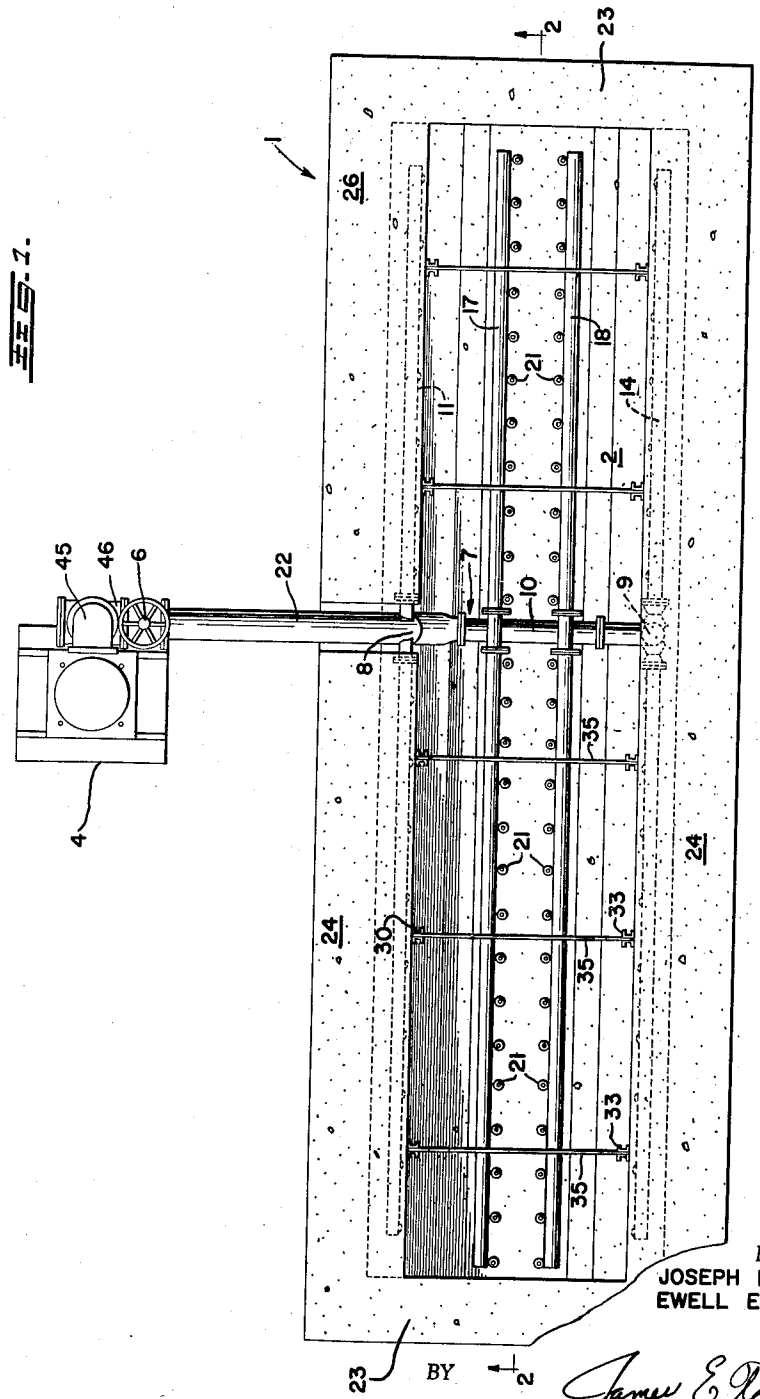
Jan. 6, 1959 J. H. WILLIAMS ET AL 2,867,226

METHOD AND APPARATUS FOR TREATING APPARATUS FOR RAPID QUENCHING OF METALS

Filed May 31, 1956

3 Sheets-Sheet 1

FIG. 1.



