June 10, 1941. W. A. DARRAH 2,244,768

APPARATUS FOR HEAT APPLICATION

Filed Oct. 31, 1938 2 Sheets-Sheet 1

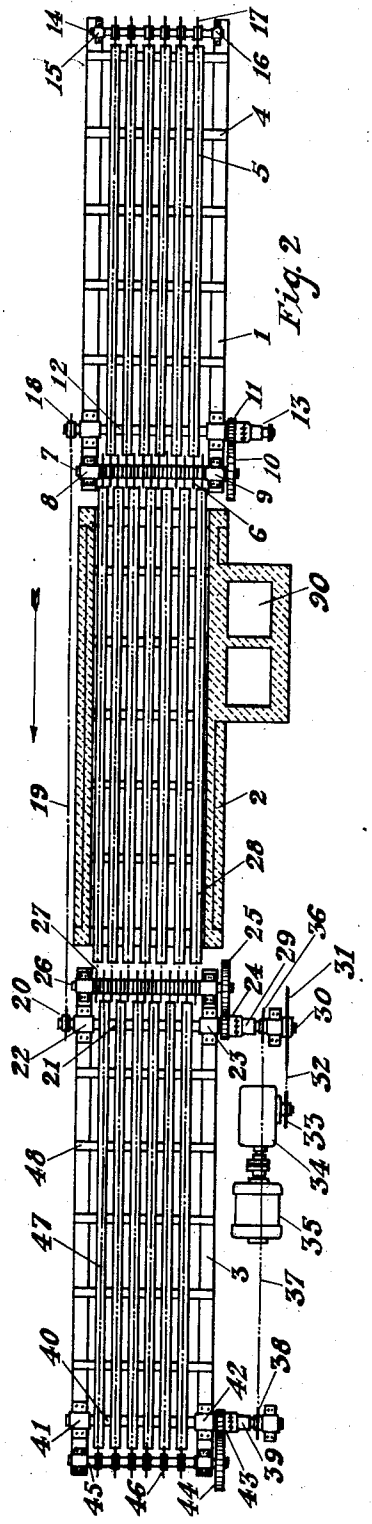


Fig. 2

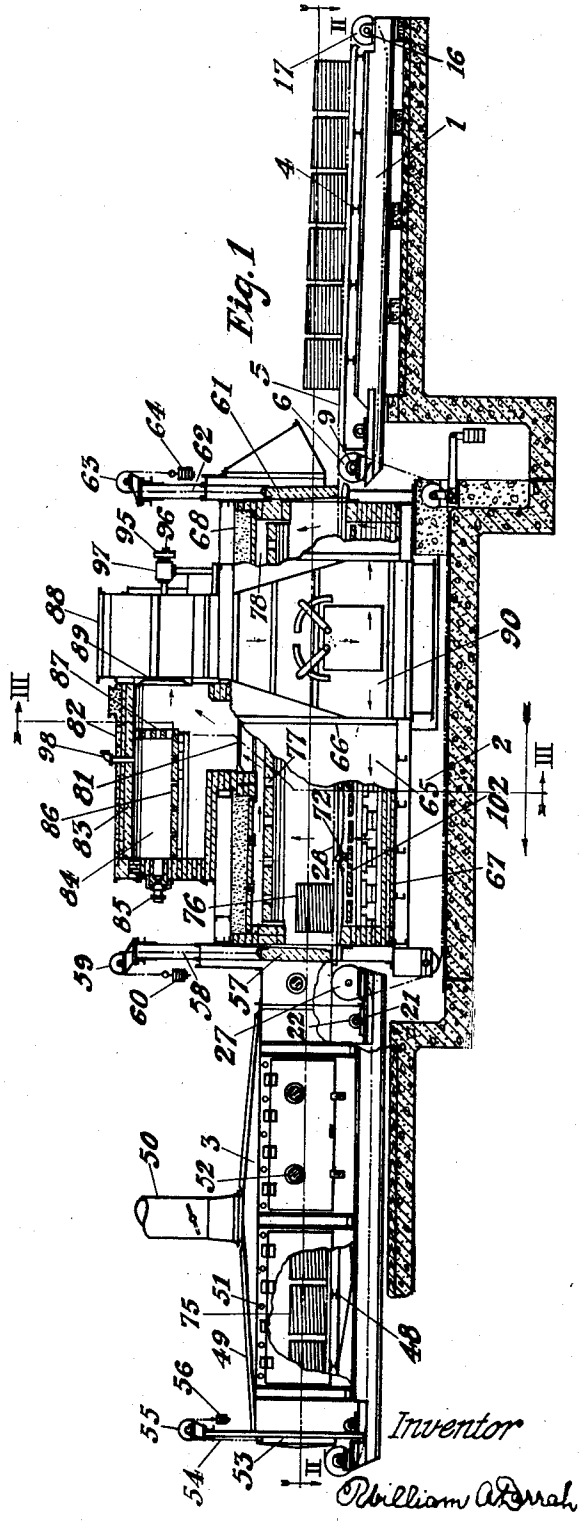


Fig. 1

Inventor

William A. Darrah

June 10, 1941. W. A. DARRAH 2,244,768

