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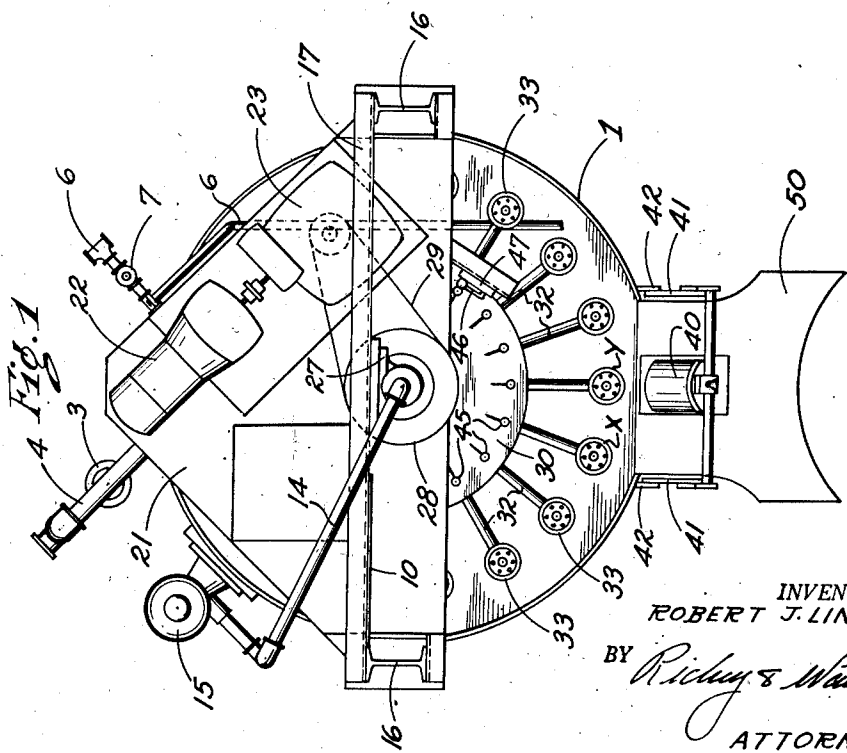
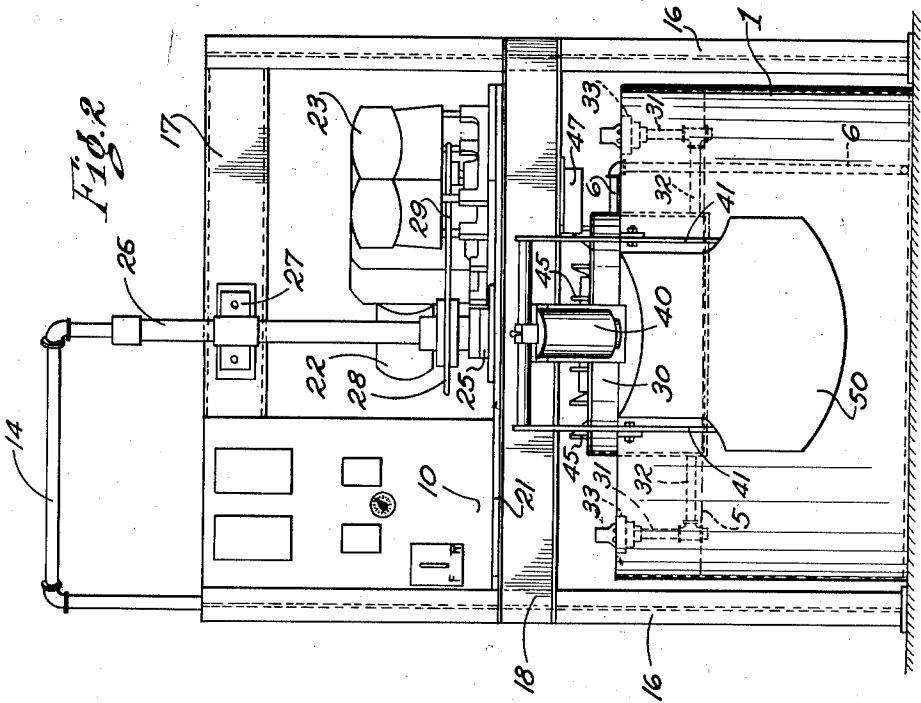
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METAL TEMPERING APPARATUS