INVENTORS
JOSEPH H. WILLIAMS
EWELL E. McDOLE

James E. Toomey
ATTORNEY

Jan. 6, 1959 J. H. WILLIAMS ET AL 2,867,226

METHOD AND APPARATUS FOR TREATING APPARATUS FOR RAPID QUENCHING OF METALS

Filed May 31, 1956

3 Sheets-Sheet 2

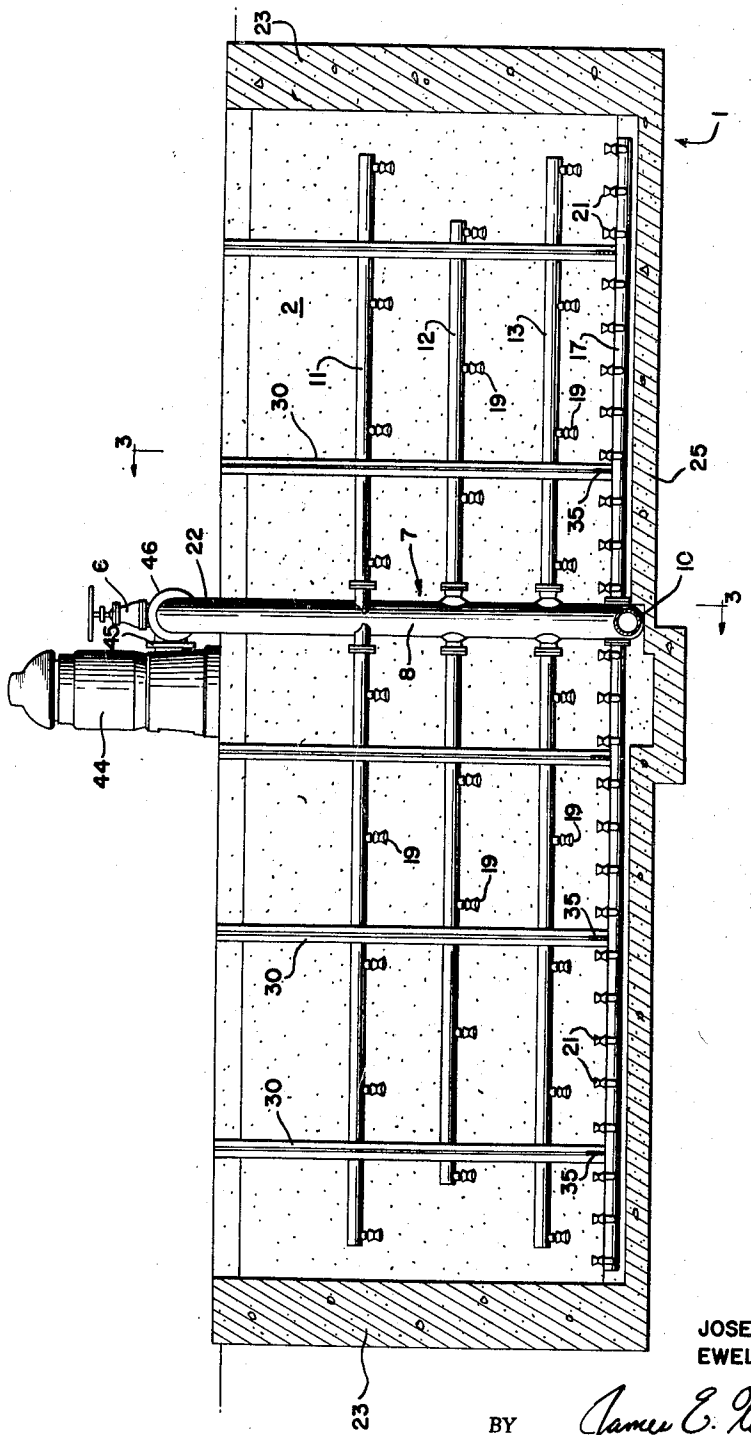


FIG. 2

INVENTORS
JOSEPH H. WILLIAMS
EWELL E. McDOLE

BY James E. Toomey
ATTORNEY

Jan. 6, 1959 J. H. WILLIAMS ET AL 2,867,226

METHOD AND APPARATUS FOR TREATING APPARATUS FOR RAPID QUENCHING OF METALS

Filed May 31, 1956

3 Sheets-Sheet 3

FIG. 3.

