ABSTRACT: A high vacuum electric furnace for heat-treating metallic articles under vacuum and including quenching apparatus to which the heat-treated articles are directed after the heat-treating operation, the quenching apparatus incorporating a liquid quenching medium therein and communicating with a cooling area of the furnace for receiving the heat-treated articles therefrom, the heat-treated articles being discharged from the cooling area into the liquid quenching medium in a subatmospheric environment and the quenching apparatus being constructed and arranged for preventing vapors escaping from the quenching medium into the furnace cooling area and heating chamber.
HIGH VACUUM ELECTRIC FURNACE WITH LIQUID QUENCH APPARATUS

BACKGROUND OF THE INVENTION

The technique of quenching metallic articles in a quench tank that is subjected to subatmospheric pressures has been employed before and is disclosed in the copending application Ser. No. 422,617. In the aforesaid copending application, liquid quenching in a vacuum is disclosed as providing an exceptionally clean surface of the articles being heat treated. Although the practice of quenching heat-treated articles in oil while under vacuum is disclosed in the aforesaid copending application, certain new procedures have been developed since the inception of this radically new concept in heat treating, and these new procedures coupled with the structure for use therewith, have produced results heretofore thought unobtainable. As will be described, the concept of the invention which pertains to liquid quenching in a vacuum also contemplates quenching in a liquid medium other than oil, such as water, since oil as a quench does have restrictive limitations with respect to time.

In the use of certain metallic articles for special purposes, unusual requirements may be necessary. For example, in fasteners employed in today’s aircraft and aerospace structures, the strength requirements may be greater than 160,000 p.s.i. and to obtain such results careful consideration must be given to the heat treating procedure. Since such design properties as creep, fatigue, stress corrosion and stress rupture are determined by the manner in which the articles are heat treated, the proper heat treating procedure is essential. Certain types of fasteners dictate the use of unusual heat treating procedures and in the heat treatment of fasteners formed of an alloy such as 6–4 titanium the heat treating operation cannot be performed in an atmosphere that will cause surface oxidation or decarburizing or that will cause structural changes that will result in failures when the fastener is subjected to the stress requirements for which the fastener is designed. Accordingly, it has been found that the heat treatment of fasteners formed of an alloy such as described above, desirably includes a quenching procedure wherein the articles are quenched under vacuum and in a liquid quenching medium such as water. When water which is a fast quench medium is employed, special precautions must be taken to prevent the water from vaporizing since vaporization of the water would result in contamination of the heat-treating area in the furnace vessel, and this would materially reduce the effectiveness of the heat-treating operation.

SUMMARY OF THE INVENTION

The present invention relates to a high vacuum electric furnace having quenching apparatus isolated from the furnace zone during heat treatment but adapted to receive heat-treated metallic articles shortly after the heat-treating operation and thereby providing for rapid quenching of the articles. The quenching apparatus includes a quench tank that is located directly below a cooling area of the furnace, the cooling area communicating with the heat-treating chamber and receiving the heat-treated articles therefrom for discharge into the quench tank. The quench medium employed in the present invention may be oil or water depending on the articles being heat treated, and in the event water is used, special equipment and procedures are provided that prevent water vapor from entering into the cooling area and/or the heat-treating chamber. Regardless of the quench medium employed the quenching operation is carried out in a subatmospheric environment. However, when water is used as the quench medium and in order to promote a downflow of the atmosphere contained in the system, the quench tank is maintained at a greater vacuum than the cooling area from which the heat-treated articles are discharged. Thus, the difference in pressure between the quench tank and the cooling area promotes the downflow of atmosphere which cooperates with a circulating quench medium located in the quench tank to entrain and entrap any vapors that might result when the heat-treated articles are discharged into the liquid quench medium in the quench tank. When using oil or water as the quench medium the liquid circulating system located in the quench tank moves the liquid in ascending columns and a descending column, the descending column of liquid acting to trap and entrain any vapors that may have resulted from the dumping of the heat-treated articles in the liquid quench from backflowing into the cooling area and heat-treating chamber.

The present invention also includes special apparatus for moving the heat-treated articles into and out of the heat-treating chamber and for discharging the articles from the cooling area into the quench tank.

