May 6, 1969 W. R. KEOUGH 3,442,274

HEAT TREATING APPARATUS

Original Filed Oct. 11, 1963 Sheet 1 of 3

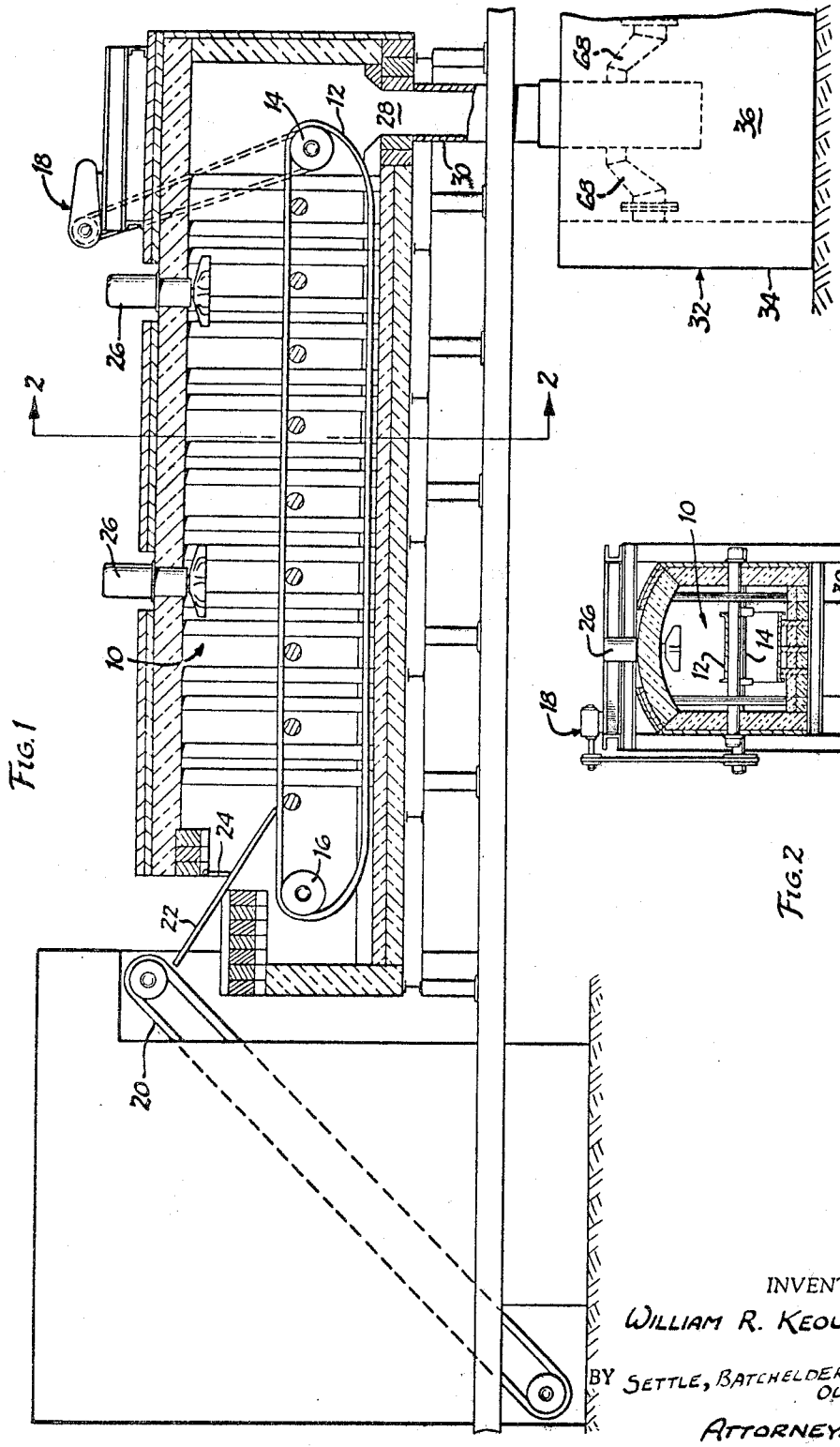


