Dec. 14, 1965 A. W. THOMPSON 3,223,396

HEAT TREATMENT APPARATUS

Filed April 22, 1963 2 Sheets-Sheet 1

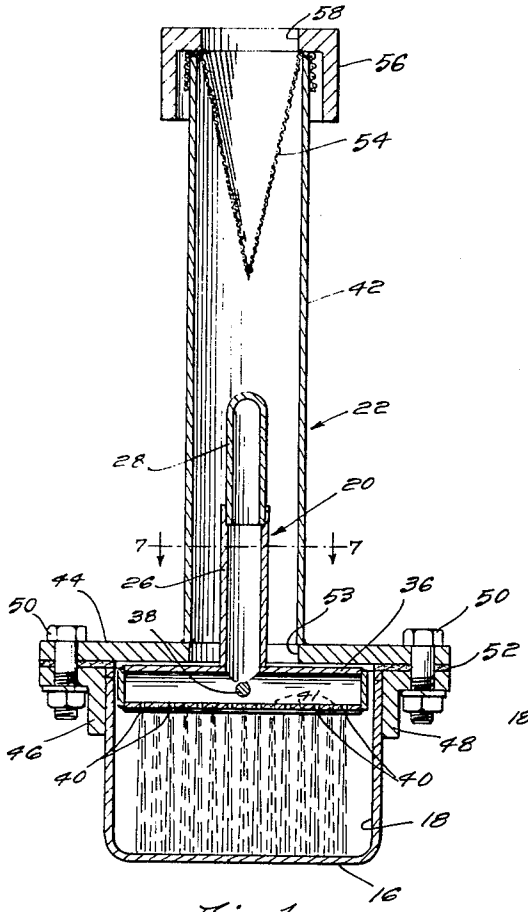


Fig. 1

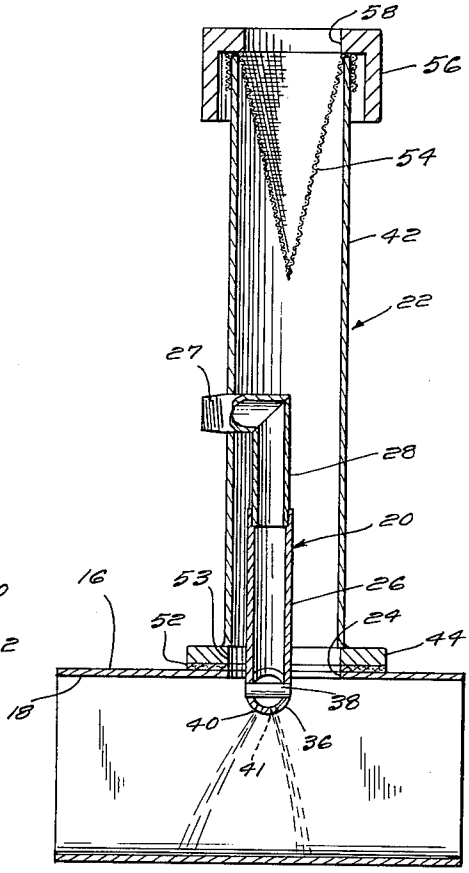


Fig. 2

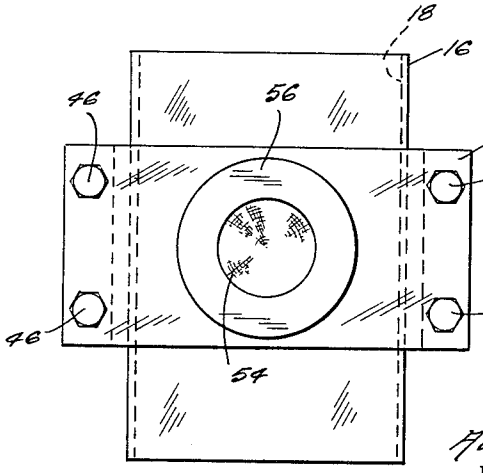


Fig. 3

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HEAT TREATMENT APPARATUS

Filed April 22, 1963 2 Sheets-Sheet 2

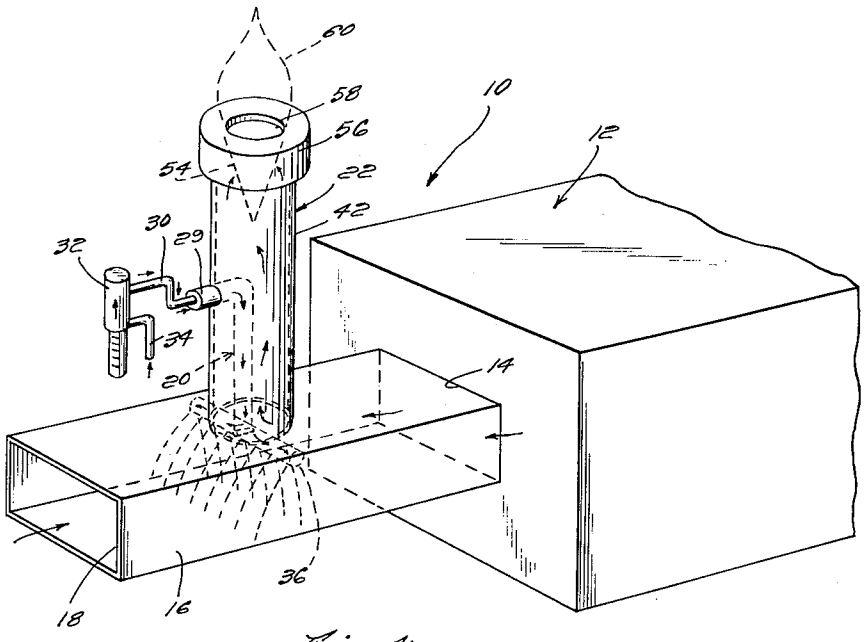


Fig. 4

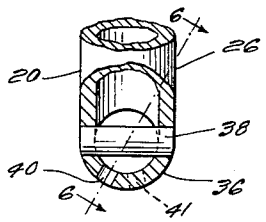


Fig. 5

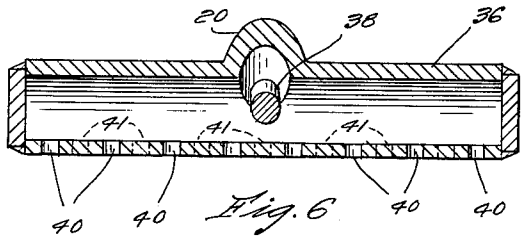


Fig. 6

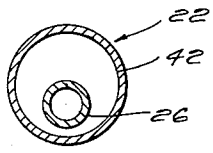


Fig. 7

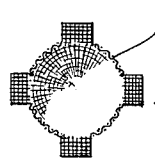


Fig. 8

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United States Patent Office 3,223,396 Patented Dec. 14, 1965

3,223,396

HEAT TREATMENT APPARATUS

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Filed Apr. 22, 1963, Ser. No. 274,502
3 Claims. (Cl. 266—5)

The present invention relates to heat treatment apparatus. More particularly, the present invention relates to apparatus of the type that is utilized in connection with the heat treatment of high-speed steels, stainless steels and the like.

The heat treatment apparatus embodied in the present invention includes a furnace construction that is normally associated with the heat treatment of metals that are moved continuously through the heat treatment chambers thereof. In the heat treatment of continuously moving work loads that are feeding through a heating chamber, the ends of the heat chamber are normally open to receive the continuously moving work load or pieces. Prior to the instant invention, it has been the practice to provide some form of curtain, such as a flame curtain, that is located at the entrance and exit sides of the heat treatment chamber for preventing the inflow of atmospheric air into the heat treatment chamber. Flame curtains have been found to be objectionable; since the flame creates water vapor, causes carbon deposits to appear on the work pieces, and otherwise provides additional heat for the work that is objectionable. The present invention eliminates the prior known flame curtain and provides for a barrier or curtain defined by an inert gas that is introduced into the passageway through which the work piece passes and exteriorly of the heat treatment chamber. By introducing the inert gas into the passageway through which the work piece or load passes under pressure, the open end of the passageway is effectively sealed from the interior of the heat treatment chamber, and atmospheric air is prevented from entering the heat treatment chamber and contaminating the work piece or load being heat treated therein.