Accordingly, it is an object of the present invention to provide a high-vacuum electric furnace for heat-treating and quenching workpieces in such a manner as to provide for maximum performance of the workpieces in use and to prevent contamination of the surfaces thereof.

Another object of the invention is to provide a high vacuum electric furnace in which articles to be heat treated are removed from a heating zone into a cooling area and are discharged into a quench tank, the cooling area and quench tank being maintained under subatmospheric conditions during the quenching operation.

Still another object is to provide a quench system for use in a high-vacuum furnace wherein oil or water is employed as a quench medium and special circulating apparatus is provided for preventing liquid vapors from backflowing into the furnace area.

Still another object is to provide a quench system for use in a high-vacuum electric furnace wherein metallic articles are quenched in a subatmospheric environment, the pressure in the quench area being maintained at a higher vacuum than that in the furnace area from which they are discharged, the difference in pressure between the furnace and the quench area providing for a downflow of an atmosphere from the furnace area to the quench area.

Still another object is to teach a method of quenching metallic articles in a high vacuum furnace wherein the articles are discharged in a liquid quench medium and the quench area is maintained under vacuum, the pressure in the quench area and the furnace area from which the articles are discharged being controlled to prevent backflow of contaminating vapors into the furnace area.

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.

DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a vertical sectional view of the high-vacuum electric furnace and quenching apparatus embodied in the present invention;

FIG. 2 is a sectional view taken along lines 2–2 in FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view of the drive connection for the ring gear assembly that rotates the work pedestal; and

FIG. 4 is a diagrammatic view showing the flow path of the atmosphere that is supplied to the furnace area and quench apparatus.

DESCRIPTION OF THE INVENTION

Referring now to the drawings and more particularly to FIGS. 1 and 2, the high-vacuum electric furnace embodied in the present invention is illustrated and is generally indicated at 10. The vacuum furnace 10 is adapted to be operated within certain vacuum ranges; and under certain conditions the vacuum may be in the range of 10⁻⁴, 10⁻⁵ mm. hg. For this purpose, suitable vacuum equipment is connected to the furnace
3,589,696

for evacuating the interior thereof as required. As illustrated in FIG. 1, the vacuum furnace 10 includes a housing generally indicated at 12 that is defined by a cylindrical section 14 to which end walls 16 and 18 are joined through flange constructions indicated at 20 and 22, respectively. The flange constructions 20 and 22 include internal annular sealing elements that cooperate to seal the ends of the housing 12. A cooling jacket 24 surrounds the cylindrical section 14, while end cooling jackets 26 and 28 are spaced from the end walls 16 and 18, respectively. A cooling fluid, such as water, is circulated in the spaces defined by the cooling jackets 24, 26 and 28 for maintaining the temperature of the housing walls at a prescribed level. Supporting the housing 12 are spaced vertically extending supports 30, 32 and 34 that normally rest on the floor in the area where the furnace is located.