APPARATUS FOR HEAT APPLICATION

Filed Oct. 31, 1938 2 Sheets-Sheet 2

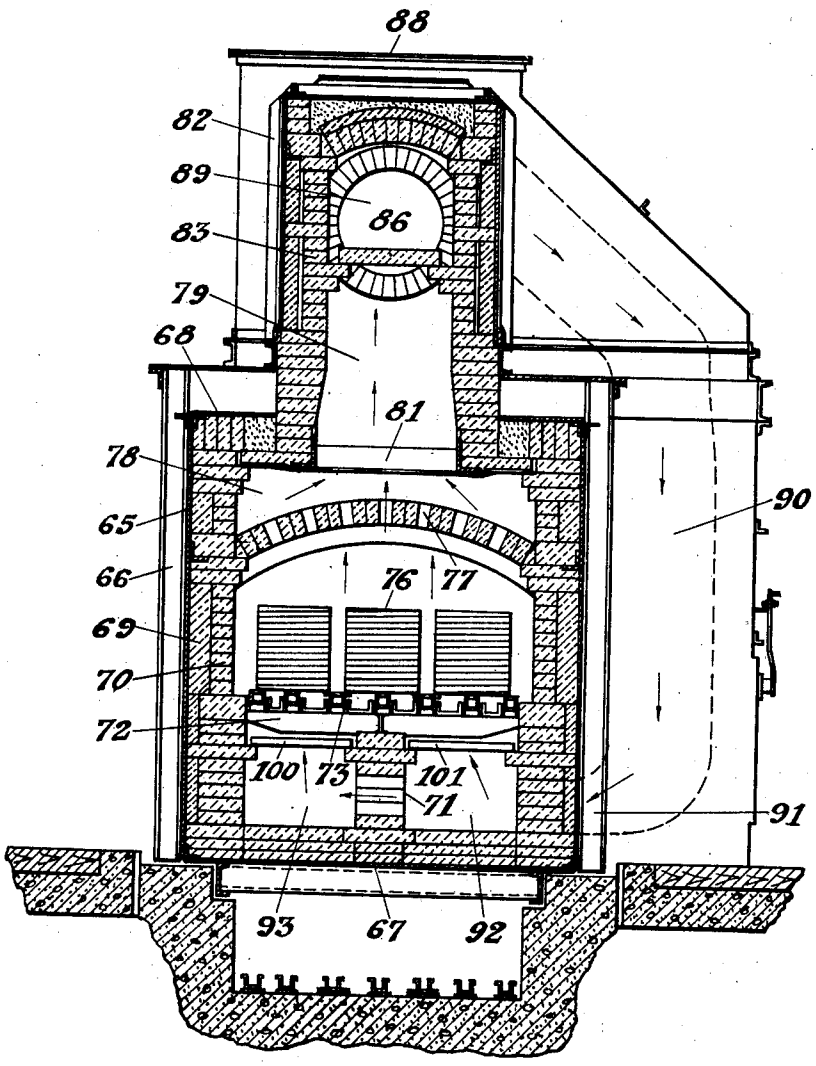


Fig. 3

Inventor
William A. Darrah

Patented June 10, 1941 2,244,768

UNITED STATES PATENT OFFICE

2,244,768

APPARATUS FOR HEAT APPLICATION

William A. Darrah, Chicago, Ill.

