March 28, 1950 R. N. COLE 2,502,204

ANNEALING FURNACE

Filed Sept. 23, 1946 3 Sheets-Sheet 1

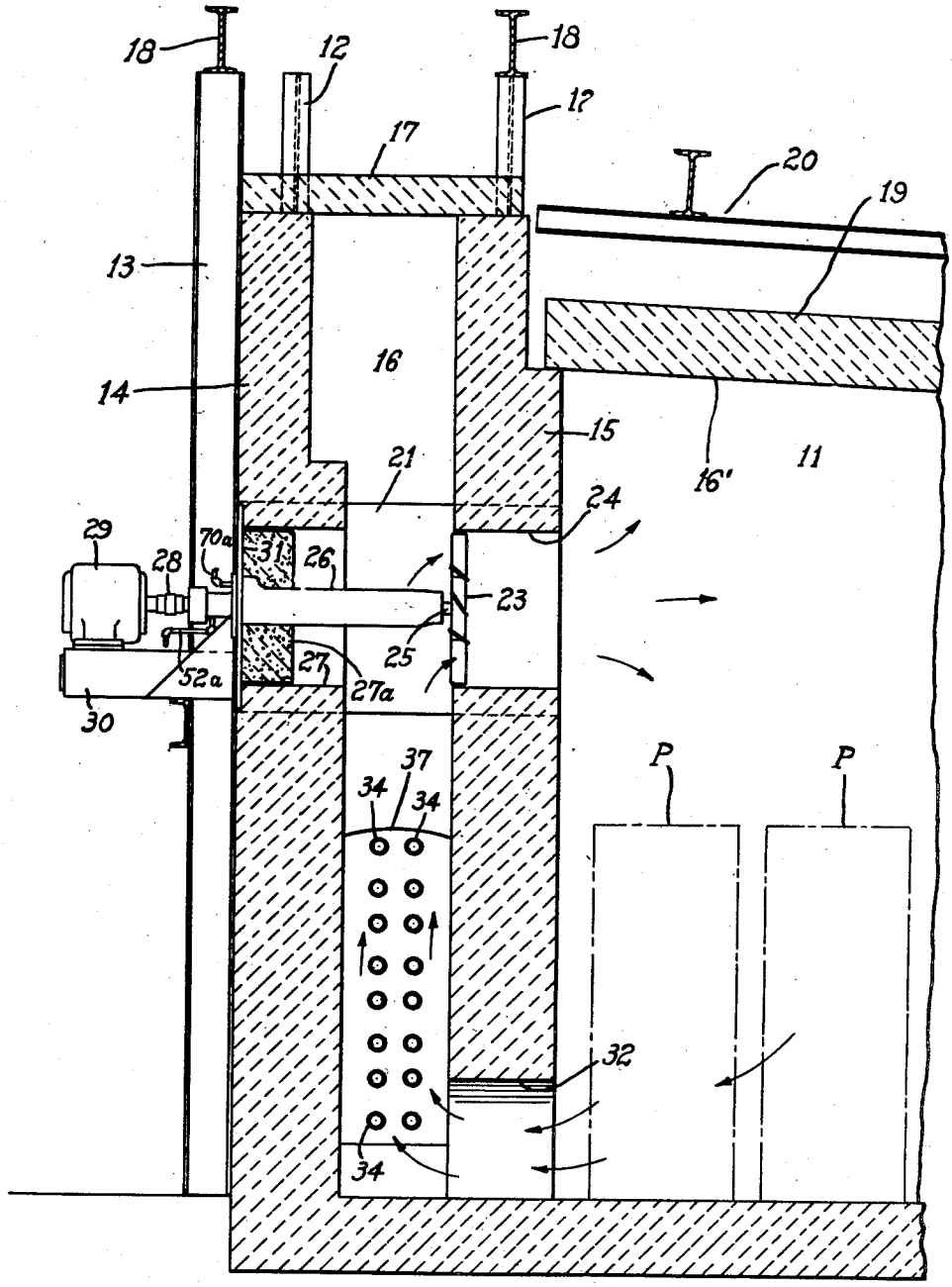


Fig. 1

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ANNEALING FURNACE

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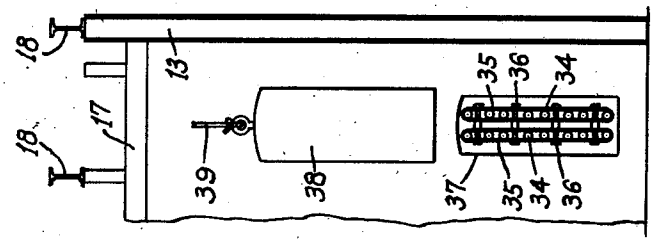


