United States Patent

Keough

[15] **3,650,853**

[45] **Mar. 21, 1972**

[54] HEAT TREATING METHOD

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[22] Filed: **Oct. 27, 1969**

[21] Appl. No.: **869,524**

[52] **U.S. Cl.** **148/143,** 148/16, 148/16.5, 148/16.6, 148/20.3, 148/153

[51] **Int. Cl.** **C21d 1/00**

[58] **Field of Search** 148/143, 153, 13, 20.6, 18, 148/16, 16.5, 16.6, 20.3

[56] **References Cited**

UNITED STATES PATENTS

2,063,784 12/1936 Bechtel et al. 148/143

Primary Examiner—Richard O. Dean

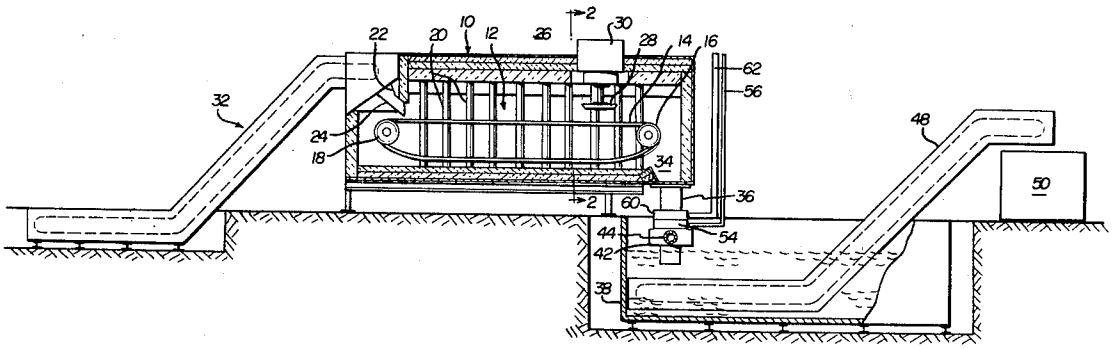
Attorney—Settle, Batchelder & Oltman

[57] **ABSTRACT**

Heat treating apparatus which includes a heat treating furnace, a chute at the back of the furnace, and a quench bath at the bottom of the chute. The chute has at least one opening in it located at a level above the quench bath, through which a purging gas is injected, and at a slightly higher level the chute has at least one opening in it through which purging gas, furnace atmosphere gas, quench bath fumes and other contaminants are exhausted.

Also included is a method of heat treating objects utilizing the apparatus.