The present invention also contemplates the use of a heat treatment atmosphere, controlled amounts of which are introduced into the heat treatment chamber, for maintaining required controlled conditions therein. Since it is necessary to provide a continuous flow of heat treatment atmosphere, some means must be provided for discharging this atmosphere from the heat treatment chamber and the furnace construction. In the present invention, a burn-off stack is provided wherein the hydrogen associated with the heat treatment atmosphere is burned off in a continuous flame at the uppermost end of the stack and the volatile materials are trapped below the flame by means of a five stream that is positioned within the stack. The system embodied in the present invention, therefore, contemplates the introduction of the inert gas to define an air curtain for preventing the ingress of atmospheric air into a heat treatment chamber and further includes means for burning off the heat treatment atmosphere, the air curtain being located in close proximity to the stack so that if the flame burns out, the inert gas that forms the gas curtain can be utilized to prevent air from circulating into the heat treatment chamber by way of the stack. It is, of course, essential to prevent the introduction of atmospheric air into the heat treatment chamber in order to prevent contamination and possible explosions.

Accordingly, it is an object of the present invention to provide heat treatment apparatus that incorporates a gas barrier for prevention of introduction of atmospheric air into the heat treatment chamber thereof.

Another object of the present invention is to provide a heat treatment furnace wherein a controlled treatment atmosphere is circulated through the heat treatment chamber and is discharged through a burn-off stack.

Still another object is to provide a gas curtain for use in the passageway of a heat treatment furnace, the gas curtain being created by the ejection of an inert gas under pressure into the passageway and toward an open end thereof.

Still another object is to provide a burn-off stack for use with heat treatment apparatus that is located in close proximity to an air curtain so that if the flame of the burn-off stack should fail, the air curtain would prevent the introduction of atmospheric air into the heat chamber of the furnace construction.

Other objects, features and advantages of the invention will become apparent as the description thereof proceeds when considered in connection with the accompanying illustrative drawings.

In the drawings which illustrate the best mode presently contemplated for carrying out the instant invention:

FIG. 1 is a vertical sectional view of a passageway that communicates with the heat treatment chamber of a furnace construction and further showing the location of a barrier gas ejection system and a burn-off stack located in close proximity thereto;

FIG. 2 is a vertical sectional view of the apparatus illustrated in FIG. 1 but rotated 90° with respect thereto;

FIG. 3 is a top plan view of the apparatus illustrated in FIGS. 1 and 2;

FIG. 4 is a perspective view of the passageway and burn-off stack illustrated in FIG. 1 and showing the relationship thereof with respect to the heat treatment chamber of the furnace construction;

FIG. 5 is a fragmentary enlarged sectional view showing the location of the nozzles with respect to the manifold of the gas barrier ejection system;

FIG. 6 is a sectional view taken along lines **6—6** in FIG. 5;

FIG. 7 is a sectional view taken along lines **7—7** in FIG. 1; and

FIG. 8 is a top plan view of the fire screen located at the uppermost end of the burn-off stack.

Referring now to the drawings and particularly to FIG. 4, a portion of the furnace construction embodied herein is illustrated, the furnace construction being generally indicated at **10**. For purposes of illustration, the heat treatment chamber is generally indicated at **12**, it being understood that the heat treatment chamber **12** is constructed in conventional fashion for the purpose of heat treating metal pieces therein, such as high speed steels, stainless steels, and the like. The present invention has particular application in the heat treatment of work pieces that are moved continuously through the heat treatment chamber **12**, this continuous movement being carried out through a belt construction or the like that is also conventional in furnace constructions of this type. It is understood, of course, that the concept of the invention may also be employed in the batch type furnace wherein a sliding door is disposed at an end of the furnace construction to cover the inlet opening thereof.