Fig. 3

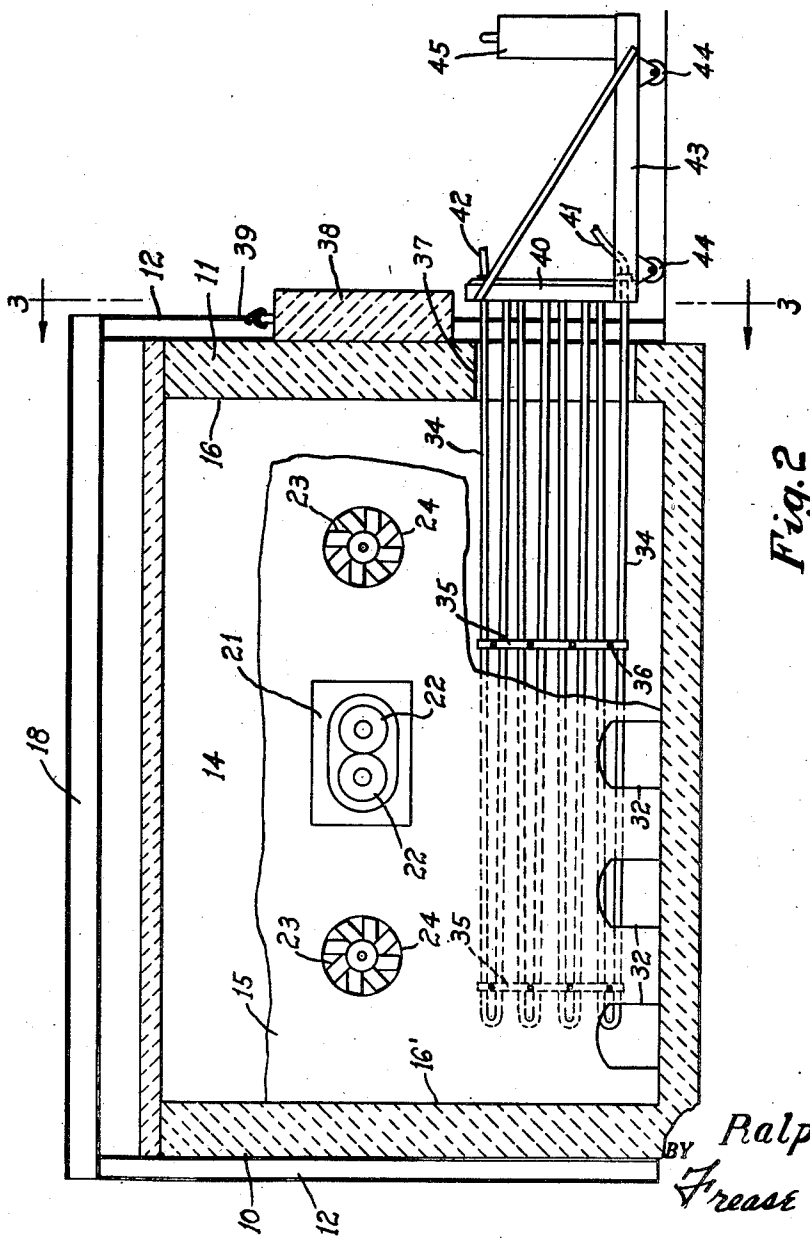


Fig. 2

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ANNEALING FURNACE

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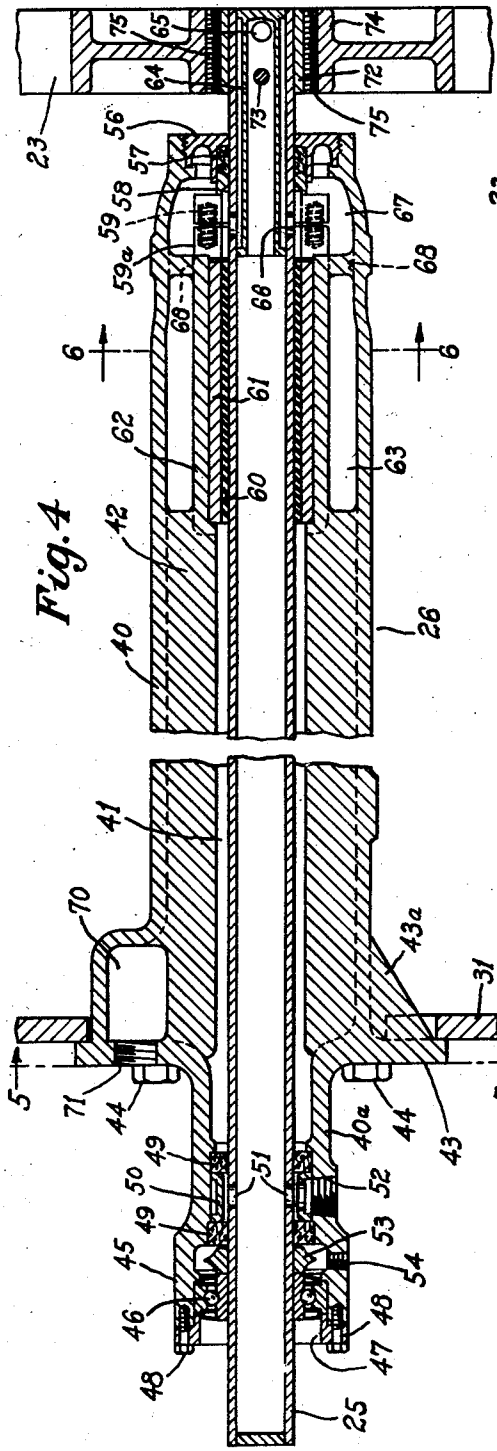


Fig. 4

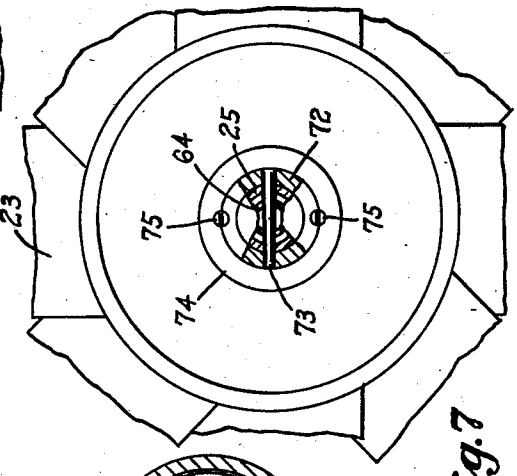


Fig. 7

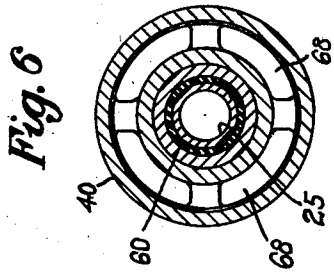


Fig. 6

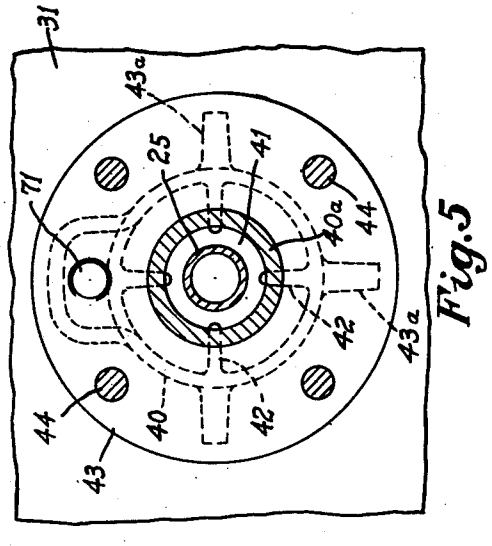


Fig. 5

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2,502,204

UNITED STATES PATENT OFFICE

2,502,204

ANNEALING FURNACE

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Application September 23, 1946, Serial No. 698,817

13 Claims. (Cl. 263—40)

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The invention relates generally to annealing furnace construction, and more particularly to furnaces for annealing malleable iron castings.

The annealing of malleable iron castings must be carried out according to a definite cycle of many hours duration including several stages of various time periods and temperatures and rates of heating and cooling, in order to impart the desired characteristics to the finished castings. Conventional practice consists in packing the castings in boxes or pots in a box-type annealing furnace, bringing the furnace up to and holding it for many hours at a high temperature above the critical range, cooling rapidly to the critical range, cooling slowly through the critical range and then rapidly to room temperature. This annealing cycle in conventional practice may take as much as eight days.

If it is attempted to shorten the annealing cycle by using higher heating temperatures in the furnace, the cost of refractory walls and linings becomes prohibitive, and the castings become badly warped and may have poor mechanical qualities.