FIG. 1

FIG. 2

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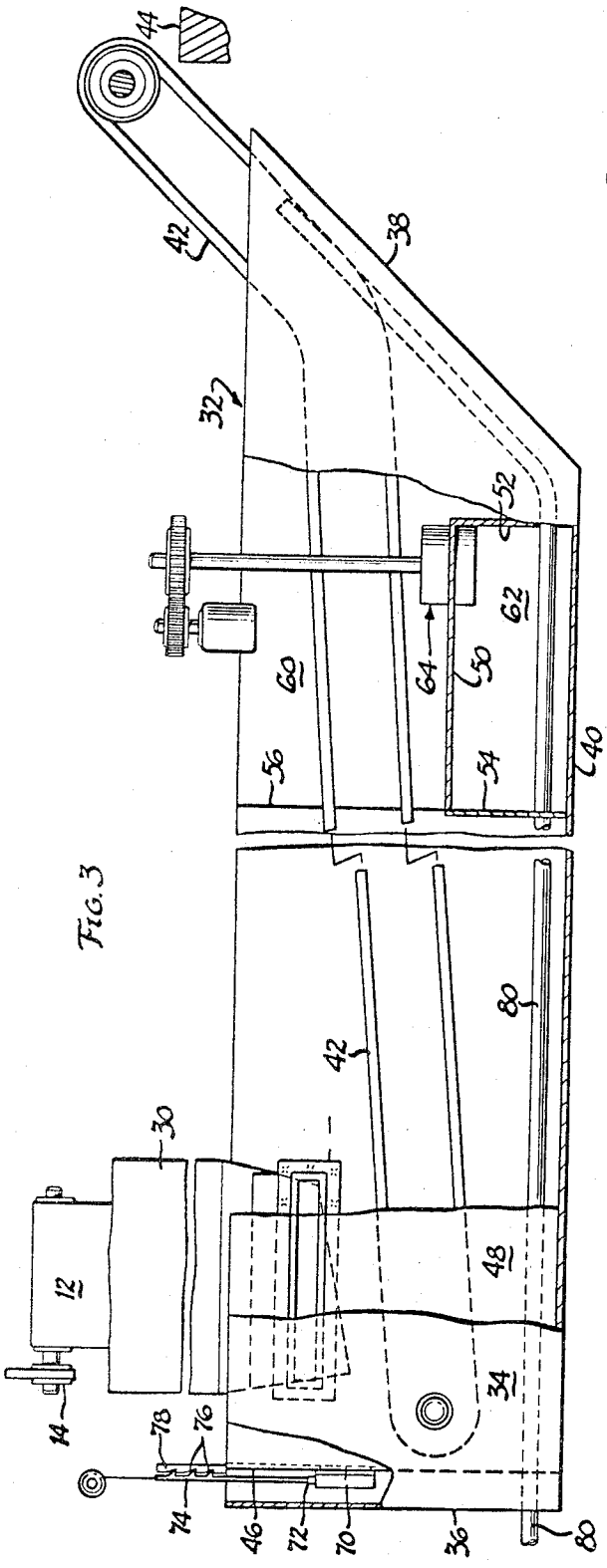