Located within the housing 12 and adjacent to the end wall 16 is a heating chamber generally indicated at 36 that is defined by walls that are composed of a series of laminated graphite felt sections which are represented as an upper wall 38, a reduced lower wall 40, a rear wall 42, and an open-ended front portion that is adapted to be closed by a vertically-pivoted double-door construction indicated at 44. Located within the heating chamber 36 is a plurality of woven graphite flexible heating elements, one of which is indicated at 46 and a more complete description of which is contained in U.S. Pat. No. 3,257,492. A plurality of terminals indicated at 48 are adapted to be electrically interconnected to the heating elements 46 and extend outwardly of the housing 12 for electrical communication with a source of power. The graphite heating elements 46 and the insulation therefor, including the terminals 48, may be of any conventional form as previously used and do not constitute a part of the present invention. Located within the area of the housing 12 in which the heat chamber 36 is disposed are spaced tracks 50. A pedestal assembly generally indicated at 51 is mounted for longitudinal movement on the tracks 50 and for this purpose includes a carrier 52 on which rollers 54 are rotatably secured. Fixed to the carrier 52 are vertical pedestals 56 on which a work support 58 is mounted. The work support 58 may include a captivated basket or the like for receiving a plurality of articles therein that are to be heat treated. An insulating assembly 59 is fixed to the pedestals 56 between the carrier 52 and the work holder 58 and is adapted to protect the pedestal components from radiation and conducted heat when located in the heating chamber. As shown in FIG. 1 the insulating assembly 59 cooperates with the lower wall 40 to effectively enclose the heating chamber when the pedestal assembly 51 is located therein. The pedestal assembly 51 including the carrier 52 and the work support 58 interconnected thereto are movable in a longitudinal direction on the tracks 50 by a chain 60 that is receivable on pulleys 62 and 64. Secured to the chain 60 by a connection 66 is a connector bar 68 that is also joined to the carrier 52. It is seen that upon movement of the chain 60 the carrier 52 will be moved on the tracks 50 in a longitudinal direction and between the limits as defined by a stop 70 in the heating chamber area and a cooling area indicated at 72 and that is located adjacent to the heating chamber 36. In order to operatively move the chain 60, a drive that is located externally of the housing 12 is interconnected to the shaft on which the pulley 64 is mounted. It is understood that the drive for the pulley 64 may be operated in timed relation and in accordance with the predetermined heating cycle for moving the pedestal assembly 51 into and out of the heating chamber 36 as required.

The heating chamber 36 is ostensibly enclosed during the heating operation by the graphite felt walls 38, 40, and 42. The vertically-pivoted double-door construction 44 is also closed during the heating operation and cooperates with the graphite felt walls to substantially confine the heat generated by the heating elements 46 within the heating chamber. When it is required to insert the pedestal assembly 51 including the work holder 58 into the heating area, the double-door construction 44 is operatively moved to an open position; and for this purpose an air-operated cylinder 74 is provided and is interconnected to a shaft 76 by a linkage 78, the shaft 76 being operatively interconnected to the double-door construction 44 for moving this construction to the open and closed position as required. Although not shown, the end wall 18 defines a door and is removable with its jacket 28 as a unit for exposing the interior of the furnace, whereby the articles to be heat treated are loaded onto the work holder 58 when it is positioned in the cooling area adjacent to the door. Since the furnace operates under a vacuum, differential pressure is employed for clamping the door in closed position, thereby avoiding the requirement for mechanical clamps.

After completion of the heating cycle, the pedestal assembly 51 with the heat-treated articles located within the work holder 58 is moved out of the heating chamber and into the cooling area 72 and the articles are thereafter discharged into a quench tank generally indicated at 80 that is located below the cooling area 72. In order to remove the pedestal assembly 51 from the heating area to the cooling area 72, spaced rails 82 are provided and are located within the cooling area 72 as illustrated in FIGS. 1 and 2. The rails 82 are aligned with but are interconnected from the tracks 50 and are adapted to receive the rollers 54 of the carrier 52 thereon. A structure 84 defines the limit position for movement of the carrier 52 in the cooling area 72. As shown more particularly in FIG. 2, the rails 82 are confined within elongated channel members 86 that are fixed within the cooling area 72 to a ring cage assembly generally indicated at 88. As will be described, the ring cage assembly 88 is movable in a vertical path and is adapted to move the work holder 58 therewith to that position that will permit the discharge of the heat-treated articles therein into the quench tank 80. In order to accomplish this purpose, the ring cage assembly 88 is formed with an internal ring member 90 to which an inner support 92 is joined. The inner support 92 is operatively connected to the channel members 86, and upon movement of the support 92 in a vertical path with the inner ring member 90, the channel members 86 will also be moved therewith. As shown in FIG. 3, a ring gear 94, to which the ring member 90 is joined, is operatively connected to a drive member (not shown), which in turn, is operatively driven from a motor that is mounted externally of the housing 12. As further shown in FIG. 3, a fixed element 96 is interconnected to the inner casing 14 and provides support upon which the inner ring member 90 is rotated. A ball bearing assembly as defined by the bearing elements 98 enables the inner ring member 90 to be easily moved in the arcuate or circular path thereof.