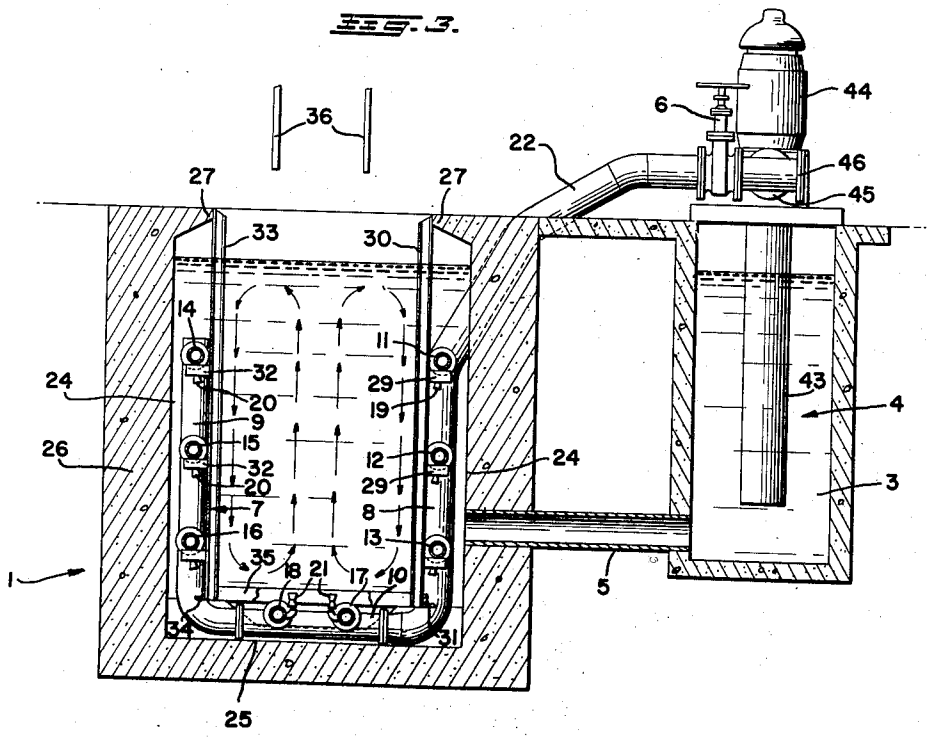
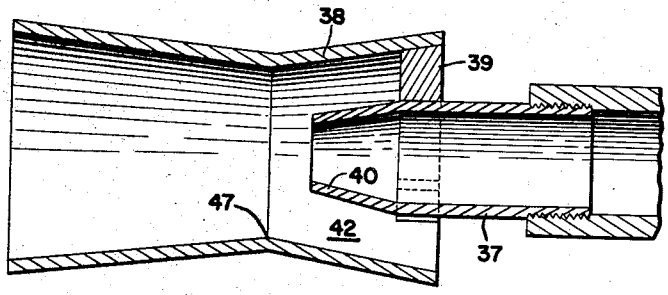


FIG. 5.



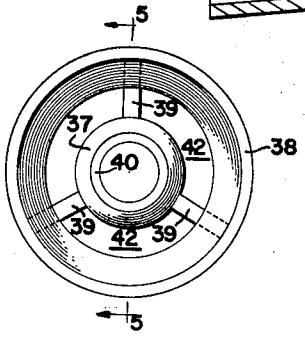


FIG. 4.

INVENTORS
JOSEPH H. WILLIAMS
EWELL E. Mc DOLE

BY James E. Toomey

ATTORNEY

United States Patent Office 2,867,226 Patented Jan. 6, 1959

2,867,226

METHOD AND APPARATUS FOR TREATING APPARATUS FOR RAPID QUENCHING OF METALS

Joseph H. Williams, Ravenswood, W. Va., and Ewell E. McDole, Berkeley, Calif., assignors to Kaiser Aluminum & Chemical Corporation, Oakland, Calif., a corporation of Delaware

Application May 31, 1956, Serial No. 588,405

6 Claims. (Cl. 134—199)

This invention relates to an improved method and apparatus for the rapid quenching of metal articles during a heat treating process. More particularly this invention relates to a method and apparatus for rapid quenching of sheets or plates of aluminum alloy during a solution heat treating process.