Application October 31, 1938, Serial No. 237,909

2 Claims. (Cl. 263—43)

This invention relates to equipment for applying heat with great uniformity and controllability and maintaining accurate atmosphere conditions within the equipment.

The apparatus which forms a part of this invention may be considered a furnace, oven or dryer when quench chamber is omitted or related equipment depending on the operating temperature range and the results desired.

Some of the objects of this invention are to provide equipment to obtain unusually high quality in the products treated, to obtain excellent temperature control and temperature distribution, to give a pre-determined surface on the material treated as well as to obtain the necessary grain structure and other characteristics as will be set forth hereafter.

Other objects of this invention will be apparent from the drawings, specifications and claims submitted herewith.

For purposes in simplicity in describing this equipment the apparatus and process used in heat treating metals will be described, but it should be distinctly understood that this equipment and the process here described are applicable to many other things.

One particular field which will be used in describing the equipment is the annealing of non-ferrous alloys, but it must be distinctly understood that this equipment may be employed to anneal steel and various ferro alloys with equal facilities merely adjusting temperatures, time cycles and atmospheres as required.

Considering this device as a furnace for the annealing of non-ferrous metals the description will be confined primarily to copper and brass although aluminum, nickel silver and numerous other metals may be handled with equal advantage and by a very similar process.

Referring to the drawings Figure 1 shows a side elevation partly in section of one form of the device covered by my invention.

Figure 2 shows a horizontal plan partly in section of my invention the section being taken along the line 2—2 of Figure 1.

Figure 3 shows a vertical cross section of one form of my device the section being taken along line 3—3 of Figure 1.

Referring now to the drawings and particularly Figures 1 and 2, the device shown may be considered to consist broadly of a loading portion 1, a furnace portion 2 and a cooling or discharge portion 3. The loading portion is shown with a group of coils of strip metal, resting on the upper surface thereof preparatory of entering the heating zone. The arrow indicates the direction of travel of the material through the equipment.

It will be understood that this equipment may be used either in a continuous process or in an intermittent or batch process with equal facility. The description here given will be confined primarily to the batch process but obviously by throwing the necessary clutches so all conveyors operate simultaneously continuous operation will be maintained and substantially satisfactory results may be secured by continuous operation.

The loading zone 1, consists of a structural frame 4 carrying on its upper surface a series of chains, one of which is indicated by 5. The number of chains and the disposition will be governed by the size and nature of the articles to be treated. Chains may be made of any convenient material, as for example, steel or malleable iron.

The chains in the loading section are driven by a series of sprockets one of which is indicated by the numeral 6. These sprockets are mounted on a shaft 7, carried in bearings 8 and 9 and driven by a gear 10 intermeshing with a second gear 11, mounted on drive shaft 12. A clutch 13 is provided so that sprocket shaft 7 may be connected or disconnected at will from drive shaft 12.

At the tail end of the chain a corresponding shaft 14 is provided mounted in bearings 15 and 16 and carrying a group of sprockets, one of which is indicated by 17. These sprockets may to advantage have the teeth removed and serve merely as traction wheels to guide the chains.

Drive shaft 12 is provided at one end with a drive sprocket 18 which is driven by means of the chain indicated by centerline 19 from drive sprocket 20. Drive sprocket 20 is mounted on drive shaft 21 which for convenience is located in the cooling zone at the discharge end of the furnace portion. This shaft is mounted in bearings 22 and 23 and carries at one end a pinion 24 arranged to mesh with drive gear 25 which serves in turn to drive shaft 26, on which are mounted sprockets as indicated by the one labeled 27. This group of sprockets serve to pull the hot chains, one of which is indicated by 28, through the furnace or heating member 2.

A clutch 29 serves to engage drive shaft 21 with motor driven shaft 30 so that the furnace conveyor including drive shaft 21 may be started or stopped independently of the operation of the balance of the conveyor system.

Motor driven shaft 30 is provided with a sprocket 31 which is driven by means of a chain

indicated by the centerline 32 from sprocket 33 mounted on reducer 34 and driven by motor 35.