In order to approach uniform temperatures throughout all of the castings during the various stages of the annealing, it has heretofore been necessary to carefully segregate and pack the castings according to size in the annealing boxes, but in spite of such precautions, the temperature has not been sufficiently uniform in all parts of the furnace or throughout all the castings in the furnace. It has been especially difficult, in making the temperature change from one stage of annealing to another, to obtain the required temperature uniformly throughout all the pots in the furnace.

In the stages of the annealing cycle where quick cooling is required it has been particularly difficult to obtain uniform quick cooling throughout the castings in all the pots. It is very important to change temperature uniformly in all castings during the quick cooling periods because the castings are at those times approaching or passing through the critical range, where the austenitic character of the castings should be changed to ferrite and temper carbon without separating out iron carbide. If the quick cooling is not rapid and uniform, too much hard iron carbide may separate out and produce undesirable characteristics in the finished castings.

Certain prior attempts to shorten the time of the annealing cycle for malleable iron castings and to improve the uniformity of temperature during the various annealing stages, have resulted in the construction of continuous or tunnel-type

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furnaces or controlled atmosphere furnaces, all of which are very expensive and sometimes wholly impractical.

It is a primary object of the present invention to provide a novel annealing furnace of simple and inexpensive construction which will reduce the time and provide increased uniformity of temperature conditions during the annealing cycle for malleable iron castings.

Another object is to provide an improved annealing furnace having novel circulating means for bringing the furnace up to uniform temperature rapidly and maintaining said temperature.

Another object is to provide an improved annealing furnace having novel means cooperating with the circulating means for rapidly cooling the furnace uniformly to a desired temperature.

More specifically it is an object of the present invention to provide an improved annealing furnace having removable cooling means adapted to be selectively introduced into the path of circulating gases within the furnace.

Another object is to provide a novel water cooled mounting for journaling a circulating fan within a furnace.

A further object is to provide a novel water cooled mounting for a circulating fan within the furnace and adapted to be driven by a motor mounted outside of the furnace.

These and other objects are accomplished by the parts, constructions, arrangements, combinations and methods which comprise the present invention, the nature of which is set forth in the following general statement, a preferred embodiment of which is set forth in the following description and illustrated in the accompanying drawings, and which is particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

In general terms, the invention consists in providing an annealing furnace with a recirculating chamber at one end thereof and utilizing a fan for forcing the hot furnace gases through the furnace and back into the recirculating chamber, the fan shaft having a water jacketed journal mounting extending through the furnace walls and adapted for operative connection at its outer end with exterior driving means, and there being cooling coils adapted to be removably inserted through the side of the furnace into the recirculating chamber in the path of the circulating gases, so as to cool the furnace temperature rapidly and uniformly when desired.

Referring to the drawings forming part hereof,

in which a preferred embodiment of the invention is shown by way of example:

Fig. 1 is a fragmentary longitudinal sectional view through one end of an annealing furnace embodying the invention;

Fig. 2 is a transverse sectional view thereof on a reduced scale, taken through the recirculating chamber, part of the inner wall of the recirculating chamber being shown in elevation;

Fig. 3 is a fragmentary side elevation as on line 3—3, Fig. 2;

Fig. 4 is an enlarged longitudinal sectional view of one of the water cooled fan mountings which extend through the recirculating chamber;

Fig. 5 is a transverse sectional view thereof, as on line 5—5, Fig. 4;

Fig. 6 is a transverse sectional view thereof, as on line 6—6, Fig. 4; and

Fig. 7 is an elevation of the fan end thereof.

Similar numerals refer to similar parts throughout the drawings.

The novel and improved annealing furnace of the present invention is a box-type furnace having the usual refractory walls supported within a steel frame work. The side walls 10 and 11 are supported in a usual manner by vertical I-beam columns 12 and end walls are similarly supported by vertical I-beam columns 13. The rear end wall 14 has a partition wall 15 spaced forwardly thereof to form a narrow transverse recirculating chamber 16 at the rear end of the furnace, and the chamber 16 is preferably covered over with a top wall 17 of refractory material to close the chamber. As best shown in Fig. 1, the end wall 14 and partition wall 15 are supported between the vertical I-beam columns 12 at the side walls of the furnace and the columns 12 are tied together with transverse I-beams 18.