FIG. 3

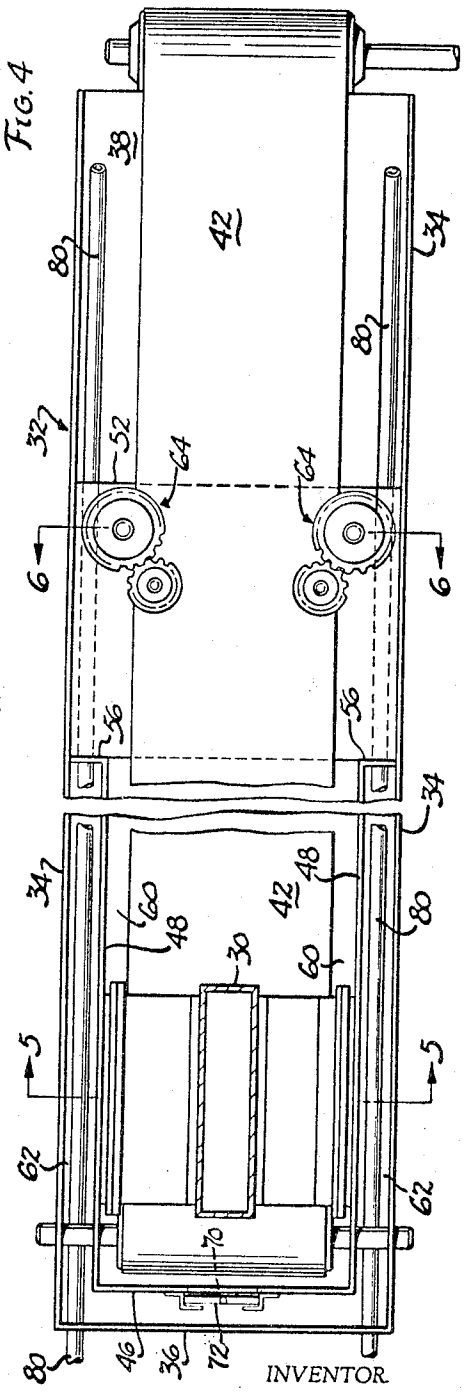


FIG. 4

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FIG. 5

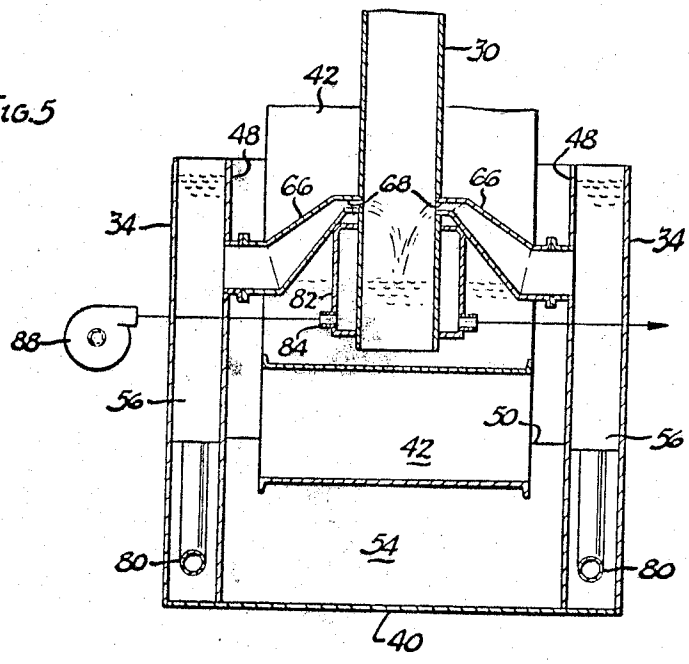
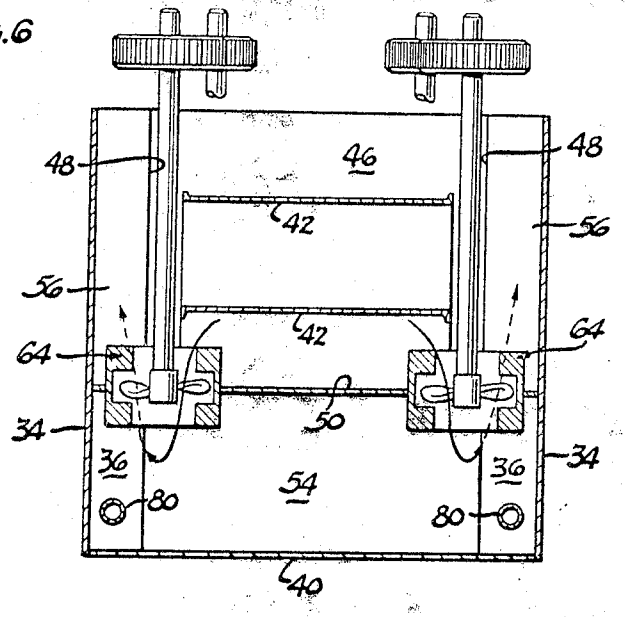


FIG. 6



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United States Patent Office 3,442,274
Patented May 6, 1969

3,442,274

HEAT TREATING APPARATUS

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Original application Oct. 11, 1963, Ser. No. 315,467, now Patent No. 3,372,065, dated Mar. 5, 1968. Divided and this application Nov. 28, 1967, Ser. No. 686,075
Int. Cl. B08 3/04
U.S. Cl. 134—108 6 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for heat treating articles by transfer from a heat treatment furnace into a quenching bath. The articles are passed through streams of cooling fluid continuously flowing towards the surface of the bath from a point above the surface of the bath. The downwardly directed streams will eliminate splashing of the quenching liquid into the furnace.

This application is divided from a copending application Ser. No. 315,467, filed Oct. 11, 1963, now Patent No. 3,372,065 by the present inventor.