The conventional practice for heat treatment of metal articles generally comprises heating the articles in a heating means such as a furnace for a suitable period of time after which the articles are rapidly immersed in a quench tank which contains a suitable quenching liquid for rapid cooling of the heated sheets. In order to secure rapid quenching, various means, such as impellers, have been employed in the prior art to agitate the fluid to obtain dissipation of heat. Such practices possess certain inherent disadvantages with regard to obtaining rapid quenching. Generally where the quenching liquid is water, contact of the water with the heated metal results in the formation of steam. This steam forms an insulation layer on the surface of the metal thereby decreasing the rate at which heat passes from the metal into the quenching liquid. The agitation employed in the prior art was applied to create a general turbulence which does not wipe away sufficient steam to achieve the rapid quench which is particularly necessary in the production of aluminum aircraft sheet and plate. Furthermore, it was common practice in the prior art to employ impeller devices which do not provide the high velocity rate of circulation necessary to adequately wipe away and disburse the layers of steam. While for certain metals, impeller circulation and general turbulence may provide a sufficiently rapid quench, such circulation does not provide a sufficiently rapid quench to obtain the desired properties with other metals. In the production of certain types of aluminum alloy aircraft sheet and plate, a very rapid quench is essential to produce the desired properties. With the impellers and circulation systems of prior art, insufficient steam is wiped away from the surface of the metal on quenching and accordingly abstraction of heat is not sufficiently rapid to produce such sheet and plate with the desired properties.

Accordingly, the primary purpose and object of this invention is to provide an improved method and means for rapid quenching of metal during a heat treating process which eliminates or substantially reduces many of the disadvantages of the prior art techniques.

It is a further object of this invention to provide an improved method and means for quenching metal articles whereby superior properties are obtained.

It is a further object of this invention to provide a method and means for removing the layer of steam formed on quenching metal articles in water, whereby a more rapid quench is obtained.

It is a still further object of this invention to provide an improved method and means for quenching aluminum articles characterized by large flat surfaces such as plate and sheet whereby superior properties are obtained.

It is another object of this invention to provide an improved quench tank for quenching metal articles whereby a more rapid quench is obtained.

It is another object of this invention to provide an improved method for heat treating and quenching metal articles whereby superior metal properties are obtained.

These and other objects of the instant invention will be apparent from the following description thereof when taken in conjunction with the accompanying drawings.

In accordance with this invention a quench tank containing a quenching liquid such as water is provided with a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the side walls thereof and a plurality of spaced upwardly directed injection nozzles located on the bottom of said quench tank in the central portion thereof. Water from the quench tank is forced through these nozzles by liquid forcing means such as a pump, to produce high velocity jets of water which are directed downwardly along the sides of said quench tank and directed upwardly in the central portion of said tank thereby causing a high velocity circulation of water within said tank in a plurality of substantially circular path wherein said liquid moves upwardly in the central portion of said tank, outwardly near the liquid surface, downwardly along the sides and inwardly along the bottom of said tank. The heated metal articles are immersed in the water of the quench tank in a manner whereby the articles cut across the paths of liquid flow whereby the high velocity water flow wipes away the layers of steam tending to form on the surface of said articles. Thus the metal contacts the water directly permitting rapid abstraction of heat therefrom.

A detailed discussion of a specific means for carrying out this invention will be described in conjunction with the following drawings wherein:

Figure 1 is a plan view of the quench tank of this invention.

Figure 2 is a sectional side elevational view of the quench tank of this invention along the line 2—2 of Figure 1.

Figure 3 is a sectional view of the quench tank of this invention along the line 3—3 of Figure 2, illustrating the quenching of metal sheets or plates therein.

Figure 4 is an end view of an injection nozzle employed in accordance with this invention, and

Figure 5 is a sectional view of the injection nozzle of Figure 4 taken along the line 5—5.