The heating chamber of the furnace is formed by the side walls 10 and 11, partition wall 15, the front wall of the furnace, and the roof wall 19, which is made of refractory material such as refractory brick suitably suspended from the steel frame work indicated generally at 20. The front end of the furnace is provided with a charging door in accordance with usual practice, and the front end of the furnace is not shown because it forms no part of the present invention.

The rear end wall 14 and the partition wall 15 are provided with longitudinally aligned burner port walls 21 preferably located midway between the side walls 11 and 12 and extending through the chamber 16, and one or more suitable fuel burners for heating the interior of the furnace are mounted within the burner port walls 21. Two such burners are indicated diagrammatically at 22, and the burners may be oil, gas, or powdered coal, or a combination thereof. The particular means for heating the furnace forms no part of the present invention, and accordingly, any form of heating means including electric heating elements may be used without departing from the scope of the invention.

The means for circulating the heated gases within the furnace, to insure uniformity of temperature throughout the furnace, preferably includes a pair of circulating fans 23 located one on each side of the burners 22 in fan openings 24 extending through the partition wall 15 and providing communication between the recirculating chamber 16 and the furnace proper.

The fans 23 are secured on the inner ends of fan shafts 25, and the fan shafts each have a water-jacketed journal mounting indicated generally at 26 extending through the recirculating chamber 16 and an opening 27 in the furnace wall 14. The outer end of each shaft 23 is connected by a coupling 28 to the shaft of a driving motor 29 which is supported on a bracket 30 attached to a plate 31 secured on the furnace wall 14 and closing the opening 27 therein.

Thus, during the operation of the furnace, the hot gases supplied by the burners 22 are circulated by the fans 23 through the furnace and back into the recirculating chamber 16 through base openings 32, then upwardly, as indicated by the arrows in Fig. 1 and then through openings 24 in the partition wall 15 and back into the furnace chamber 16'. This circulation of the hot gases provides for raising the furnace temperature rapidly and uniformly to the desired degree, so that the annealing pots P packed with malleable iron castings and located in the furnace chamber are uniformly heated and maintained at the required temperature. Accordingly, the time required to uniformly heat the castings to a high holding temperature is reduced, and the holding time at the required high temperature is also substantially reduced.

In order to accomplish quick and uniform cooling of the furnace to cool the castings uniformly and rapidly down to just above the critical range when the quick cooling stage of the annealing cycle is reached, without admitting any material amount of air causing excessive oxidation of pots or castings, novel heat exchange means is provided for being selectively introduced into the recirculating chamber 16 in the path of the hot gases moving therethrough. The heat exchange means preferably comprises a series of cooling pipe coils 34 arranged in two vertical rows so as to pass between the walls 14 and 15 of the chamber 16, and said pipe coils have a length substantially equal to the transverse width of the chamber 16 so as to extend substantially the full width of the chamber when inserted therein.

Preferably, the pipe coils 34 are secured together at intervals by vertical bars 35 connected by spacer bolts 36 in a usual fashion, and a door opening 37 through one side wall 11 of the furnace permits insertion of the pipe coils into the chamber, as indicated in Fig. 2. When the pipe coils 34 are removed the door opening 37 is closed by a refractory door 38 suspended by a cable 39 in a usual manner.

The pipe coils are preferably connected at one end to a manifold 40 which provides communication between the coils, and a conduit 41 may be connected to the lower end of the manifold for introducing cooling water, while a conduit 42 may be connected to the upper end of the manifold for conducting the cooling water from the exit end of the pipe coils. As shown, the manifold 40 is preferably conveniently mounted on one end of a carriage 43 rollably supported on wheels 44, and a counter-weight 45 is supported on the end of the carriage opposite the manifold 40 for counterbalancing the weight of the extending pipe coils 34. As indicated in Fig. 2, when the pipe coils are fully entered into the chamber 16, the manifold 40 acts as a door for closing the opening 37.

Accordingly, when the quick cooling stage of the annealing cycle is reached, the burners 22 or other heating means are shut off, the door 38 is opened and the cooling coils 34 projected through the door opening 37 to extend across substantially the full width of the recirculating chamber 16, while the circulating fans 23 continue to operate. As the furnace gases pass through the base openings

32 and upwardly over the cooling coils, they are rapidly cooled so that, when forced into the furnace chamber through the fan openings 24, they act to quickly and uniformly drop the temperature in the furnace chamber without admitting any material amount of outside air which would cause undue oxidation of the pots and castings. By keeping close watch on suitable pyrometers connected to the furnace chamber and to the insides of annealing pots P, the temperature drop can be regulated accurately and as soon as the desired temperature is reached, the cooling coils 34 are wheeled out of the furnace, the door 38 closed and the burners started up again to maintain the furnace at the desired reduced degree of temperature.