In the furnace construction of the present invention, an inlet opening to the heat treatment chamber **12** is indicated at **14**, an outlet opening or discharge opening being located on the opposite side of the heat treatment chamber **12** but not shown herein. It will be further understood that the concept of the invention embodied herein may be incorporated in connection with either the inlet opening **14** or the exhaust opening (not shown), as will be more apparent from the following description. As illustrated in FIG. 4, an inlet housing **16** that is substantially rectangular in cross sectional configuration is joined

to the heat treatment chamber **12** and defines an inlet passageway **18** that communicates with the inlet opening **14** of the heat chamber **12**. The work to be heat treated is normally introduced into the heat chamber **12** by a continuously moving belt (not shown) that carries the work through the passageway **18** and inlet opening **14** into the interior of the heat chamber **12**. The direction of movement of the work is illustrated by the arrow in FIG. 4. The corresponding outlet communicating with the heat chamber **12** is constructed similarly to the inlet housing **16** and is formed with a passageway through which the work travels after it is discharged from the heat chamber **12** by the continuously moving belt.

Since the passageway **18** of the inlet housing **16** is open to atmosphere at the outer end thereof, it is necessary to prevent the ingress of atmospheric air into the chamber **12**. For this purpose, a gas barrier is provided, the gas barrier being defined by an inert gas that is ejected into the passageway **18** under pressure and in the direction of the opening to the passageway.

Referring now to FIGS. 1, 2 and 4, the particular constructional arrangement for ejecting the gas barrier into the passageway **18** is illustrated and, as shown, includes a vertically extending conduit **20** that is disposed internally of a cylindrical stack **22** that is secured directly to the upper wall of the inlet housing **16** and that has communication with the passageway **18** through an opening **24**. As will be described in more detail hereinafter, the stack **22** is utilized for discharging the heat treatment atmosphere by burning off certain components thereof at the upper open end of the stack.

The inlet gas conduit **20** is formed with a lower section **26** that extends through the opening **24** of the housing **18** and also includes an upper section **28** that has an elbow configuration and that extends through the wall of the stack **22**. The upper section **28** is threaded at the exposed end thereof, as indicated at **27**, and receives a coupling **29** in threaded relation thereon. The coupling **29** is mounted on a reduced conduit **30** that is joined directly to the outlet of a flow meter **32**, an inlet conduit **34** being joined to the inlet side of the flow meter **32** and being further connected to a source of an inert gas, such as nitrogen, helium, argon, etc. It will be understood that the inert gas is introduced into the conduit **20** by means of the inlet conduit **34**, flow meter **32**, reduced conduit **30**, coupling **29** and upper section **28** of the conduit **20**.

Joined directly to the lower section **26** of the conduit **20** and located interiorly of the inlet housing **16**, extending transversely with respect thereto, is a manifold **36**. As shown more clearly in FIGS. 1, 2, 5 and 6, the manifold **36** is located adjacent the upper wall of the inlet housing **16** and extends substantially the width thereof. A deflector **38** is located within the manifold **36** just below the intersection of the manifold with respect to the conduit **20** and is adapted to direct the incoming gas to the opposite portions of the manifold. Formed in the manifold are a plurality of nozzles **40** which, as shown in FIGS. 2, 5 and 6 are formed in adjacent rows in the manifold **36**. One row of the nozzles **40** is located adjacent the front of the manifold **36**, each front nozzle **40** being positioned such that the axis thereof defines an angle of 30° with respect to the vertical. The forwardly facing nozzles **40** thus direct the gas ejected therethrough at an angle of 30° to the vertical and toward the open end of the passageway **18**. The other row of nozzles **41** are located adjacent the rear of the manifold **36**, each rear nozzle **41** being positioned such that the axis thereof defines an angle of 15° with respect to the vertical. The rearwardly facing nozzles **41** thus direct the gas ejected therethrough at an angle of 15° to the vertical and toward the rear of the passageway **18**. The rearwardly directed gas stream thereby acts to form an inert gas barrier in the area below the stack **22** for inhibiting the heat treatment atmosphere from flowing toward the open end of the passageway **18**. Both sets of the nozzles **40** are disposed in spaced-apart relation substantially the width of the passageway **18** and are thus adapted to eject the inert gas into the passageway so as to substantially envelop the passageway to form a gas curtain therein. As shown in FIG. 6, the position of the rearwardly facing nozzles **41** is staggered with respect to the forwardly facing nozzles **40**.