4 Claims, 3 Drawing Figures



PATENTED MAR 21 1972

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SHEET 1 OF 2

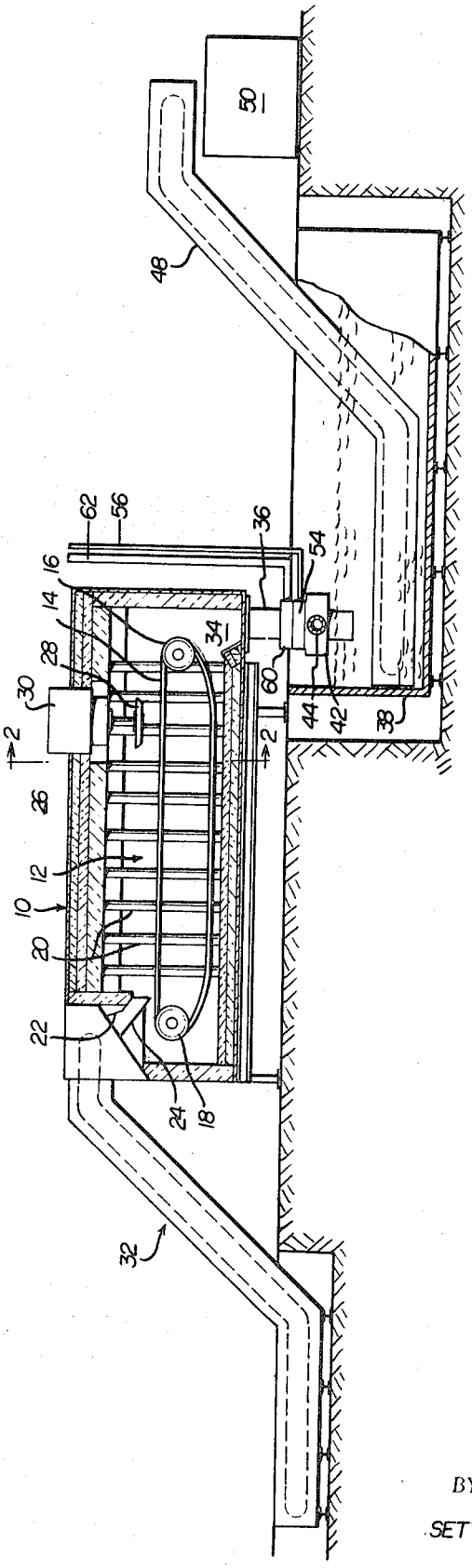


FIG. 1

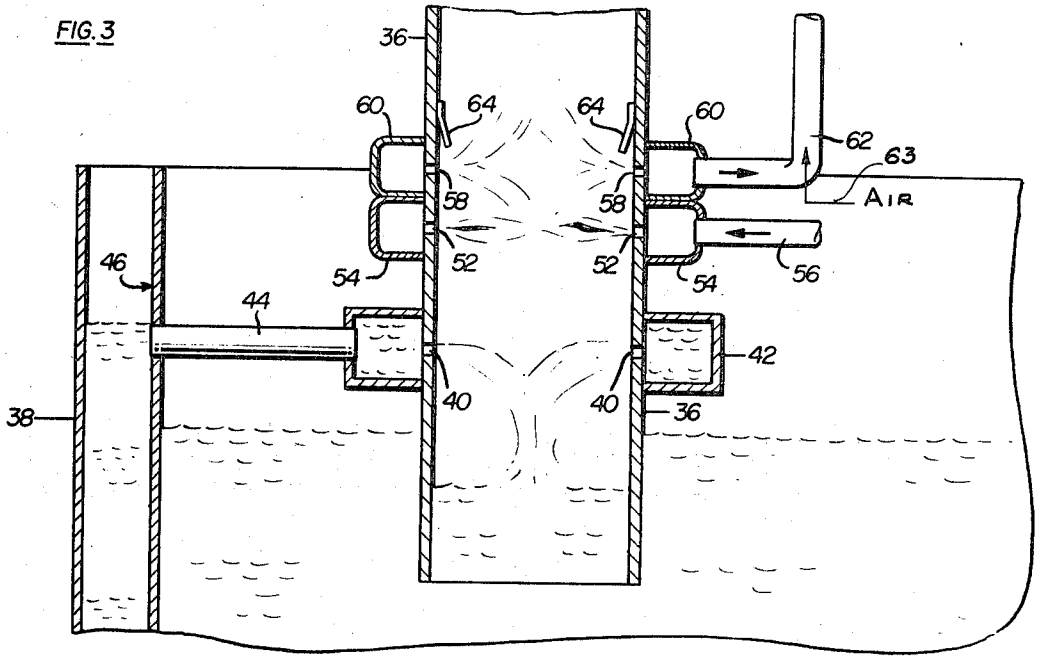
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FIG. 3



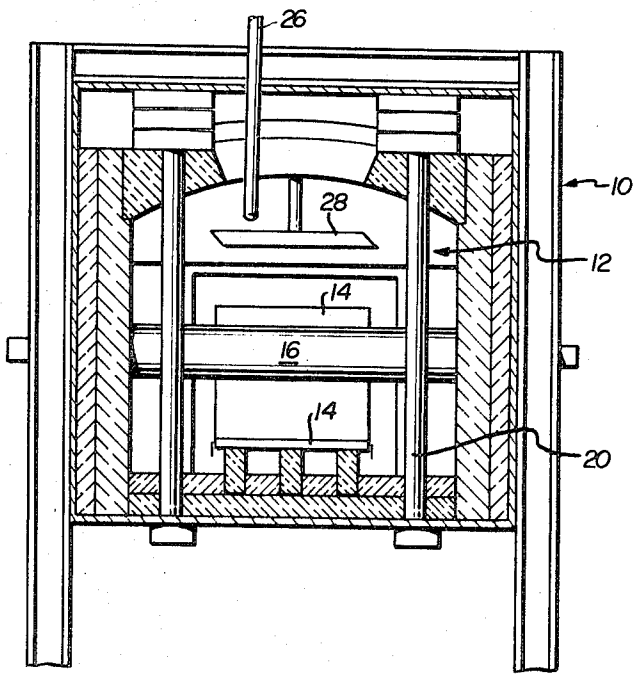


FIG. 2

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HEAT TREATING METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a heat treating furnace and associated apparatus of a type having a chute located at the back of the heating chamber of the furnace which serves as a conduit for channeling heat treated metal objects into a liquid quench bath. After the heat treating step is completed, the objects being treated are automatically dumped down through the chute into the quench bath where isothermal transformation of the metal occurs.