After the furnace has been maintained and slowly cooled a certain amount from the desired reduced degree, so as to slowly cool the castings through the critical range and produce the desired ferritic-temper carbon structure, the cooling coils may if desired be reinserted into the furnace with the burners shut off so as to start the final cooling stage rapidly and uniformly before the furnace doors are opened.

The preferred operation of the present improved furnace to anneal malleable iron castings includes first raising the furnace temperature and the temperature of the castings packed in the annealing pots P up to approximately 1600° F. in about twenty hours; holding at that temperature for approximately thirty hours in order to dissolve all of the iron carbide; cooling the furnace rapidly and uniformly to drop the temperature of the castings to about 1350° F. in about nine hours, by shutting off the burners and introducing the pipe coils into the recirculating chamber, so as to change the character of the castings from austenitic to ferritic without separating out iron carbide; then slowly and uniformly reducing the temperature of the castings from 1350° F. to about 1290° F. in about twenty-three hours so that they pass safely through the critical range without forming pearlite to any substantial extent.

From this point on the castings are cooled as fast as possible to about room temperature and in order to cool all of the pots uniformly as well as rapidly, it is preferable to again shut off the burners and introduce the cooling coils while the fans are circulating. This may be done for a period of about five hours, after which the furnace door is opened and the pots are allowed to cool in the open furnace to about room temperature, which may take an additional six to eight hours.

The total time for the aforesaid annealing cycle as carried out in the present improved furnace is about four days, whereas the annealing cycle for the same type of malleable iron castings in a conventional box-type furnace requires seven to eight days. Moreover, in the conventional box-type furnace excessive time and labor are required in segregating and packing the castings in the pots according to size in attempting to prevent cold spots and consequent poor quality of a substantial percentage of the castings. With the present improved furnace having the novel removable cooling coils, it has been demonstrated in actual practice that substantial uniformity of temperature is maintained throughout all of the castings during all stages of the annealing cycle, even though the castings are packed substantially at random without regard to variation in size, and the castings coming out of the anneal have

a high quality with respect to physical and metallurgical characteristics, and very little if any warping takes place.

Referring to Figs. 5, 6 and 7, the improved journal mounting 26 for each of the fan shafts preferably includes a hollow cast jacket 40 of heat-resisting alloy forming a water-circulating chamber 41 around the hollow fan shaft 25, and having longitudinal reinforcing ribs 42 extending radially inward from its outer wall. Adjacent the outer end of the shaft, the jacket casting 40 is provided with a transverse flange 43 supported by angular ribs 43a. The flange 43 at its outer edge overlaps the plate 31 secured in the furnace wall, and the flange is secured to the plate by means of bolts or cap screws 44.

The outer end portion 40a of the jacket housing is provided with an enlargement 45 which mounts an anti-friction or thrust ball bearing 46 in which the outer end portion of the shaft 25 is journaled. The ball bearing 46 may be held in place by a suitable retainer ring 47 secured in the end of the enlargement 45 by cap screws 48 or the like. The projecting outer end of the shaft 25 is coupled in usual fashion to the shaft of drive motor 29, as by a coupling 28 (Fig. 1).

Adjacent to the enlargement 45, a pair of spaced water-sealing packing rings 49 is interposed between the jacket 40a and the shaft 25, being spaced apart by a perforate spacer ring 50, and openings 51 are provided through the wall of shaft 25 under the spacer ring and between the packing rings. A tapped hole 52 is preferably provided through the jacket wall in register with the spacer ring 50 for connecting a water supply pipe 52a to introduce cooling water between the packing rings 49 and into the interior of the hollow shaft 25. Preferably, a slinger thrust ring 53 is secured to the shaft 25 on the outer side of the packings and abutting the inner race of bearing 46 to act as a thrust collar. The slinger ring 53 serves to throw outwardly any moisture which may get past the outer packing 49, and a drain opening 54 is provided opposite the slinger 53 to carry away any such moisture. Preferably, the jacket 40 has annular collar of insulating cement 27a built up thereon within the opening 27 to protect the plate 31.