It is seen that when the pedestal assembly 51 is moved into the cooling area 72, the rollers 54 on the carrier 52 are moved from the rails 80 onto the rails 82 and are confined within the channel members 86 as illustrated in FIG. 2. The carrier 52 and the work holder 58 mounted thereon are thus operatively mounted on the ring cage assembly 88; and upon rotation of the ring gear 94 through operation of the externally located motor, the support member 92 and the channel members 86 operatively connected thereto are rotated with the ring member 90 in an arcuate path. When the work holder 58 reaches that position in the arcuate transfer thereof to permit dumping of the articles therein, the articles will fall by gravity from the work holder and downwardly into the quench tank 80.

As shown in FIG. 1, a fan 100 is located adjacent to the cooling area but normally is not utilized when a liquid quench medium is employed. In those instances when an atmosphere is used to quench the articles, the fan 100 would be employed for rapidly circulating the atmosphere during the quench cycle. Any suitable sealed drive connection may interconnect the fan 100 to an external motor for producing the desired operation therefrom.

One of the novel features embodied in the present invention is the queenching of the heat-treated metallic articles in a liquid and providing for directing the heat-treated articles into the liquid shortly after the withdrawal of the articles from the
heating chamber, the quench tank that communicates with the furnace area being retained under subatmospheric pressure therewith. As previously described, the quench tank 80 is located directly below the cooling area 72 and is adapted to receive the heat-treated articles as they are discharged by gravity from the work holder 58 upon rotating movement of the ring assembly 88. When water is used as the liquid quench medium communication between the quench tank 80 and the cooling area 72 of the furnace is provided by conical overlapping sections 102 and 104, the conical section 102 being enclosed within a cylindrical section 106 that is joined to the housing 12 and the conical section 104 being contained within an enclosure 108 to which a flange 110 is joined. The flange 110 mates with a flange 112 that is fixed to the cylindrical section 106, and clamps 114 as shown in Fig. 1 removably interconnect the enclosure 108 and the cylindrical section 106. A jacket 116 surrounds the cylindrical section and defines a cooling chamber that communicates with the cooling chamber formed around the furnace housing 12. Because of the vapor problems associated with water a restricted neck section generally indicated at 118 is provided and is connected to the upper part of the quench tank 80 and to the enclosure 108. Located in the restricted neck section 118 is a vacuum type valve 120 that controls communication of a passageway 121 that extends through an upper flange 122, a lower flange 123 and a central annular valve section 126. The vacuum valve 120 includes an annular "O" ring 128 that is adapted to abut the shoulder formed in the valve section 126, and roller 130 and 132 that are formed as part of the valve structure, ride on a surface in the valve section 126. An operating member 134 that is interconnected to a remotely controlled power source is adapted to move the vacuum valve in a longitudinal direction and upon inward movement of the member 134, the roller 130 is engageable with a cam surface 136 for positively urging the valve 120 into the sealing position, thereby closing communication between the cooling area 72 and the quench tank 80. When the quench liquid is water, a baffle 138 is located in the restricted neck section 118 and a pipe 140 is positioned below the baffle 138, the pipe 140 being connected to a suitable vacuum pumping source which as will be described continuously evacuates the area at the top of the quench tank and thus aids in preventing water vapors from entering the furnace area.

The quench tank 80 includes a housing 142 on which a dome is illustrated in Fig. 2, the lower disc 124 of the restricted neck section 118 is secured to the dome 144 centrally thereof, the dome 144 being removably interconnected to the housing 142 through a flange construction 146 that provides for sealing of the tank housing 142 to the dome 144. After the quenching operation, the quench tank 80 is removable from engagement with the furnace and for this purpose is fitted with external wheels 148 that are receivable on spaced tracks 150. The track framework on which the tracks 150 are mounted is adapted to be fulcrummed and elevated slightly by an air cylinder (not shown) so as to cause the housing 142 to be lifted in engaging relation with the dome 144 through the flange construction 146. An "O" ring seal is disposed in the flange construction 146 to provide for a sealed connection between the housing 142 and the dome 144. Located within the housing 142 are vertical baffles 152 that are spaced from the sidewalks of the housing 142 and define channels therewith. Positioned between the baffles 152 is a basket 154 that is disposed centrally of the quench tank housing and that is adapted to receive the heat-treated articles as they are directed from the cooling area 72 into the quench tank. Screening 156 is located above the basket 154 and is adapted to direct the articles into the basket as they are dropped from the cooling area 72 and through the restricted neck section 118. When water is the quench medium optically dense baffles 158 are located in the dome 144 and cooperate with baffles 160 to permit passage of the heat-treated articles therethrough but, as will be described, the baffles act to prevent water vapors from traveling upwardly into the restricted neck section. An agitator 162 is mounted on a shaft 164 at the bottom of the quench tank, the shaft 164 being driven by a pulley 166 located externally of the quench tank housing 142. The pulley 166 is driven through a belt 168 by a pulley 170 that is in turn driven by a motor 172. As will be described, the agitator 162 is adapted to circulate quench liquid located in the housing 142 for movement within the housing in a manner to effectively prevent backstreaming of vapors into the furnace area.