A sprocket 36 mounted on motor driven shaft 30 actuates chain shown by centerline 37 and serves to provide sprocket 38 which, through clutch 39, actuates the head drive shaft 40. Drive shaft 40, which is carried in bearings 41 and 42, supports pinion 43 which meshes with gear 44 and serves to drive head shaft 45. Head shaft 45 is provided with a series of sprockets one of which is indicated by 46. These sprockets in turn operate a series of chains which may be made from steel or malleable iron, one of which is indicated by 47. These chains are carried on a structural frame work and housed in an air tight housing 49 provided with a vent stack 50. A series of water pipes carrying spray nozzles are provided in the top of cooling zone and above the chains described. 51 indicates a typical water spray pipe.

For convenience in inspecting the work a series of refractory glass inspection openings, one of which is indicated by 52, are provided in cooling zone 3.

An air tight door 53 is provided at the discharge end of the cooling zone carried on cable or other flexible support 54 which passes over sheave 55 and is attached to counterweight 56.

A similar door, but one possessing refractory and heat insulating characteristics, is provided at the opposite end of cooling zone 3 and serves to separate cooling zone 3 from hot zone 2. This door is represented by numeral 57 supported by flexible head 58 which passes over sheave 59 and is attached to counterweight 60.

A corresponding door 61 is provided at the entering end of the hot zone and supported in a similar manner by cable 62 passing over sheave 63 and ending at weight 64.

Heating chamber 2 consists of a steel shell or frame work 65 reinforced by buck stays or supporting steel 66 as indicated. This housing is provided with a tight bottom portion 67 and a tight roof 68. The interior of this heated chamber may be constructed in any satisfactory manner, the exact type of construction depending upon the operating temperature, desired service and other factors.

As shown the chamber is lined first with insulation part of which is indicated by numeral 69. Inside the insulation is provided a layer of brick 70 which may preferably be formed from a well-known insulating refractory. The shell or housing thus formed from the steel enclosure with the insulating lining is provided with a pier 71 located conveniently to support cross members 72 which may well be constructed of heat resisting alloy.

A series of these transverse members 72 are provided and they serve to support a group of guides or channels, one of which is indicated by 73. Heat resisting alloy chains pass through these channels as indicated. One of these chains is given the number 74.

The materials to be treated are loaded on the low temperature chain of Figure 1, indicated by numeral 5. A group of typical coils being treated are shown by numeral 76 in the hot zone.

A perforated arch or other horizontally extended partition member indicated by 77 is located above the enclosure surrounding the alloy chains 28 and serves to provide a duct member 78 above the heating chamber. Numerous connections, as for example 77, are provided so that there may be a free travel of furnace atmosphere from the heating chamber surrounding the work and chains into the duct member 78. An opening 81 is provided between the duct member 78 and the so-called heater chamber 82 which is mounted above the furnace chamber.

Heater chamber 82 consists of a steel shell lined with refractory, preferably of the insulating type as indicated by 83 and provided with a combustion chamber 84 supplied with a mixture of air and fuel by burner member 85.

Combustion chamber 84 is separated by a lower wall 86 and a checkered baffle 87 from the heater chamber. A circulating fan 88 is connected with an air tight joint to heater chamber 82 and arranged so that the intake of fan 88 draws hot gases from heater chamber 82. The hot gases drawn are a mixture of the return gases which travel through duct member 78 and the hot products of combustion which come from combustion chamber 84. These gases are both drawn into the intake 89 of fan 88 and discharged by means of down-comer duct 90 along the side of the furnace connecting by duct 91 to the two plenum chambers 92 and 93 located beneath the carrying chains.

The hot gases pass up between the chains and through the interstices thereof around the material being heated and then through the openings in the arch or partition 77 back into the combustion chamber 84 thus traveling in a closed circuit. Such exhaust gases as may constitute an excess leak out under the doors or through the spaces by which the chains enter thus causing the furnace to remain under a slight positive pressure which prevents the entrance of air into the system.

Fan 88 is constructed of heat resisting materials and is driven by pulley 95 mounted on shaft 96 carried in bearing 97. Pulley 95 may be driven by belt or chain from a motor or suitable source of power which is not shown.