As mentioned hereinabove, the stack **22** is provided for burning off the heat treatment atmosphere that is circulated within the heat treatment chamber **12** during the heat treatment of the work within the chamber. The purpose of using such an atmosphere is to prevent contamination of the work when it is subjected to relatively high heat heat treatment temperatures, which contamination would occur if air or any other impure or non-humidified atmosphere were present in the heat treatment chamber. It is standard practice in the operation of industrial heat treatment furnaces to maintain a steady flow of a carefully controlled and dried atmosphere through the heat treatment chamber of the furnace, the flow of the heat treatment atmosphere normally serving to prevent the ingress of air or other impure atmospheres into the heating chamber of the furnace where contamination of the work is most likely to occur. In the present invention, use of the heat treatment atmosphere for preventing contamination of the work within the furnace is supplemented by the use of the gas barrier as described, thereby insuring that air will not reach the heat treatment chamber during the heat treatment operation. Since there is a continuous flow of heat treatment atmosphere through the heat treatment chamber, some provision must be made for continuously discharging this atmosphere from the chamber. For this purpose, the stack **22** is provided, and, as shown in FIGS. 1, 2 and 4, the stack **22** is mounted on the upper wall of the inlet housing **16** for communication with the interior of the heat treatment chamber **12** by way of the passageway **18** and the inlet opening **14**. Referring particularly to FIGS. 1 and 2, the stack **22** is shown comprising an elongated tubular member **42** that is secured at the lowermost end thereof to a plate **44**. The plate **44** is secured to flanges **46** and **48** by bolts **50**, the flanges **46** and **48** being joined to the side walls of the inlet housing **16** by welding or the like. As shown more clearly in FIG. 1, a silicone type washer or gasket **52** is disposed between the plate **44** and the flanges **46**, **48** so as to effectively seal the plate **44** in position on the housing **16** and thereby preventing air leakage within the housing. It is understood, of course, that the plate **44** is also formed with an opening **53** that generally corresponds to the opening **24**, thereby providing for communication of the stack **22** with the passageway **18** of the inlet housing **16**.

As mentioned hereinabove, the stack **22** is provided for discharging the heat treatment atmosphere from the chamber **12**. Since a component of the heat treatment atmosphere is burned off at the top of the stack, some provision must be made for screening the interior portions of the stack. For this purpose, a fire screen **54** is provided and, as shown in FIGS. 1 and 2, the fire screen **54** has an inverted cone shape configuration and is secured to the uppermost end of the tubular member **42** of the stack. In order to removably mount the fire screen in position, the uppermost ends of the fire screen **54** are folded over the adjacent uppermost edge of the tubular member **42**, and a cap **56** formed with a depending skirt and an opening **58** therein that communicates with the interior of the tubular member **42** is placed over the folded edges of the fire screen to lock the screen in place.

As illustrated in FIG. 4, the heat treatment atmosphere is discharged from the heat chamber **12** through the inlet opening **14** and flows upwardly through the stack **22** as indicated by the arrows. Normally the heat treatment atmosphere is dissociated ammonia, and accordingly, it is desirable to burn off the hydrogen component of the

dissociated ammonia. By providing a pilot (not shown), a flame may be produced as indicated in the dotted lines at 60 in FIG. 4 at the upper exposed end of the stack 22, the flame being caused by the continuous burning off of the hydrogen of the heat treatment atmosphere that flows upwardly through the stack 22. The fire screen 54 is adapted to collect the volatile materials of the heat treatment atmosphere, the hydrogen of the heat treatment atmosphere being lighter than the volatile materials and thereby passing upwardly through the fire screen 54 and being burned off at the top of the stack. The fire screen 54 not only collects the volatile materials of the heat treatment atmosphere, but also acts to break up the flame and thereby prevents flame backup within the stack 22. The continuously burning flame and the fire screen 54 thus cooperate to prevent any air leakage from entering the inlet passageway 16 and inlet opening 14 by way of the stack 22.