A nonoxidizing atmosphere is ordinarily used in the furnace to prevent decarbonization of the metal objects being treated, or in some instances to carburize them.

2. The Problem

It is important in furnaces of the above described type, that the composition of the nonoxidizing atmosphere be rigidly controlled to obtain consistent results in heat treating. Any contaminants present in the atmosphere will affect the decarbonization or carburization of the metal objects being treated, and thus ultimately affect the hardness of them.

Molten salt is commonly used as a quench bath, and is normally heated to a temperature of 600°–700° F. At that temperature the salt has a rather strong vapor pressure, thus fumes, vapor and the like from the quench bath drift up the aforementioned chute into the heating chamber of the furnace and contaminate, to a certain extent, the nonoxidizing atmosphere. The fumes also erode the metal alloy or stainless steel conveyor belts used in transporting objects through the furnace.

Additionally, when natural gas, or other carburizing gases such as carbon monoxide, ethane and propane, is used in the nonoxidizing atmosphere, all of it does not react with the metal objects being treated, but rather some of it breaks down and "snows out" or precipitates, liberating small carbon particles in the form of soot. If a significant quantity of these soot particles should happen to drop into the quench bath they could cause an explosion due to the heat of reaction with the molten salt.

Still further, water is sometimes added to a quench bath to increase the severity of the quench, and to increase the fluidity of the bath, thus minimizing the amount of quench bath fluid which adheres to the objects being treated when they are removed from the bath. Most of the water introduced into the bath vaporizes out. When the water vapor enters into the furnace heating chamber, it reacts with methane in the carburizing gas to form carbon dioxide and hydrogen, with the result that the carburizing gas burns out.

It is therefore necessary to keep the fumes given off by the quench bath from contaminating the atmosphere in the furnace and keep precipitated carbon particles in the furnace atmosphere from dropping into the quench bath.

An object of this invention is to provide a furnace construction which will minimize the contamination of the furnace atmosphere by quench bath fumes, and which will substantially eliminate the change of precipitated carbon from the furnace atmosphere dropping into the quench bath.

It is also an object of this invention to provide a heat treating process which will substantially eliminate the change of precipitated carbon from the furnace atmosphere from dropping into the quench bath.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

ON THE DRAWINGS

FIG. 1 is a side elevation view, partly in section, of the heat treatment apparatus of the invention;

FIG. 2 is a transverse cross-sectional view taken on line 2—2 of FIG. 1; and

FIG. 3 is an enlarged cross-sectional view of the chute leading from the heat treating furnace to the quench bath tank with parts broken away.

SUMMARY OF THE INVENTION

The objects of this invention are achieved by providing the chute, through which the heat treated objects are fed into the quench bath, with at least one opening in it at a level above the level of the quench bath and through which a purging gas is injected. At least one exhaust opening is located in the chute directly above the purging gas opening. Gas, fumes, and other contaminants are exhausted from the chute at a rate sufficient to prevent fumes from the quench bath entering into the heating chamber of the furnace, and to prevent soot from dropping into the quench bath.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, there is shown a heat treatment furnace **10** of more or less conventional construction which takes the form of a thermally insulated tunnellike heating chamber **12**, through which objects to be heated are conveyed on the upper run of an endless conveyor belt **14**. The belt **14** is trained around a drive roller **16** and an opposite end roller **18**, and is driven by a motor (not shown) in a direction such that the upper run of the belt moves from the left to right as viewed in FIG. 1. Heat is imparted to the heating chamber **12** by means of a plurality of burner tubes **20** connected to burner pots (not shown). The temperature within the chamber **12** and the speed of movement of the objects are cooperatively adjusted to achieve the desired heat exposure during their transit through the chamber **12**. The furnace **10** has an inlet opening or entrance **22**, and a chute **24** surrounding the opening **22** depending toward the forward end of the upper run of the conveyor belt **14**.

A gas inlet tube **26** is mounted in the top of the furnace **10**, opening into the heating chamber **12**. A fan **28** driven by a motor **30** is also mounted in the top of the furnace **10** to circulate the gas being injected through the gas inlet tube **26**.