Filed April 28, 1948

2 SHEETS—SHEET 1



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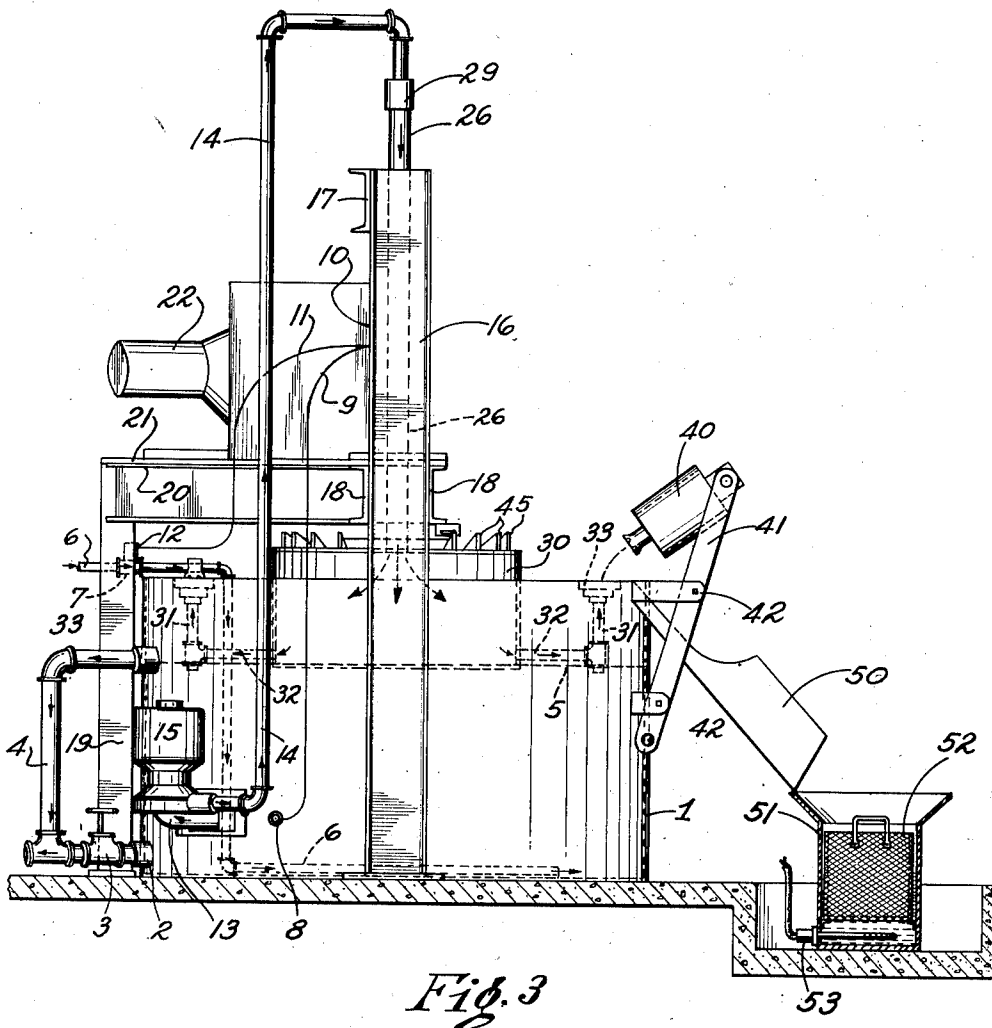
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2 SHEETS--SHEET 2



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METAL TEMPERING APPARATUS

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7 Claims. (Cl. 134—57)

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This invention relates generally to the art of metal heat treatment, and particularly to a new apparatus for the tempering of ferrous metal objects, especially drill bits.