One form of the quench liquid as contemplated for use in the present invention is water, this form of quench liquid being most desirable in the quick quenching of small heat treated articles such as fasteners formed of a titanium alloy. However, the high vapor pressure of this medium necessitates isolation of the medium from high vacuum. Furthermore, quenching of metallic articles in water would normally generate steam vapors, which, if permitted to backflow into the furnace area, would create operating problems even at partial pressures. In order to prevent backstreaming of water vapor, the water is circulated in the quench tank by the agitator 162 in ascending columns and a uniflow descending column. This is provided for by the location of the internal baffles 152 that cooperate with the quench tank housing sidewalks to form vertical channels. When the agitator is rotated, the water within the quench tank 80 is circulated upwardly through the vertical channels and then directed downwardly in a descending column toward the basket 154. The uniflow descending column of water tends to entrap and entrain any water vapors that may be generated by the quenching of the metallic articles and prevent these vapors from escaping from the surface of the quench liquid.

The quenching operation as carried out by the apparatus of the present invention is performed with the furnace vessel including the quench tank 80 in a subatmospheric condition. Quenching under vacuum has been found to produce superior results insofar as surface condition of the articles heat treated is concerned and with respect to the general characteristics of the heat treated articles following the quench operation. The articles that are heat treated are also subjected to a vacuum or subatmospheric pressure within the heating chamber 36, and similarly the cooling area 72 is maintained under vacuum, since this area communicates generally with the heating chamber 36. During the quench operation, the vacuum within the cooling area 72 is somewhat reduced by automatically backfilling this area with an inert gas that is compatible with the work being heat treated. The quench tank that is isolated from the system is also evacuated prior to the quenching operation, and, as will presently be described, is automatically backfilled to a pressure somewhat below that of the quench area 72. Thus when the valve 20 is opened there is an induced downward flow of gases from the quench area into the quench tank, thereby further preventing backflowing of vapor from the quench tank into the furnace area.

Referring now to FIG. 4, a diagrammatic illustration of the furnace construction and quench tank is illustrated and further shows the flow path of the gases that are used to backfill and maintain the furnace area and the quench tank at the required vacuum prior to the quenching operation. In describing the operation of the furnace and the method of quenching and when water is employed as the quench medium, reference will be made to FIG. 4 and the flow diagram illustrated therein. The system is automatically operated with a timed sequence so that manual controls are avoided. During the heating cycle and when the pedestal assembly 51 and the articles being heat treated are in the furnace chamber, and assuming that the quench liquid in the tank 80 is water, the quench tank agitator 162 is started and the vacuum pump communicating with the pipe 140 is energized to begin evacuating the quench tank. The combined effect of the agitation and pumping is to rid the water in the quench tank of dissolved oxygen. When the heating cycle is complete and the heat-treated articles are to be quenched, an automatic backfill system is energized and as shown in FIG. 4, a solenoid valve 174 that is responsive to a pressure switch 176 located in the
furnace area is operated to introduce an appropriate inert gas into the cooling area. The work pedestal has now been removed from the heating chamber 36 and the heat-treated articles are located in the cooling area ready for quenching. The pressure switch 176 controls the solenoid valve 174 so that the flow of the inert gas into the cooling area reduces the vacuum to approximately 10 inches of mercury therein.

