrated in the drawings the unidirectional control motor 95 is preferably of the impulse type extensively available on the market today which rotates only through an angle of 180° upon the reception of an impulse and then rotates through a successive 180° angle in the same direction upon the reception of a different impulse. Such a motor 95 generally is provided with four terminals as indicated best in Fig. 6 of the drawings.

Any suitable control circuit for the furnace 10 may be provided. As illustrated in Fig. 6 of the drawings, the control circuit comprises a source of potential 100. The pyrometer 87 is connected to a temperature control device 101 for controlling a valve 102 associated with the gas burner 66 thereby varying the temperature in the heat source chamber 51, in accordance with the operation of the temperature control device 101 in a manner which will be understood by those skilled in the art.

For the purpose of providing the desired periodic reversal of gas flow through the heating chamber 12 the damper motor 95 has two terminals thereof connected directly by the conductors 103 and 104 with the power source 100. The other two terminals of the motor 95 are connected by conductors 105 and 106, to one line of the power source 100 through the contacts 107a and 107b respectively of a relay 107, the contacts 107a being indicated as normally open contacts and the contacts 107b as normally closed contacts. It will be apparent that with this arrangement the conductors 105 and 106 are alternately connected to one conductor of the power source 100 in response to the alternate energization and deenergization of the relay 107. The relay 107 forms a part of a timer unit generally designated by the reference numeral 108.

In order to provide a time control cycle, the control apparatus includes a timer motor generally designated at 109 including the winding 109a and 109b and the rotor 109c which is adapted to rotate in either a forward or a reverse direction depending upon whether the winding 109a or the winding 109b is energized. The rotor 109c includes a pair of spaced control arms 111 and 112 for actuating the switches 113 and 114 respectively when the rotor 109c reaches its limiting positions. The control arm 111 is adapted to close normally open switch 113, in one extreme portion of the rotor 109c while the arm 112 is adapted to open a normally closed switch 114 when the rotor 109c assumes its other extreme position. One terminal of each of the windings

109a and 109b of the motor 109 is connected directly to the same conductor 104 and thence to the power line 100. The other terminals of the windings 109a and 109b are connected through the contacts 107c and 107d respectively of the relay 107 to the other terminal of the power line 100 through a suitable manual switch 115 and the conductor 103. The winding 107' of the relay 107 is connected in parallel with the winding 109b of a timer motor 109. With this arrangement when the switch 115 is closed and the parts of the mechanism are in the position indicated in Fig. 6 of the drawings, power is supplied to the winding 109a of the motor 109 causing it to rotate in a direction to close the switch 113. As soon as the switch 113 is closed, which occurs after the expiration of a predetermined time the relay 107 is energized to close its contacts 107a which supply the motor 95 through the conductor 106 with the necessary impulse to produce 180° rotation of the control motor 95, with the consequent movement of the damper 90 to reverse the flow of air to the heating chamber 22. Opening of the contacts 107d furthermore deenergizes the winding 109a. Also closing of the contacts 107c energizes the winding 109b to reverse the direction of the rotation of the rotor 109c of the timer motor 109. Subsequent opening of the switch 114 when the rotor 109c reaches its other extreme position causes deenergization of the relay 107 and the winding 109b, with a further 180° movement of the motor 95 and reversal of the position of the damper 90. It will be apparent that with this arrangement alternate positions of the damper 90 are assumed successively during a heating cycle in dependence upon any predetermined desired timing cycle.

In view of the detailed description included above the operation of the recirculating furnace 10 will be apparent to those skilled in the art and no further discussion is included herewith.

Although the present invention has been described in connection with a so-called basket or batch type of recirculating furnace it should be apparent that it might equally well be employed with other types of furnaces such as the oven type of furnace, car or conveyor type, and the like and the illustrated embodiment is by way of example only.

While there has been shown and described a particular embodiment of the present invention it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention in its broader aspects and it is therefore aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A recirculating furnace comprising a heating chamber adapted to receive a removable container for the material to be heated, said container being provided with suitable openings in the ends thereof to permit the circulation of a gas therethrough, the combination of a blower disposed adjacent said heating chamber and having a gas inlet and a gas outlet, duct means for connecting said outlet with both ends of said heating chamber, a source of hot gas, a mixing chamber disposed adjacent said inlet to said blower, means connecting said source to said mixing chamber, a return gas chamber connected to said duct means, means for connecting said inlet to said mixing chamber, means connecting said return gas chamber with said mixing chamber, means for venting to atmosphere gas from said return gas chamber, a single damper at said outlet for controlling the direction of flow of gas through said heating chamber, and control means for periodically actuating said damper to reverse the flow of gas through said heating chamber.

2. In a recirculating furnace comprising a heating chamber adapted to receive material to be heat treated, the combination of a blower disposed adjacent said heating chamber and having a gas inlet and a gas outlet, duct means adapted to connect said outlet with both ends of said heating chamber, a source of hot gas, a mixing chamber adjacent said inlet to said blower, means connecting said source to said mixing chamber for injecting said hot gas into said furnace, a return gas chamber connected to said duct means, means for connecting said inlet to said mixing chamber, means connecting said return gas chamber with said mixing chamber, means connected to said return gas chamber for bleeding off an amount of gas comparable to that injected by said source, a single damper at said outlet for controlling the direction of flow of gas through said heating chamber, and control means for periodically actuating said damper to reverse the flow of gas through said heating chamber.

3. In a recirculating furnace comprising in combination, a unitary structure including a heating chamber adapted to receive material to be heat treated, a blower disposed adjacent said heating chamber and having an axial inlet and a gas outlet, duct means adapted to connect said outlet with both ends of said heating chamber, a hot gas chamber, a mixing chamber disposed adjacent said axial inlet, means connecting said hot gas chamber to said mixing chamber for supplying newly heated gas to said mixing chamber, a return gas chamber connected to said duct means, means connecting said axial inlet to said mixing chamber, means connecting said return gas chamber with said mixing chamber, means connected to said return gas chamber for venting a predetermined amount of gas to atmosphere, an adjustable damper in said last mentioned means, a single pivotal damper disposed at said blower outlet for controlling the direction of flow of gas through said heating chamber, and control means for periodically actuating said damper to reverse the flow of gas through said heating chamber.

JOHN WALLERIUS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,324,667	Hanson	Dec. 9, 1919
1,392,317	Fisher	Oct. 4, 1921
1,542,954	Puening	June 23, 1925
1,799,702	Puening	Apr. 7, 1931
1,923,145	Harsch	Aug. 12, 1933
2,163,727	Dean	June 27, 1939
2,228,564	Guthrie	Jan. 14, 1941
2,277,592	Keener et al.	Mar. 24, 1942
2,338,965	Parsons	Jan. 11, 1944
2,414,312	Lee	Jan. 14, 1947
2,469,740	Moore	May 10, 1949
2,474,505	West	June 27, 1949