In the manufacture of certain metal articles it is quite important that they should be properly tempered, that is, so cooled from a heat-treating temperature that they will possess the desired properties. For example, steel bits used with drilling machines for drilling holes in hard rock should be properly and uniformly tempered. Frequently a plurality of bits of progressively decreasing size are used in drilling a single hole, the largest drill being used first and the smaller ones following thereafter in the decreasing order of their sizes. If one of the bits should be improperly tempered, for example, if it should be softer than the succeeding bits, it will not make a hole of the desired size for succeeding bits and may stick in the hole. Hence, it is important that each bit of a set of drill bits should be properly and uniformly tempered, but it is also important that all bits whether intended for use in a certain set or not should be properly and uniformly tempered.

So far as I know, it was not possible, prior to the present invention, automatically to temper steel drill bits properly and uniformly or to insure that the tempering will be proper and uniform from bit to bit. By the present invention I am able not only to temper steel drill bits and also other metal objects properly, but also to insure that all the objects of the same composition will be tempered properly and substantially uniformly.

The present invention is predicated on the discovery that proper and uniform tempering may be attained by cooling highly heated metal objects with a predetermined amount of cooling liquid maintained at substantially constant temperature, or by exposing the highly heated objects to the cooling effect of a substantially uniform temperature coolant for a predetermined length of time, then transferring the thus partially cooled objects, without substantial decrease in their temperature, to a second cooling liquid maintained at a lower temperature and allowing the objects to cool to the temperature of that liquid.

In the drawings accompanying and forming a part of this specification,

Fig. 1 is a top plan view of one form of apparatus embodying the present apparatus invention and with which the present method invention may be practiced;

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Fig. 2 is an elevational view taken from the chute side of the apparatus of Fig. 1; and

Fig. 3 is an elevational view taken from the left side of Fig. 1.

5 In the drawings the reservoir 1 is provided with a drain pipe 2 controlled by a valve 3 and an overflow pipe 4. Liquid is maintained in reservoir 1 to the level indicated by line 5. Liquid may be brought into reservoir 1 through 10 pipe 6 which is equipped with a thermostatically controlled valve 7. In this case the thermostat 8 is of the electrical type and is connected through lead 9, panel 10 and lead 11 to an electrical device 12. The thermostat 8 and the device 12 15 may be, respectively, the well-known Mercoid thermostat control and Mercoid magnetic valve. When the temperature of the liquid in reservoir 1 rises above a predetermined point the thermostat 8 actuates the valve 12 and opens valve 7, 20 thereby admitting cold liquid through pipe 6. Since the discharge end of pipe 6 is remote from the thermostat 8, the incoming fluid will continue to flow for some little time before the thermostat 8 will be actuated by a lowering of the temperature of the liquid in reservoir 1 to de-energize 25 the valve control device and close the valve 7 against further entry of cold liquid.

30 Adjacent to the thermostat 8 is disposed a pump 13 which communicates with the interior of the reservoir 1 and serves to withdraw liquid therefrom and to force it through pipe 14 and into the top of a hollow shaft presently to be described. The pump 13 is actuated by a motor 15.

35 Two upright beams 16 are disposed on opposite sides of reservoir 1 and are connected together at their upper ends by a channel 17 and at a point some little distance above the top of reservoir 1 by a pair of channels 18. An upright leg or beam 19 also located outside of reservoir 1 is connected at its upper end to one or more channels 20 which extend horizontally toward and connect to one of the channels 18. A plate or platform 21 rests on channels 20 and is secured to channels 18 and 20 and serves as a support for a power unit consisting of a motor 23 and a reduction gearing device 23. Panel 10, above mentioned, is secured to channel 17, 40 to one of the uprights 16 and to plate 21.

50 The plate 21 supports a thrust bearing 25 which, in turn rotatably supports the hollow shaft 26 above mentioned. This shaft passes through a pillow block or bearing 27 on channel 17. A sprocket 28 is keyed to shaft 26 and is 55 connected to the reduction gearing device 23 by

a driving chain 29. Pipe 14, leading from pump 13, is connected with the upper end of hollow shaft 26 by a packing nut.

The hollow shaft 26, at its lower end, is connected to a tank 30 into which liquid may flow from shaft 26. Tank 30 is provided with a plurality of members 31 which may be called fountains or spray-heads, each comprising a right angled pipe 32 communicating with the interior of tank 30, and an enlarged upper end 33 provided with a screen on which an object to be tempered may be placed. It will be understood that when pump 13 withdraws liquid from tank 1 and forces it through pipe 14 into hollow shaft 26, such liquid will fill the tank and will flow out through pipes 32 and up through the perforations in the screen and against an object on the screen. It will also be understood that when the motor 22 is actuated the chain 29 will rotate shaft 26, tank 30 and members 31 and that by varying the speed of rotation of the shaft objects on those members may be subjected for various lengths of time to cooling liquid flowing there-against through said members.