Simultaneously with the introduction of the backfill gas into the cooling area, a solenoid valve 180 that is responsive to a pressure switch 182 located in the quench tank is operated to permit introduction of the inert gas into the quench tank. The pressure switch 182 controls the backfill gas such that the vacuum obtained in the quench tank is approximately 15 inches of mercury. With these differential pressures established in the furnace and in the quench tank, the vacuum valve 120 is opened, prior to which the backfill system in the quench tank 80 is sealed by closing the valve 180. As the vacuum valve 120 is opened, a rush of inert gas is produced in a direction from the cooling chamber 72 and toward the quench tank 80. At this time, the ring gear assembly 88 is operated to rotate the carrier 52 and the work holder 58, which in the meantime have been moved into the cooling area 72. The work is thus returned from the work holder 58 into the overlapping conical sections 102 and 104 and through the restricted neck section 118. The heat-treated articles pass through the open valve 120 and the baffles 158 and settle in the basket 154 that is submerged in the water located in the quench tank. Since the agitator 162 has been continuously operated during this sequence of events, the water has been moved upwards along the sides of the quench tank and flowing downward into the basket 154. As the inert gas flows downwardly from the relatively high-pressure area of the cooling chamber 72 and into the lower pressure area of the quench tank, any vapors that may have been generated by the heat-treated articles entering the water are entrained and carried down rather than allowed to escape from the surface of the quench liquid. The downward movement of the column of water and the downwardly flowing gas creates sufficient velocity to scrub any steam film that may have appeared on the surface of the heat-treated articles, and this tends to prevent steam blanketing which would retard the quench operation. Any bubble of steam that may tend to rise from the water that would encounter the downwardly flowing column of water would be re-formed back into the water before it can break the surface and create a vapor problem. Any vapor that may break the surface is effectively caught by the optically dense baffles 158 and is prevented from backstreaming upwardly into the furnace area. Further, the combined action of the vacuum exhaust created by the pipe 140 and the downward flow of the inert gas from the cooling chamber 72 of the main vessel effectively prevents any backstreaming of vapor into the main vacuum vessel. As soon as is practical, the valve 120 is closed to once again isolate the quench tank 80 from the main furnace area.

Since the quenching operation is carried out in a relatively short period of time, the quench tank 80 may be removed from the interlocked position thereof immediately following the quench operation and rolled to another location for removal of the heat-treated and quenched articles. The cycle is repeated after the quench tank has been reinserted into the sealed position and a new load of articles is introduced into the work holder in the furnace and the pedestal assembly is moved into the heating chamber 36.

In the description of the vacuum furnace and the operation thereof as set forth hereinafter, water was employed in the quench tank 80 as the quenching medium. Although water is required for quenching in a subatmospheric environment under certain conditions and provides for quick quenching of the articles being heat treated, it is sometimes more desirable to quench in an oil medium. Quenching heat-treated articles in an oil subatmospheric environment is disclosed in the previously referred to copending application Ser. No. 422,617, although the quench tank as disclosed in the copending application required baffling in the upper portion thereof to prevent oil vapors from backstreaming into the furnace chamber. In the present invention, when oil is utilized as the quench medium, upper baffling is not required in the quench tank 80, and the restricted neck section 118 and the conical section 104 may also be eliminated. Referring again to FIG. 2, the quench tank 80 is constructed essentially the same when oil is contained therein, although the dome 144 including the upper baffles 158 and 160 are preferably removed. As previously mentioned the restricted neck section 118 and conical section 104 are eliminated and the tank 80 is connected directly to the flange 112 through the flange 146. Even with the elimination of the neck section 118 and the dome 144, the height of the tank housing 142 is such as to prevent backstreaming of oil vapors when coupled with the circulation concept as described hereinafter.

In order to promote a more definite descending column in the oil quench, the vertical baffles 152 are extended upwardly as indicated by the dotted lines at 154 and the circulating oil is directed over the extensions 184 toward the center of the tank, the velocity and volume of oil being sufficient to cause the deflected columns to meet at the central portion of the tank, as indicated by the arrows to produce a descending column of liquid that traps and entrains oil bubbles and carries them downwardly into the tank.