The inner end of the jacket 40 is provided with a packing nut 56 screwed therein for abutting a packing ring 57 fitting around the shaft 25. The opposite side of the packing is preferably abutted by a gland member 58 which is yieldingly urged against the packing by means of suitable helical springs 59 in socket members 59a located at intervals around the shaft. Adjacent to the socket members 59a, the jacket 40 is journaled on the shaft 25 by means of a water-lubricated rubber bearing sleeve 60 of well-known construction, and a bronze ring 61 surrounds the bearing and is secured in a cylindrical wall 62 of the jacket, said wall being spaced inwardly of the outer jacket wall to provide an annular chamber 63 communicating with the chamber 41 surrounding the intermediate portion of the shaft.

The inner end of the shaft 25 is closed by a sleeve insert 64 closed at its outer end and spaced inwardly of the sleeve 25 to provide an annular pasageway therebetween. Adjacent its outer end the sleeve insert 64 is provided with suitable ports 65 communicating with the interior of the sleeve 25, and adjacent the inner end of the sleeve insert 64, the sleeve 25 is provided with ports 66 through its wall which communicate with an annular chamber 67 surrounding the packing gland 58,

the chamber 67 being in communication with chamber 63 through circumferentially spaced openings 68.

Thus, the circulating water entering the shaft 25 at its outer end through ports 51 flows inwardly through the shaft and into sleeve insert 64, then out of ports 65 and through ports 66 into chamber 67, then through openings 68 into chambers 63 and 41 from which it flows into a communicating outlet chamber 70 and thence into a return or outlet pipe 70*a* connected into the tapped opening 71.

Because of this improved water-jacketed journal mounting for the fan shaft, the fans 23 can be kept operating at the required high annealing temperatures of 1600° F. for long periods without burning off or damaging the fan shafts, which makes it practicable to continuously circulate the hot gases through the furnace and obtain uniform temperature conditions, and also to obtain uniform quick cooling by introducing the cooling coils into the path of said gases.

In mounting the circulating fans 23 on the inner projecting ends of the fan shafts 25, it was found that the usual means of securing the fan hub to the shaft, including keys, set screws and the like, were not at all satisfactory because under the high temperature conditions to which the fans are subjected for long periods, the fan hubs expand and loosen on the shaft. After repeated experiments the mounting construction shown in Figs. 4 and 7 was finally determined to be practical and satisfactory under the particular temperature conditions. As shown, a collar 72 is secured on the end of shaft 25 by means of a transverse pin 73, and the fan hub 74 is secured on the collar 72 by means of dowel set screws 75 extending parallel to the shaft and threaded substantialy half in the collar 72 and half in the fan hub 74.

Referring to Fig. 7, it will be seen that even though the fan hub 74 expands, tending to loosen it on the collar 72, the rotation of the fan will exert a wedging action on the dowels 75 so as to continue to hold the fan hub tight on the collar 72.

Accordingly, the improved water cooled jacket for the fan shaft and the improved means securing the fan on the inner end of the shaft within the furnace make it practicable to circulate the hot furnace gases continuously through the recirculating chamber, into which the cooling coils are introduced for effecting a rapid uniform drop in furnace temperature.

In the foregoing description, certain terms have been used for brevity, clearness and understanding, but not unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Morever, the embodiment of the improved construction illustrated and described herein is by way of example, and the scope of the present invention is not limited to the exact details of construction.

Having now described the invention, the construction, the operation and use of a preferred embodiment thereof, and the advantageous new and useful results obtained thereby; the new and useful methods and constructions, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

I claim:

1. In an annealing furnace having a heating chamber and a recirculating chamber communicating with the heating chamber with means for circulating gases from the heating chamber to the recirculating chamber and back to the heating chamber, means supplying heat to said heating chamber, heat exchange means, and means for moving said heat exchange means selectively into said recirculating chamber in the path of said gases.

2. In an annealing furnace having a heating chamber and means for circulating hot gases through said chamber in a definite path, means supplying heat to said heating chamber, and heat exchange means movably supported on the floor outside of the furnace and adapted for selective positioning into the furnace in the path of said gases.

3. In an annealing furnace having a heating chamber and a recirculating chamber with means for circulating gases from the heating chamber to the recirculating chamber and back to the heating chamber, means supplying heat to said heating chamber, heat exchange means, and a carriage movably mounting said heat exchange means for selective insertion into said recirculating chamber in the path of said gases.

4. In an annealing furnace having a heating chamber and a recirculating chamber with means for circulating gases from the heating chamber to the recirculating chamber and back to the heating chamber, means supplying heat to the heating chamber, a cooling coil, a carriage movably supported on the floor outside of the furnace and supporting one end of said cooling coil for selectively inserting said coil into said recirculating chamber in the path of said gases, and a door on said carriage for closing said recirculating chamber when the cooling coil is inserted therein.