The controlled atmosphere gas most commonly used is a high carbon potential carburizing gas comprising about 19.9% CO, 38.7% H_2, 5–8% CH_4, 0.2% CO_2, and the balance nitrogen.

Other carburizing gases can be used. In general these contain a relatively high proportion of carbon monoxide, methane, ethane or propane. To minimize the deposition of free carbon particles, or soot, the gases are conventionally diluted with nitrogen or hydrogen. By suitable adjustment of temperature, and gas composition, the surface carbon content and carbon gradient of the objects to be treated can be varied to meet almost any requirement.

Nomoxidizing gases are also used to prevent decarbonization of the metal objects being treated. Gases which are designed to simply prevent decarbonization usually have a low carbon content.

The gas which is supplied to the heating chamber **12** through the tube **26** may also be ammonia for nitriding purposes. In general, any desired gas may be introduced into the heating chamber **12** to provide a controlled atmosphere, and the gas may be any desired temperature.

Objects to be conveyed through the furnace are fed from an infeed conveyor **32** through the entrance **22** and the chute **24** onto the upper run of the belt **14**.

When the objects reach the right hand end of the conveyor, as viewed in FIG. 1, they drop freely from the belt **14** downward through an outlet opening **34** in the floor of the heating chamber **12** and through a rectangular chute **36** which extends downwardly from the opening **34** into a quench bath tank **38**. A quench bath of molten salt, or oil in some instances, is contained within the tank **38**. A suitable tank is described in U.S. Pat. No. 3,442,274, and is hereby incorporated by reference.

The lower end of the chute **36** has a horizontal slot **40** (see FIG. 3) cut into it around the periphery thereof. A manifold **42** is mounted around the outside of the chute **36** and encloses the slot **40**. A conduit **44** connects the manifold **42** to a compartment **46** containing quench bath liquid, located along a wall of the quench bath tank **38**. Quench bath liquid is pumped from the compartment **46**, through the conduit **44** and into the manifold **42**. The liquid is discharged from the manifold **42** into the chute **36** through the slot **40**. Streams from opposite sides of the chute intersect each other in approximately the center of the chute **36**. The streams serve as a liquid curtain to prevent liquid in the quench bath tank **38** from splashing up the chute **36** into the heating chamber **12** when objects are dropped from the conveyor belt **14** into the quench bath tank **38**. The liquid curtain and its function is also described in U.S. Pat. No. 3,442,274. The liquid curtain, quench bath tank, and associated apparatus form no part of this invention.

A conveyor **48** is situated in the bottom of the quench bath tank **38** for receiving objects falling through the chute **36**. The conveyor **48** transports the objects to a water bath **50** where they are washed and further cooled.

Referring to FIG. 3, the chute **36** has a horizontal slot **52** through which a purging gas is injected, cut into it around the periphery thereof at a level above the level of the slot **40** through which quench bath liquid is flowing. A manifold **54** containing purging gas is mounted around the outside of the chute **36**, enclosing the slot **52**. The manifold **54** is connected by means of a conduit **56** to a source of the purging gas.

The chute **36** has still another horizontal slot **58** cut into it around the periphery thereof at a level above the level of the slot **52** through which purging gas is injected. Purging gas, quench bath fumes, and other contaminants are exhausted through the slot **58** into a manifold **60** mounted around the outside of the chute **36** and enclosing the slot **58**. A conduit **62** leading from the manifold **60** delivers the exhausted gases to the external atmosphere. They are burnt off at the mouth of the conduit. An exhaust pump or eductor (schematically shown at **63**) is utilized to pull the purging gas through the conduit **62**. An inwardly projecting skirt **64** is attached to the interior wall of the chute **36** at a level above the slot **58** to direct fumes, gases and the like, into the exhaust slot **58**.

A plurality of spaced apart slots or orifices around the periphery of the chute **36** can be used instead of the single slots **52** and **58**.

When a high carbon potential carburizing gas is being used for the controlled atmosphere in the heating chamber thermic gas (e.g., 40% H_2, 20.9% CO, 40% N_2). This is injected into the chute through the slot **52**, preferably at a rate of about 400 cubic feet per hour. The endothermic gas contains a low amount of carbon as compared to the high carbon potential gas normally used in the heating chamber of the furnace.