This invention relates to the heat treating of articles, and more particularly to improvements in apparatus for the transfer of heated metal articles from a heat treatment furnace into a quenching bath.

The present invention is especially concerned with that type of heat treatment process wherein metal articles are conveyed through a heat treatment furnace at a rate chosen to achieve the desired exposure of the article to heat during its transit through the furnace and to discharge the article from the conveyor directly into a quenching bath. Because of the high temperatures maintained within the furnace and the continuous exposure of the conveyor to these temperatures, the choice of materials which are satisfactory for this purpose are exceedingly expensive. In the machine disclosed in this application, the belt is constructed of stainless steel. Frequently, the liquid in the quenching bath is extremely corrosive and splashing of the bath liquid onto a conveying belt of the furnace materially decreases the useful life of the belt.

Accordingly, it is an object of the present invention to provide a heat treatment installation wherein heated articles may be dropped directly from a heat treatment furnace into a quenching bath in a manner such that splashing created by the entry of the part into the quenching bath is minimized.

It is another object of the invention to provide a quenching bath installation in which quenching fluid is recirculated in a manner which assists in maintaining a constant temperature throughout the bath and at the same time minimizes the splashing of liquid as articles to be quenched are dropped into the bath.

The foregoing, and other objects, are achieved in an installation in which an endless conveyor belt is employed to convey articles through a heat treatment furnace and to discharge the articles by discharging the heated articles into a quenching bath located below the discharge end of the conveyor. The quenching bath is contained in a tank divided into two chambers. An open-ended vertical tube projects downwardly into a first chamber and articles discharged from the furnace conveyor drop downwardly through this tube into the quenching bath contained in the first chamber of the tank. A conveyor is located within the first chamber with a carrying run extending below the lower end of the tube and articles are thus conveyed from the quenching bath to the next treatment station.

At a location above the normal level of quenching liquid in the first chamber, a pair of conduits place the interior of the tube in communication with the second of the two chambers, the conduits entering the tube at opposed sides of the tube. Pump means are provided to continuously recirculate quenching liquid from the first chamber into the second chamber from which the fluid flows through the conduits and is discharged into the tube in intersecting streams which intersect each other at a location above the level of liquid within the first chamber. The pump means are operated to maintain a generally constant static head in the second chamber which is above the level of the apertures. The rate of flow of liquid into the tube through the apertures is such that the streams of liquid have a substantial downward component at their point of intersection. Articles dropping downwardly into the quenching bath are dropped from a location such that they strike the downwardly converging streams substantially at their point of intersection, thus, splashing of quenching liquid upwardly to a distance such that it could contact the belt of the furnace conveyor is prevented.

To achieve a constant temperature throughout the bath, a cooling jacket is mounted on the tube at a location below the apertures and cooling air or other suitable cooling fluid is continuously circulated through the cooling jacket; this particular region representing the highest temperature region of the quenching bath, because this region is that into which the heated parts from the furnace are dropped.

The second chamber partially surrounds the first chamber and heating means are located in the second chamber. Operation of the heating and cooling means is coordinated to achieve the desired temperature regulation.

Other objects and features of the invention will become apparent by reference to the following specification and to the drawings.

On the drawings:

FIGURE 1 is a side elevation view, partly in section, of a heat treatment furnace;

FIGURE 2 is a transverse cross-sectional view of the furnace of FIGURE 1 taken on line 2—2 of FIGURE 1;

FIGURE 3 is a side elevational view with certain parts broken away or shown in section of a quenching bath tank employed to receive heated articles from the furnace of FIGURE 1;

FIGURE 4 is a top plan view, with certain parts broken away or shown in section, of the tank of FIGURE 3;

FIGURE 5 is a cross-sectional view of the tank of FIGURE 3 taken on the line 5—5 of FIGURE 4; and

FIGURE 6 is a cross-sectional view, partially taken on line 6—6 of FIGURE 4.

Referring first to FIGURES 1 and 2, there is shown a heat treatment furnace of more or less conventional construction which takes the form of a thermally insulated tunnel designated generally **10**, through which parts to be heated are conveyed on the upper run of an endless conveyor belt **12**. Belt **12** is trained around a drive roller **14** and an opposite end roller **16** and is driven by a motor **18** in a direction such that the upper run of the belt moves from left to right as viewed in FIGURE 1.