In operating this equipment I prefer to have the burner member 85 arranged so as to be sealed into the heater chamber 82 in an air tight manner thus no material may enter the heater except by passing through the burner. I prefer to proportion the mixture of air and fuel entering the burner by well-known commercial devices usually adjusted so that there is no free oxygen present in the products of combustion and there may be even a slight deficiency of oxygen from that necessary to obtain complete combustion. I may further supplement this deficiency by controlled addition of additional fuel and gas, as for example, by means of pipe 98 which makes it possible to maintain a wide range of controlled atmospheres within the oven structure.

Since the over structure is built in an air tight manner, since it is maintained under slight positive pressure, and since nothing can enter it but the controlled products of combustion, the device disclosed gives me absolute control of the atmosphere within the heating chamber and at the time makes it possible to circulate it rapidly and change it many times per minute. When the furnace is operating as a continuous furnace the door is opened only sufficient to clear the work passing into the furnace. In the case of batch operation, which is most common, the door is closed at all times that the load is in the furnace.

Cooling chamber 3 is sealed to heating chamber 2 in an air tight manner so that there is no opportunity for leakage of air into either the cooling chamber or the heating chamber. This makes it possible to carry the same atmosphere

in the cooling chamber 3 which I carry in the heating chamber 2 so that I am able to deliver the material being treated from the heating chamber 2 into the cooling chamber 3 and cool it by a spray or other device without at any time bringing it into contact with the air outside the equipment.

It is a well-known fact that many of the non-ferrous alloys, particularly copper, bronze, many brasses and related metals will not oxidize in the presence of carbon monoxide, carbon dioxide, water vapor or nitrogen. These materials, however, will oxidize readily and excessively when exposed to even small traces of free oxygen.

It will be evident, therefore, that the device I have disclosed makes it possible to heat and cool various materials without at any time exposing them to free oxygen. I am, therefore, able to heat treat and cool many articles without exposing them to air and, therefore, without causing scale or oxide on the surface.

This procedure is a decided advance in the industry in that it makes it possible to further roll, draw or work the metal without pickling; and pickling is a troublesome, costly and annoying operation which it is highly desirable to eliminate where possible.

It appears to be highly desirable in the construction I have disclosed to avoid sudden cooling as by spraying water on hot metal parts of the furnace, such as conveyor chains and attachments. When heat resisting alloys are suddenly chilled after being highly heated they are likely to develop strains or crystal changes which greatly increase the deterioration and chances of failure.

The device I have shown avoids this condition by mechanically transferring material to be heated successively by a cold chain at the loading end of the furnace to a hot chain in the heating furnace and then again to a cold chain in the cooling zone.

In providing a proper transfer of heat for special metallurgical operations, particularly those involving the annealing at relatively low temperatures of various non-ferrous alloys as well as steels and aluminum alloys, it is desirable to maintain a flow of large volumes of circulating gases which serve as a means of transferring the heat by convection.

I have found it desirable from the standpoint of maximum uniformity and quality of product being treated to maintain a velocity of 400 or 500 feet per minute over the material being heated as a minimum, and I prefer where feasible to maintain velocities of the order of 1000 feet a minute.

It is desirable likewise to maintain a relatively low thermal head between the maximum temperature of the circulating atmosphere and the maximum temperature of the metal being heated. For extremely accurate work and nicety of control, I prefer to maintain the circulating atmosphere at exactly the maximum temperature to which the metal is to be raised thus providing no average or thermal head.

The slots 102 are arranged as shown in Figure 1 located below the material to be heated and above the gas supply duct and are quite desirable in obtaining a uniform distribution of hot circulating gases over the entire area of the hearth. It will be noted by referring to Figures 1 and 3 that the openings between the cover plates 100 and 101 which may be made from tile or other materials, are distributed from end to end of the heating chamber and from side to side of the heating chamber. The size and position of the openings are distributed to obtain complete uniformity of heat distribution. Obviously if this is not provided some of the metal being heated will not receive its proper contact with the hot circulating gases and, therefore, will not be heated to the same degree as the balance of the metal.

It is desirable to have the slots provided a substantial distance below the metal as if the metal is placed too close to these slots in a vertical direction there are likely to be unequal streaks produced due to unequal heat distribution.