With reference to the accompanying drawings in which the same reference numerals have been applied to various corresponding parts, a quench tank 1 containing water 2 is shown. The quench tank 1 consists of end walls 23, side walls 24, having flanges 27 at the top and a bottom 25. For many applications of this invention, tank 1 would be located below ground level and would take the form of a pit lined with concrete 26 as shown in the drawings. A circulation system is provided comprising a sump 3 and a pump 4. Sump 3 is connected to quench tank 1 through a conduit 5. Pump 4 as shown is of a type of centrifugal pump generally known as a sump pump wherein the pump is immersed in the liquid contained in the sump and has a suction open to the surrounding liquid. As shown in Figure 3 the pumping mechanism e. g. impeller etc. (not shown) is contained in the lower portion of a suitable vertical housing 43. The impeller (not shown) of the pump is driven, through a suitable shaft (not shown) passing through hoursing 43, by a motor 44, mounted vertically over sump 3. The discharge pipe 45 from the pump passes vertically upward through housing 43 and out above the top of the sump 3 where it may be connected to a valve 6 through a T 46. Valve 6 is connected through a pipe 22 to a U-shaped distributor head 7 located within tank 1. The

pump 4 described above is a conventional pump which is easily obtainable and accordingly it has not been described in detail. Further it is to be distinctly understood that the pump as above described is illustrative only and it is within the scope of this invention to employ types of pumping means other than as described above.

Distributor head 7 comprises two vertical legs 8 and 9 and a horizontal portion 10 which passes across the bottom of tank 1. From vertical leg 8, three horizontal distributor heads 11, 12 and 13 are connected. Similarly from vertical leg 9, horizontal distributor heads 14, 15 and 16 are connected. Along the bottom of the tank, distributor heads 17 and 18 are connected to horizontal portion 10. Horizontal distributor heads 11, 12 and 13 may be supported by any suitable means such as horizontal members 29 fastened by suitable means such as bolting or welding to vertical members 30. Vertical members 30 are suitably affixed at the upper end to one of the flanges 27 and at the lower end to a member 31 affixed to bottom 25. Where tank 1 takes the form of a concrete lined pit as shown, anchor bolt means may be employed to fasten the members 30 and 31 to the concrete. Similarly horizontal distributor heads 14, 15 and 16 may be supported by horizontal members 32, vertical members 33 and a member 34.

Distributor heads 17 and 18 which are centrally disposed and which extend along the bottom 25 of tank 1 may be supported by suitable horizontal members 35. Members 35 rest on the bottom 25 of tank 1 in a position transverse to the longitudinal dimensions thereof and are fastened by suitable means at the extremities thereof to respective vertical members 30 and 33.

Suitable injection nozzles 19 are connected to distributor heads 11, 12 and 13 and are directed downwardly and to the left at a small angle to the vertical, for example 10 degrees. Similar injection nozzles 20 are connected to distributor heads 14, 15 and 16 and directed downwardly and to the right at a small angle to the vertical, for example 10 degrees. Injection nozzles 21 are connected to distributor heads 17 and 18 and are directed vertically upward.

With reference more specifically to Figures 4 and 5, it will be seen that injection nozzles 19, 20 and 21 generally comprise a main pipe 37 having a jet nozzle 40 at the end thereof and an auxiliary pipe 38 having a venturi throat 47. One end of the auxiliary pipe 38 is concentrically spaced about the end of main pipe 37 forming an annular space 42 and attached to main pipe 37 by means of a plurality of spacer members 39 which are affixed both to the main pipe 37 and auxiliary pipe 38 by suitable means such as welding. Jet nozzle 40 is positioned ahead of the venturi throat 47 whereby a jet stream of liquid is directed axially through venturi throat 47 at a high velocity whereby tank water 2 surrounding nozzles 19 is injected into the jet stream through annular space 42 and auxiliary pipe 38, according to well known principles. Through the use of this type of nozzle, a high velocity stream is ejected from the nozzles providing high velocity circulation within the tank 1.

When pump 4 is operating, water passes from tank 1 through conduit 5 to sump 3. The water in sump 3 enters the suction of pump 4, passes through said pump, valve 6 and line 22 to distributor head 7. From distributor head 7, the water passes through horizontal distributor heads 11, 12, 13, 14, 15, 16, 17 and 18 and is projected downwardly through injection nozzles 19 and 20 and upwardly through injection nozzles 21. This causes a high velocity circulation within tank 1 as indicated by the arrows in Figure 3 whereby the water moves upwardly in close proximity to the longitudinal central plane of the tank 1, outwardly near the surface of the water, downwardly along the sides and inwardly along the bottom of the tank.