5. In an annealing furnace having a heating chamber and a relatively narrow recirculating chamber, with means for circulating gases from the heating chamber to the recirculating chamber and back to the heating chamber, a doorway at one end of said recirculating chamber communicating with the outside atmosphere, means supplying heat to said heating chamber, and heat exchange means movably mounted for selective insertion through said doorway into said recirculating chamber.

6. In an annealing furnace having a heating chamber and a partition wall adjacent to one wall of the heating chamber forming a recirculating chamber therebetween, a fan located in said partition wall and adapted for circulating gases from the heating chamber through the recirculating chamber, said partition wall having a return opening providing communication between the recirculating chamber and said heating chamber, means supplying heat to the heating chamber, a heat exchanger, and means for moving said heat exchanger selectively into and out of the recirculating chamber into and out of the path of said gases.

7. In an annealing furnace having a heating chamber and a partition wall adjacent to one wall of the heating chamber forming a recirculating chamber therebetween, a fan located in said partition wall and adapted for circulating gases from the heating chamber through the recirculating chamber, a fan shaft mounting the fan and extending through said recirculating chamber, a water-jacket journal around said shaft within said recirculating chamber, said partition

wall having a return opening providing communication between the recirculating chamber and said heating chamber, means supplying heat to said heating chamber, a cooling coil, and means for moving said cooling coil selectively into the recirculating chamber in the path of said gases.

8. In annealing furnace construction having, a fan for circulating gases therethrough, a hollow fan shaft mounting the fan and extending through one of the furnace walls to the exterior of the furnace, said fan shaft having an inlet port at its outer end and an outlet port at its inner end, a hollow jacket enclosing said shaft and communicating with said shaft outlet port, bearings in said jacket journaling said shaft, and means exterior of the furnace for circulating cooling fluid into the hollow shaft and out of the jacket.

9. In annealing furnace construction having a fan for circulating gases therethrough, a hollow fan shaft mounting the fan and extending through one of the furnace walls to the exterior of the furnace, said fan shaft having an inlet port at its outer end and an outlet port at its inner end, a hollow jacket enclosing said shaft and communicating with said shaft outlet port, sealing means interposed between the shaft and jacket beyond said outlet port for preventing leakage of cooling fluid into the furnace, bearings in said jacket journaling said shaft, and means exterior of the furnace for circulating cooling fluid into the hollow shaft and out of the jacket.

10. In annealing furnace construction having a fan for circulating gases therethrough, a hollow fan shaft mounting the fan and extending through one of the furnace walls to the exterior of the furnace, said fan shaft having an inlet port at its outer end and an outlet port at its inner end, a hollow jacket enclosing said shaft and communicating with said shaft outlet port, said jacket having an inlet port extending radially therethrough and communicating with the shaft inlet port, bearings in said jacket journaling said shaft, and means exterior of the furnace for circulating cooling fluid into said jacket inlet port and out of said jacket.

11. In annealing furnace construction having a fan for circulating gases therethrough, a hollow fan shaft mounting the fan and extending through one of the furnace walls to the exterior of the furnace, said fan shaft having an inlet port at its outer end and an outlet port at its inner end, a hollow jacket enclosing said shaft and communicating with said shaft outlet port, said jacket having an inlet port extending radially therethrough and communicating with the shaft inlet port, bearings in said jacket journaling said shaft, water seals interposed between the shaft and jacket enclosing said inlet ports, sealing means between the shaft and jacket beyond of said shaft outlet port, and means exterior of the furnace for circulating cooling fluid into said jacket inlet port and out of said jacket.

12. In annealing furnace construction having walls forming a chamber, a fan shaft extending into said chamber, a collar secured on the inner end of said shaft, a circulating fan having a hub encircling said collar, and dowel screws parallel with said shaft threaded partly into the exterior of said collar and partly into the interior of said hub for securing the fan on the shaft.

13. In an annealing furnace including walls forming a heating chamber and a recirculating chamber communicating therewith, a hollow fan shaft extending from the exterior of the furnace into said recirculating chamber and having an inlet port adjacent its outer end and an outlet port adjacent its inner end, a collar secured to the inner end of said shaft, a fan on said collar, dowel screws parallel with said fan shaft threaded partly into said collar and partly into the hub of the fan for securing the fan on the shaft, a hollow jacket journaling said shaft and communicating with said outlet port, and means exterior of the furnace for circulating cooling fluid into the hollow shaft and out of the jacket.

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