As described hereinabove, the inlet conduit 20 for the gas barrier or curtain is located within the stack 22, the nozzles 40 of the manifold 36 being disposed directly beneath the lowermost end of the stack 22. By providing this constructional arrangement wherein the inlet conduit 20 and the ejection nozzles 40 are located closely adjacent the stack 22, in the event of flame burnout a small portion of the inert gas that is ejected through the nozzles 40 will have a tendency to back up into the stack 22. Thus the inert gas will tend to prevent the air from flowing inwardly from the top of the stack into the inlet passageway 18 and eventually into the heat treament chamber 12. Since a small portion of the inert gas does flow upwardly into the stack 22 at all times, the temperature of the lower portions of the stack is reduced so that no burning action takes place therein. By reason of this arrangement, all of the burning of the hydrogen is produced at the top of the stack in the burnout area above the fire screen 54.

It will also be noted that some portion of the hydrogen that is formed as part of the heat treatment atmosphere may sometimes mix with the inert gas curtain. However, this mixture of the gases is not objectionable since an inert forming gas is produced that is not harmful if it is introduced into the heat treatment chamber 12. It is seen that the heat treatment atmosphere that is continuously circulated within the heat treatment chamber 12 cooperates with the gas barrier that is ejected from the nozzles 40 to prevent the introduction of air into the heat treatment chamber. The ejection nozzles 40 may be spaced from the front edge of the inlet housing 16 as desired and depending upon the cross sectional area of the inlet passageway 18. In other words, if the passageway 18 has a large cross sectional configuration, then it would be desirable to place the ejection nozzles 40 more closely adjacent the outer or exposed end of the inlet housing 16.

As pointed out hereinabove, the concept of the invention embodied herein is not limited to the location of the gas barrier at the inlet side of the heat treatment chamber 12. It is understood that a similar gas barrier may be employed on the discharge side of the heat treatment chamber, and it is further understood that a stack similar to the stack 22 may be located adjacent the gas barrier on the discharge side of the heat treatment chamber.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the underlying inventive concept and that the same is not limited to the particular forms herein shown and described except insofar as indicated by the scope of the appended claims.

What is claimed is:

1. In a furnace for use in the heat treatment of a continuously moving work piece, a heat treatment chamber through which said work piece travels during the heat treatment thereof, a passageway open to atmosphere communicating with said chamber and through which said work piece passes, means for introducing a heat treatment atmosphere into said heat treatment chamber, a vertically extending stack communicating with said passageway and through which the heat treatment atmosphere is discharged and burned off after circulation through said heat treatment chamber, a conduit located in said stack and projecting downwardly therethrough, said conduit terminating directly beneath said stack and extending into said passageway, and means for introducing an inert gas under pressure into said conduit for passage therethrough into said passageway, said conduit directing the major portion of said inert gas toward the open end of said passageway to define a barrier for preventing atmospheric air from entering said heat treatment chamber from the entrance end of said passageway, a relatively small portion of the inert gas being directed upwardly from the lowermost end of said conduit into said stack for reducing the temperature of the lower end of said stack to prevent burning of treatment gas therein, said inert gas directed into said stack further preventing ingress of atmosphere into said passageway from said stack in the event that burn-out of said heat treatment atmosphere occurs at the upper end of said stack.

2. In a furnace as set forth in claim 1, a manifold joined to the lowermost end of said conduit and located in said passageway transversely thereof and directly beneath said stack.

3. In a furnace as set forth in claim 1, said conduit directing means consisting of a manifold including nozzles being formed in a forwardly facing row in said manifold and a rearwardly facing row therein, said forwardly facing nozzles being staggered with respect to said rearwardly facing nozzles and directing said inert gas toward the front of said passageway for preventing ingress of atmospheric air therein, the staggered rearwardly facing nozzles directing the inert gas toward the rear of said passageway to prevent discharge of said heat treatment atmosphere through the front of said passageway.

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