The operation of the furnace is generally the same as described, although it is not necessary nor is it desirable to backfill the cooling area 72 and quench tank 80 with an inert gas after the heating cycle. However, the entire furnace area and quench tank are maintained under vacuum and preferably at the working vacuum. In this connection, backfilling the furnace area and quench tank may be accomplished during the heating cycle, but the pressures are still maintained in the order of 10—15 in. Hg. vacuum below atmosphere. The work articles are discharged from the cooling area 72 through the conical section 102 and into the quench tank 80. In the meantime, the impeller 162 has begun circulation of the oil in the tank and an oil curtain is created at the top of the basket 154 through which the articles drop. Due to the downflow of oil as it is circulated at a fairly rapid rate, and because the tank 80 is relatively long, any vapor bubbles that form as the hot articles come into contact with the liquid, are effectively trapped and are pulled downwardly into the tank by the descending oil column.

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.

We claim:

1. A vacuum furnace comprising a heating chamber for heat treating metallic articles therein, a cooling area located adjacent to said heating chamber for receiving said articles after the heat treating operation, a quench tank located below said cooling area for receiving the articles for the quenching thereof, means for maintaining said cooling area and quench tank under vacuum during the quenching of said articles, a stationary article-holding member removably mounted in said quench tank for receiving the heat-treated articles therein, means for continuously circulating a quench liquid in said quench tank, and a baffle located in said tank in association with the article-holding member and defining a channel in said tank through which the quench liquid is directed in an upwardly ascending column, said baffle inducing the liquid in the tank to fall in a waterfall effect at the upper end of the article-holding member to form a descending central column of liquid in said tank, the central column being directed into said article-holding member and then outwardly therefrom by said circulating means, the descending column of liquid-trapping and -entraining vapors created by said heat-treated articles that
are introduced into said quench tank during the quenching operation, said descending column of liquid carrying said vapors downwardly into said quench tank and thereby preventing said vapors from rising upwardly into said cooling area and heating chamber.

2. In a vacuum furnace as set forth in claim 1, means located in said cooling area for directing said articles into said quench tank.

3. In a vacuum furnace as set forth in claim 2, a holder for retaining said articles thereon, said directing means including means for rotating said holder, wherein said articles retained therein are dumped therefrom and discharged into said quench tank.

4. In a vacuum furnace as set forth in claim 1, means for backfilling said quench tank and cooling area with an inert gas prior to the quenching operation and for maintaining the pressure in said cooling area greater than that in said quench tank, wherein a downflow of gases from said cooling chamber to said quench tank is obtained.

5. In a vacuum furnace, a heating chamber for heat-treating metallic articles therein, a cooling area located adjacent to said heating chamber for receiving said articles after the heat-treating operation, a quench tank located below said cooling area and being adapted to receive the articles for the quenching thereof, means for maintaining said cooling area and quench tank under vacuum during the quenching of said articles, means for circulating a quench liquid in said quench tank in a manner to form a descending central column of liquid in said tank, wherein vaporization of said liquid when the heat-treated articles are introduced into said quench tank is prevented, a restricted neck section interposed between said cooling area and quench tank, value means located in said restricted neck section for controlling communication between said cooling area and quench tank, and means for maintaining the area on the quench side of said valve means at a lesser pressure than on the cooling area side, thereby promoting a downflow of gases from said cooling area to said quench tank when said valve means is moved to an open position, wherein vaporization of said liquid is minimized and prevented from contaminating the heating chamber during the quenching operation.

6. In a vacuum furnace as set forth in claim 5, said quench tank being removably sealed to said restricted neck section, whereby after the quenching of said articles therein, said quench tank is disengaged and is isolated from said neck section for movement to a station remote from said furnace for withdrawal of the articles therefrom.

7. In a vacuum furnace as set forth in claim 6, means for backfilling said quench tank and cooling area with an inert gas prior to the quenching operation and for maintaining the pressure in said cooling area greater than in said quench tank, and valve means located between said cooling area and quench tank and being operable to establish communication between said cooling area and quench tank, wherein a downflow of gases from said cooling chamber to said quench tank is obtained.