Articles to be conveyed through the furnace are fed onto the upper run of belt **12** from an infeed conveyor **20** to a chute **22** which passes through an inlet opening **24** into the interior of tunnel **10**. As the parts are conveyed by belt **12** through tunnel **10**, they are exposed to the high temperature maintained in the interior of tun-

nel 10 by a suitable number of burners 26. The temperature within tunnel 10 and the speed of movement of the articles through the tunnel are cooperatively adjusted to achieve the desired heat exposure of the article during its transit through tunnel 10.

When the parts reach the righthand end of the conveyor, as viewed in FIGURE 1, they drop freely from the belt downwardly through an outlet opening 28 in the bottom of tunnel 10 and into an open-ended tube 30 which extends downwardly from opening 28 into an open tank designated generally 32.

Tank 32 is constructed with outer side walls 34, and walls 36 and 38 and a bottom wall 40. A belt conveyor designated generally 42 is suitably mounted to extend longitudinally of the tank, end wall 38 being inclined as best seen in FIGURE 3, to accommodate the exit of conveyor 42 from the tank. Conveyor 42 takes the form of an endless belt and is driven by suitable means, not shown, so that its upper run is driven from left to right as viewed in FIGURE 3 to carry articles dropped through tube 30 onto the belt through a bath of quenching liquid contained in tank 32 and to discharge the parts or articles to a suitable receiving means schematically indicated at 44 in FIGURE 3.

A series of interior walls divide tank 32 into two chambers. An interior end wall 46 extends upwardly from bottom wall 40 in spaced parallel relationship with tank end wall 36 and a pair of interior side walls 48 extend forwardly from interior end wall 46 at locations spaced inwardly on the respective outer side walls 34 of the tank.

At the forward portion of tank 32 an interior top wall 50 and an interior front wall 52 extend entirely across the tank between outer side walls 34, while an interior rear wall 54 extends vertically between bottom wall 40 and interior top wall 50 and horizontally between interior side walls 48. The space between interior side walls 48 and their adjacent outer side walls 34 is closed by end walls 56 which extend upwardly from top wall 50 to the top of tank 32.

The foregoing construction divides the interior of tank 32 into two separate chambers, one of which extends the entire width of the tank below plate 50 and between walls 52 and 54 and extends the entire height of the tank between inner and outer side walls 48 and 34 and inner and outer end walls 46 and 36. The second chamber is constituted by the remainder of the interior of the tank. For convenience, these two chambers are identified as first chamber 60 and second chamber 62, conveyor 42 being located in chamber 60, while chamber 62 is that chamber which includes the space between side walls 34 and 48 and beneath interior top wall 50.

Quenching liquid contained in tank 32 is continuously recirculated between chambers 60 and 62 by a pair of pumps designated generally 64 which continuously pump quenching liquid from chamber 60 downwardly through openings in interior top wall 50 into chamber 62. From beneath top wall 50, the liquid flows below walls 56 into the space between side walls 34 and 48. From each of side walls 48, a conduit 66 extends to the adjacent side of tube 30 to place chamber 62 in communication with the interior of tube 30 through apertures 68 in the opposed side walls of tube 30. Liquid flowing into tube 30 from conduits 66 passes downwardly through tube 30 to return to chamber 60.

Interior rear wall 46 is formed with an opening through the wall as at 70, and a baffle plate 72 is guided for vertical sliding movement to adjustably regulate the size of the opening. A vertical rod 74 coupled to plate 72 is provided with a series of hooks or notches 76 which may be engaged by any suitable stationary cooperating member 78 to position plate 72 vertically relative to opening 70.

When pumps 64 are placed in operation, liquid is continuously pumped from chamber 60 into chamber 62 and returns from chamber 62 through conduits 66 and tube 30 to chamber 60. In order to achieve the desired flow through conduits 66, it is necessary to maintain a static head of liquid in chamber 62 which is above that maintained in chamber 60. The desired difference in static head is achieved by lowering plate 72 to completely close opening 70 and operating pumps 64 until the desired difference in static head is achieved. Plate 72 is then elevated to uncover opening 70 and the size of opening 70 is adjusted until the flow of liquid from chamber 60 into chamber 62 induced by pump 64 is equalized by the flow of fluid from chamber 62 into chamber 60 via conduits 66 and opening 70.