While I have described the cover plates 100 and 101 as being made from tile it will be evident that these may be of metal or other materials properly designed to withstand the operating temperatures to which they may be subjected. The essential point is to obtain a uniform heat distribution and uniform air flow over all sections of the heating chamber.

This feature is one of the important elements of my invention.

When referring to products of combustion I am considering the mixture which is usually obtained under commercial conditions and so designated.

This mixture ordinarily contains carbon dioxide, carbon monoxide, water vapor and nitrogen and I prefer to keep the free uncombined oxygen at a percentage well under 1% and preferably much lower. For many applications I have found that an amount of oxygen ranging from a quarter of 1% to zero will cause no difficulty and in some cases as much as 1% may be present without excessive scaling.

Commercial products of combustion may contain small amounts of sulphur dioxide and possibly some unburned products of the fuel. I prefer to have as little smoke, soot, tar and free oil as possible.

As an illustration of typical operating conditions I might mention that a furnace having a hearth around twenty feet long and four feet wide is under commercial conditions loaded with around five tons of coiled strip. When annealing a typical brass at around 950° F. a heating time between three and one-half and four hours is not unusual. The heat is of course all transferred by circulating hot gases which are maintained exclusively products of combustion thus being free from oxygen and averaging in a typical case between 11 and 12% of carbon dioxide, about 1% carbon monoxide, the balance being nitrogen and water vapor.

Under these conditions the brass if clean and reasonably free from oil when placed in the furnace will complete the anneal without oxidation and normally without substantial discoloration.

By keeping the spray chamber filled with the same atmosphere, which is obtained by exhausting under and around the door between the furnace and the spray chamber, the metal may be cooled in this atmosphere and may leave the furnace in a very clean bright condition.

In the case of any radiantly heated furnace it is evident that radiation will be greater to those parts closely adjacent to the hot radiating surfaces irrespective of whether those surfaces be electric resistances or hot combustion chambers. Much brass equipment constructed along the lines of my invention have commercially displaced electrically heated and direct fired furnaces of many types with greatly improved results.

It will be evident that the equipment which I

have invented may be operated with any of the commercial fuels including natural gas, city gas, compressed gases such as butane and propane and also with oil or liquid fuel. Coke or coal beds may be employed but they involve the inherent problems of disposing of ash.

My equipment is commercially operatable under almost any temperature range. In the so called relief annealing field of brass and the annealing of aluminum, temperatures as low as 500 or 600° F. are used with success.

In annealing nickel silver or alloy steels temperatures of 1400 to 1600° F. may be demanded.

My equipment will operate with entire success in any of these ranges.

In the cooling zone of a structure made in accordance with my invention I provide doors or closures so that it is possible to pull the charge of hot metal into the cooling chamber and then close it off from the furnace by means of a door.

Having now fully described my invention what I claim as new and wish to secure by Letters Patent in the United States, is as follows:

1. An apparatus for convection heating with great uniformity in a recirculating atmosphere, said apparatus consisting of a tight, insulated housing, a hearth member spaced from the bottom of the said housing and dividing said housing into a work chamber above the hearth member, and a gas supply duct below, ports through said hearth member and distributed over a large portion thereof and connecting said duct with said work chamber, and arranged to give close uniformity of heat distribution, a circulating fan having an inlet duct and an outlet duct; said fan inlet connected to the upper portion of said housing, and said fan outlet duct connected to said gas supply duct, whereby exhaust gases from said housing are delivered to said gas supply duct; and a combustion chamber connected to said fan inlet to supply hot gases thereto.

2. An apparatus for convection heating with great uniformity in a controlled recirculating atmosphere, said apparatus consisting of a tight, insulated housing, a hearth member spaced from the bottom of the said housing and dividing said housing into a work chamber above the hearth member, and a gas supply duct below, ports through said hearth member and distributed over a large portion thereof and connecting said duct with said work chamber, and arranged to give close uniformity of heat distribution, a circulating fan having an inlet duct and an outlet duct; said fan inlet connected to the upper portion of said housing, and said fan outlet duct connected to said gas supply duct, whereby exhaust gases from said housing are delivered to said gas supply duct; and a combustion chamber connected to said fan inlet to supply hot gases thereto, and a gas inlet to said combustion chamber for controlling the nature of the hot gas formed by said burners.

WILLIAM A. DARRAH.