The carbon potential of a gas is measured with reference to its dew point. The high carbon potential gases have a relatively low dew point, while the low carbon potential gases have a relatively high dew point. For the purposes of this invention a high carbon potential gas can be defined as any carbon containing gas having a dew point of about 70° F. or lower. A low carbon potential gas can be defined as any carbon containing gas having a dew point substantially higher than that of the high carbon potential gas.

The preferred high carbon potential gas used in the heating chamber may have a dew point as low as 0° F. and thus has a tendency to precipitate out carbon when it cools. For example, in the treatment of steel having 0.70 percent carbon, the dew point is controlled at 30°–35° F. when the furnace is operating at 1,600° F. In a steel having 1.00 percent carbon the dew point will be about 20°F. **at the same temperature in the furnace. The low carbon potential endothermic purging gas, on the other hand, has a dew point in excess of the specific carbon potential gas preferably at least about** 70° F. and does not precipitate out carbon when it cools. The terms "high carbon potential gas" and "low carbon potential gas" thus are comparative, the dew point of the high carbon gas depending upon the carbon content of the steel being treated and the low carbon gas having a dew point dependent upon the specific high carbon gas utilized.

Thus injecting the low carbon potential purging gas into the chute and mixing it with the high carbon potential gas has the effect of raising the dew point of the high carbon potential gas and preventing carbon from precipitating out. This, coupled with the exhausting of all gases and contaminants through the slot **58** effectively prevents precipitated carbon from falling into the quench bath.

Any other low carbon potential purging gas can be used in conjunction with the high carbon potential gas used for the furnace surface atmosphere to prevent precipitated carbon from falling into the quench bath. Other suitable gases include, for example, carbon dioxide.

Purging gases other than the low carbon potential gas can be used when carbon precipitating gases are not used as the controlled atmosphere in the heating chamber. The specific nature of this purging gas is not critical, as long as it is nonoxidizing.

Injected gas, quench bath fumes, and other contaminants are exhausted sufficiently to prevent quench bath fumes from entering the heating chamber and precipitated carbon particles from falling into the quench bath. Preferably exhaust gases are drawn through the slot **58** at a rate at least two times the rate purging gas is injected into the chute **36** through the slot **52**. In a preferred embodiment it is exhausted at the rate of 800 cubic feet per hour. Some controlled atmosphere gas in the heating chamber will be drawn out at the same time.

Exhaustion of the gases and quench bath fumes through the slot **58** serves the dual function of preventing contamination of the furnace atmosphere and erosion of the belt by quench bath fumes, and also prevents the precipitating carbon from unreacted gas from falling into the quench bath.

In the event a controlled atmosphere which does not precipitate soot is being used in the furnace chamber **12**, gases need be exhausted through the slot **58** in the chute **36** at a rate sufficient only to prevent quench bath fumes from rising through the chute **36** into the heating chamber **12**.

What I claim is:

1. In the method of heat treating objects which includes transporting objects through the heating chamber of a heat treating furnace, and thereafter feeding the objects down through a chute into a quench bath giving off fumes, the improved method of preventing contaminating particles from the furnace from falling through the chute to the bath comprising (1) injecting a continuous stream of purging gas into the chute through a lateral opening above the level of the quench bath and (2) exhausting purging gas, fumes and other contaminants from the chute at a level above the level of injection of the purging gas; the purging gas, fumes, and other contaminants being exhausted at a rate sufficient to preclude fumes from the quench bath from rising through the chute into the heating chamber.

2. In the method of heat treating objects which includes transporting objects through a heating chamber having a controlled atmosphere, and thereafter feeding the objects down through a substantially vertical chute having the same controlled atmosphere, into a quench bath giving off fumes, the improved method of preventing contaminating particles from the furnace from falling through the chute to the bath comprising (1) injecting a continuous stream of purging gas into the chute through a substantially horizontal opening in the generally vertical chute and (2) exhausting gas, fumes and other contaminants from the chute at a level directly above the level of injection of the purging gas; the gas, fumes and other contaminants being exhausted at a rate sufficient to preclude contaminants from falling into the quench bath.

3. The method of claim **2** in which the controlled atmosphere is a high carbon potential carburizing gas, the purging gas is a low carbon potential gas, and in which the gas, fumes and other contaminants are exhausted from the chute at

a rate equal to about two times the rate the purging gas is injected.

4. The method of claim 3 in which the purging gas is injected into the chute at the rate of about 400 cubic feet per minute, and the gas, fumes, and other contaminants are exhausted at about 800 cubic feet per minute.

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