The difference in static head between chambers 62 and 60 is adjusted to be such that bath liquid discharged into tube 30 through apertures 68 is discharged from the opposed sides of tube 30 in streams which intersect each other centrally of the tube at a level below the level from which the streams are discharged. In this manner, at the intersection of the streams within tube 30, both streams have a substantial downward component of velocity.

Because of the extremely high temperature maintained in furnace 10, the most satisfactory material for belt 12 has been found to be stainless steel. Stainless steel belts employed in heat treatment processes of the type under consideration are extremely expensive and the cost of the belt alone can represent a major portion of the cost of the entire installation. Stainless steel belts are entirely satisfactory from the standpoint of withstanding the high temperatures encountered in the furnace. However, in most cases the composition of the liquid in the quenching bath is of an extremely corrosive nature. From the standpoint of efficiency of the heat treating operation, it is desirable to quench the heated article in the least possible time after it has passed through the furnace so that the article is quenched before any substantial cooling of the article has occurred.

Thus, from the standpoint of obtaining properly treated articles, the distance between the quenching bath and the conveying belt should be at a minimum.

In the particular apparatus disclosed in the drawings, the quenching bath liquid is molten salt. Molten salt is extremely corrosive and in the event even a small amount of molten salt should contact belt 12, the belt would shortly be rendered useless.

In order to prevent splashing of molten salt onto belt 12, molten salt within tank 32 is recirculated in the manner described above. The discharge end of belt 12 is located so that parts dropping from the discharge end of the belt are dropped downwardly through the center of tube 30 so that the articles first contact the bath liquid at the point at which the streams of liquid discharged from apertures 68 intersect each other. As described above, the rate at which the streams are discharged into the tube is so regulated that at the intersection of the streams, both streams have a substantial downward component of velocity. Thus, the relative velocity at which the article strikes the liquid of the bath is substantially reduced, thereby minimizing and substantially eliminating the upward splash of molten salt. The normal level of liquid within chamber 60 is such that the surface of the main body of liquid within chamber 60 is located below the intersecting streams, thus the splash created as the article drops into the main body of quenching liquid is smothered by the streams.

As described above, articles dropping through tube 30 fall through the liquid bath onto the upper or carrying run of conveyor 42 and are conveyed through and out of the bath to be discharged on the receiving means 44.

When the apparatus disclosed in the drawings is operated at full capacity, the heat of the articles dropped into the bath may be sufficient to maintain the salt bath in molten form. However, because of the relative large volume of tank 32, it is desirable to provide additional heating means so that the temperature of the bath can be maintained as uniform as possible through the tank.

To accomplish this, a pair of radiant heaters 80 are

mounted in the tank to extend along each side of the tank near the bottom throughout the entire length of the tank. Because of the fact that the portion of the tank surrounding the bottom of tube **30** tends to become the hottest because the continuous flow of heated parts from the furnace enters the bath at this location, it is desirable to provide a means for locally cooling this particular region. To this end, a cooling jacket **82** is mounted on the lower end of tube **30** in surrounding relationship to the tube and provided with an inlet **84**. Cooling fluid may be introduced into the interior of jacket **82** as by the schematically illustrated blower and conduit **88** of FIGURE 5, and in the case where air is employed as the cooling fluid, a suitable conduit connection to outlet **86** may be provided to exhaust heated air from the cooling jacket. It will be appreciated that operation of heaters **80** and the cooling jacket will be coordinated as required to achieve the desired effect.

While one embodiment of the invention has been disclosed and described in detail, it will be apparent to those skilled in the art that the disclosed embodiment may be modified. Therefore, the foregoing description is to be considered exemplary rather than limiting, and the true scope of the invention is that defined in the following claims.

I claim:

1. Apparatus for use in the heat treatment of articles comprising a tank containing a bath of quenching liquid for quenching heated articles, means dividing said tank into a first chamber and a second chamber, means for discharging liquid from said second chamber at a predetermined level into a predetermined region of said first chamber in a plurality of streams intersecting each other above the liquid level in said first chamber, means for creating a pressure differential to circulate liquid from said first chamber into said second chamber at a rate sufficient to maintain the level of liquid in said second chamber at an elevation above said predetermined level, and means for dropping articles to be quenched into said first chamber from a location vertically above the intersection of said streams.