The operation of this invention will now be described as applied to the solution heat treatment of aluminum alloy articles characterized by large flat surfaces such as sheets or plates 36. The aluminum sheets or plates 36 are first heated in a suitable furnace (not shown) to such a temperature and for such a period of time to cause at least a part of the alloying elements to go into solution. In order to most effectively accomplish the heat treating operations, said sheets or plates 36 are generally suspended from a movable overhead frame by suitable means. The frame and suspended sheets are then raised into the furnace which is positioned directly over the quench tank 1. After heating is completed, the sheets and frame are rapidly lowered into quench tank 1, thereby immersing sheets or plates 36 in water 2. As shown in Figure 3, a portion of sheets or plates 36 are shown in position immediately prior to entry into water 2. As the sheets or plates 36 enter water 2 they cut across the paths of flow of the circulating water indicated by arrows on Figure 3, whereby the layers of steam tending to form on the surface of said sheets or plates 36 are wiped away permitting rapid abstraction of heat therefrom.

While there has been shown and described hereinabove the present preferred embodiments of this invention, it is to be understood that the invention is not limited thereto and that various changes, alterations and modifications can be made thereto without departing from the spirit and scope thereof as defined in the appended claims wherein what is claimed is:

1. A device for quenching heated articles comprising a quench tank containing a quenching liquid, a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the side walls thereof, a plurality of spaced upwardly directed injection nozzles located on the bottom of said quench tank in the central portion thereof, liquid forcing means whereby liquid from said tank is forced through said nozzles to produce high velocity jets of liquid which are directed downwardly along the sides of said quench tank and directed upwardly in the central portion of said tank thereby causing a high velocity circulation of liquid within said tank in a plurality of substantially circular paths which circulatory paths envelope the immersed articles to be treated within the quenching liquid whereby the upward directed jets cause the liquid to wipe across one surface of each of the articles and the downwardly directed jets cause the liquid to wipe across the opposite surfaces of the articles.

2. A device for quenching heated articles comprising a quench tank, containing a quenching liquid, a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the side walls of said tank, a plurality of spaced upwardly directed injection nozzles centrally located at the bottom of said tank, liquid forcing means whereby liquid from said tank is forced through said nozzles to produce high velocity jets of liquid which are directed downwardly along the sides of said quench tank and are directed upwardly in the central portion of said tank, thereby causing a high velocity circulation within said tank wherein said liquid moves upwardly in the central portion of said tank, outwardly near the liquid surface, downwardly along the sides and inwardly along the bottom of said tank wherein articles to be quenched when immersed in said quenching liquid are wiped on one surface by the upwardly moving liquid in the central portion of the tank and on the opposite surface by the downwardly moving liquid along the sides of the tank.

3. A device for quenching heated articles comprising a quench tank containing a quenching liquid, a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the longitudinal side walls of said tank, a plurality of upwardly directed injection nozzles spaced at intervals along the bottom

of said quench tank in close proximity to the longitudinal central plane thereof, said downwardly directed nozzles being connected to a plurality of horizontally disposed distributor heads spaced one above the other in close proximity to said longitudinal side walls of said tank, and connected to each of two vertical legs of a U-shaped distributor head, said upwardly directed nozzles being connected to a plurality of horizontal distributor heads, extending along the bottom of said tank in close proximity to and parallel to said longitudinal central plane of said tank, and connected to the horizontal portion of said U-shaped distributor head, liquid forcing means whereby fluid from said tank is forced through said U-shaped distributor head, into said horizontal distributor heads and out through said nozzles whereby high velocity jets of liquid are directed downwardly along said longitudinal sides of said quench tank, and high velocity jets of liquid are directed upwardly in close proximity to the longitudinal central plane of said tank thereby causing high velocity circulation of liquid within said tank wherein the liquid moves upwardly in the vicinity of the longitudinal central plane of the tank, outwardly near the liquid surface, downwardly along the longitudinal sides and inwardly along the bottom of said tank which circulation envelopes the immersed articles to be treated within the quenching liquid whereby the upward directed jets cause the liquid to wipe across one surface of each of the articles and the downwardly directed jets cause the liquid to wipe across the opposite surfaces of the articles.