2. Apparatus for use in the heat treatment of articles comprising a tank containing a bath of quenching liquid for quenching heated articles, means dividing said tank into a first reservoir and a second reservoir, an open-ended passage, means supporting said passage in a vertical position with the lower open end of said passage projecting downwardly into the bath liquid of said first reservoir and the upper open end of said passage projecting above the bath level of the first reservoir, said passage having generally opposed orifices therethrough at a location above the submerged lower end of the passage below the top of said tank, and above the bath level of the first reservoir, conduit means interposed between the second reservoir and the orifices for conducting quenching liquid from said second reservoir to said orifices, pump means interposed for pumping quenching liquid from said first reservoir to said second reservoir at a rate sufficient to maintain the surface level of liquid in said second reservoir above the level of said orifices and to maintain the surface level of said liquid in said first reservoir substantially below said orifices, said conduit means being effective responsive to pressure differential created by said pump means to discharge liquid from said second reservoir into said passage through said orifices in descending trajectory streams intersecting each other in said passage below said orifices and above the surface level of liquid in said first reservoir, and means for dropping articles to be quenched through said passage into said first reservoir.

3. Apparatus for heat treating articles wherein articles are heated in a heat treatment furnace and discharged into an open tank located adjacent said furnace and containing a bath of quenching liquid, comprising means dividing said tank into an open first chamber and an open second chamber, means accommodating flow of bath liquid from a first level in said second chamber into said first chamber, pump means interposed between said first and second chambers for pumping liquid from said first chamber into said second chamber to maintain the level of liquid in said second chamber above said first level to maintain the level of liquid in said first chamber substantially below said first level and to establish a stream of quenching liquid flowing through said flow accommodating means downwardly against the liquid surface of said first chamber whereby said heated articles is discharged into said tank along a path wherein the article enters said bath through said stream of liquid at a location where the stream has a substantial component of velocity parallel to the path of entry of the article into said bath.

4. Apparatus for heat treating articles wherein articles are heated in a heat treatment furance and discharged into an open tank located adjacent said furnace and containing a bath of quenching liquid comprising means dividing said tank into an open first chamber and an open second chamber, an open-ended tube extending downwardly from said furance into the first chamber of said tank, conduit means for flowing quenching liquid from said second chamber to said tube and discharging the liquid into the interior of said tube at a first level, pump means for creating a pressure differential to pump quenching liquid from said first chamber into said second chamber to maintain the level of liquid in said second chamber above said first level and to maintain the level of liquid in said first chamber substantially below said first level for continuously discharging a cascading stream of quenching liquid from said conduit means partially across the interior of said tube whereby said discharged articles fall freely downwardly through said tube to enter the cascading stream of liquid discharged from said conduit means at a location where said stream has a substnatial downward component of velocity.

5. Appratus for heat treating articles heated in a heat treatment furnace and discharged into an open tank located adjacent said furnace and containing a bath of quenching liquid, the improvement of said tank comprising outer side walls and interior walls within said tank dividing said tank into an open first reservoir and an open second reservoir at least partially surrounding said first reservoir, an open-ended tube projecting downwardly into said first reservoir, conduit means extending from said second reservoir through to opposed sides of said tube at a location above the lower end of said tube, pump means interposed between the first and second reservoirs for pumping quenching liquid from said first reservoir to said second reservoir to establish a flow of quenching liquid through said conduit means into the interior of said tube at a rate such that streams of liquid are discharged from opposed sides of said tube to intersect each other at a level below the level from which the streams are discharged, said heated articles being dropped into said tube to enter said bath through the streams of liquid discharged from said conduit means into said tube in the region of the intersection of said streams, a cooling jacket disposed in heat exchange relation to said tube below said conduit means, and means for circulating a cooling fluid through said cooling jacket.

6. Apparatus for use in the heat treatment of articles comprising a tank for containing a bath of molten quenching liquid for quenching heated articles, a heating conduit extending through said tank below the surface level for quenching liquid when provided in said tank, an endless conveyor extending through said tank below said surface level and having a portion extending upward above said surface level so that said conveyor is adapted to carry articles through a quenching bath when provided in said tank and upward out of said bath where said conveyor portion extends above said surface level,

said conveyor having an upper run adapted to support articles thereon, said heating conduit also having a portion extending above said surface level and terminating in an outlet immediately adjacent to and below the upper run of the portion of said conveyor extending above said surface level, so that said conduit is adapted to heat said conveyor portion as well as said bath.

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U.S. Cl. X.R.

134—130, 131, 191, 193, 199; 266—4, 6