4. A device for quenching heated articles comprising a quench tank containing a quenching liquid, a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the longitudinal side walls of said tank, a plurality of upwardly directed injection nozzles spaced at intervals along the bottom of said quench tank in close proximity to the longitudinal central plane thereof, said downwardly directed nozzles being connected to a plurality of horizontally disposed distributor heads spaced one above the other in close proximity to said longitudinal side walls of said tank and connected to each of two vertical legs of a U-shaped distributor head, said upwardly directed nozzles being connected to a plurality of horizontal distributor heads, extending along the bottom of said tank in close proximity to and parallel to said longitudinal central plane of said tank, and connected to the horizontal portion of said U-shaped distributor head, pumping means, the suction of which is connected to the fluid in said tank and the discharge of which is connected to said U-shaped distributor head through conduit means, whereby fluid from said tank is forced through said U-shaped distributor head, into said horizontal distributor heads and out through said nozzles whereby high velocity jets of liquid are directed downwardly along both longitudinal sides of said quench tank, and high velocity jets of liquid are directed upwardly in close proximity to the longitudinal central plane of said tank thereby causing a high velocity circulation of liquid in said tank whereby the liquid moves upwardly in the vicinity of the longitudinal central plane of the tank, outwardly near the liquid surface, downwardly along the longitudinal sides and inwardly along the bottom of said tank wherein articles to be quenched when immersed in said quenching liquid are wiped on one side by the upward movement of liquid in the longitudinal central plane of the tank and on the opposite side by the downward movement of liquid along the longitudinal sides of the tank.

5. In an apparatus for the heat treatment of metal articles wherein said articles are heated in an overhead furnace and rapidly lowered into a quenching liquid, subsequent to said heating, the improvement comprising the employment of a quench tank containing said liquid and having a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the side walls thereof, a plurality of spaced upwardly directed injection nozzles located on the bottom of said quench tank in the central portion thereof, liquid forcing means whereby liquid from said tank is forced through said nozzles to produce high velocity jets of liquid which are directed downwardly along the sides of said quench tank, and are directed upwardly in the central portion of said tank thereby causing a high velocity flow of liquid within said tank in a plurality of substantially circular paths which circular paths envelope the immersed articles to be treated within the quenching liquid whereby the upward directed jets cause the liquid to wipe across one surface of each of the articles and the downwardly directed jets cause the liquid to wipe across the opposite surfaces of the articles.

6. In an apparatus for the heat treatment of metal articles wherein said articles are heated in an overhead furnace and rapidly lowered into a quenching liquid, subsequent to said heating, the improvement comprising the employment of a quench tank containing said liquid and having a plurality of downwardly directed injection nozzles spaced at intervals within said tank in close proximity to the side walls of said tank, a plurality of spaced upwardly directed injection nozzles centrally located on the bottom of said tank, liquid forcing means whereby liquid from said tank is forced through said nozzles to produce high velocity jets of liquid which are directed downwardly along the sides of said quench tank and are directed upwardly in the central portions of said quench tank thereby causing a high velocity circulation within said tank wherein the liquid moves upwardly in the central portion of said tank, outwardly near the liquid surface, downwardly along the sides and inwardly along the bottom of said tank wherein articles to be quenched when immersed in said quenching liquid are wiped on one side by the upward movement of liquid in the central portion of the tank and on the opposite side by the downward movement of liquid along the sides of the tank.

References Cited in the file of this patent

UNITED STATES PATENTS

1,047,639	Hunt et al.	Dec. 17, 1912
1,687,458	Lancelot et al.	Oct. 9, 1928
2,317,233	Taylor	Apr. 20, 1943
2,354,656	Annesley	Aug. 1, 1944
2,389,488	Dailey	Nov. 20, 1945
2,516,282	Wilton	July 25, 1950
2,638,909	Hiatt et al.	May 19, 1953

FOREIGN PATENTS

458,451	Great Britain	Dec. 21, 1935