A magnet 40 is mounted on supports 41 which are connected to reservoir 1 by arms 42. This magnet is adjustably positioned relative to metallic articles on the spray-heads, so that when energized the magnet may attract to itself and thereby remove from an adjacent spray-head a magnetic metal article on the latter. The magnet 40 is alternately energized for a short period of time and then is de-energized for another short period of time. The top of tank 30 is provided with a plurality of pegs 45 positioned radially inward of the respective spray-heads 31. These pegs 45 are so disposed as to make contact with the switch closing member 43 of a limit switch 47 which is connected to a suitable source of electric current and also to the windings of magnet 40. When one of these pegs 45 closes the contacts of the limit switch 47 the electrical current energizes magnet 40 and the magnet in turn attracts to itself a metal object on the spray-head adjacent the magnet. When the peg 45 moves on and permits the contacts of the limit switch 47 to separate, the current to magnet 40 is interrupted and the metal object which had been attracted to the magnet is allowed to fall. In this way the magnet is energized for a short time and then is de-energized for another short time, and the energization occurs when a spray-head is adjacent to the magnet.

An inclined chute 50 is disposed with its upper end in position to receive metal articles which fall from the de-energized magnet 40. The lower end of this chute 50 is disposed above a stationary tank 51 so that metal articles dropping from magnet 40 may slide into that tank. An open-top screen-basket 52 is provided in tank 51 to receive such articles. This tank also contains a cooling liquid which may be maintained at above a predetermined temperature by means of a heating unit 53 which may be of any suitable construction, for example, the well-known Calrod immersion heating unit.

The general operation of the above described apparatus will be understood from the foregoing description. However, when it is to be operated to temper steel drill bits for hard rock drilling it may be operated substantially as follows: The motor 15 is energized and pump 13 circulates coolant from reservoir 1 through pipe 14, shaft 26, tank 30 and spray-heads 31 and

brings the level of coolant in tank 30 to above the tops of heads 31 so that the coolant will overflow the heads and return to reservoir 1. The motor 22 is energized and tank 30 is rotated. Then steel drill bits which have been heated to the proper temperature, which may be about 1440° F. for one particular kind of steel, are removed from the heating furnace and are placed one at a time points down on the spray-heads when they reach the position indicated by the letter X in Fig. 1 and while tank 30 is rotating. As tank 30 rotates, the pressure exerted on the cooling liquid is so regulated that the liquid bubbles up through the spray-heads and to a predetermined distance thereabove which is sufficient to cover only the drilling points of the bits or about $\frac{1}{16}$ " for the average size jack bit. This liquid is maintained at a temperature under 75° F. preferably at about 72° F. The liquid thus regulated as to pressure and temperature cools the points from the time they leave point X until they reach the position indicated by the letter Y in Fig. 1. When a bit reaches that position, a peg 45 several stations behind that spray-head will close the circuit through limit switch 47, thereby energizing magnet 40. When energized this magnet attracts to itself the drill bit on the spray-head at station Y and when de-energized drops that drill bit onto chute 50 and the bit slides into tank 51.

It will be understood that during the time of about 53 seconds which elapses between the placing of a bit on a spray-head at station X and the time the drill bit is removed therefrom at station Y, the liquid coming into contact with the drill bit will have lowered the temperature of the drill bit considerably, for example, from about 1440° F. to about 900° F., that the bit will then be at a temperature within the magnetic temperature range of the steel, and that the temperature of the drill bit will not sensibly decrease between the time it is removed at station Y and the time it arrives in tank 51. The speed of rotation of tank 30 should be so adjusted for bits of different sizes that the bits are cooled through the just mentioned range during one revolution of the tank. Higher or lower speeds may, of course, be used when smaller or greater decreases in temperatures are desired.

Drill bits of the type referred to herein are composed of steel which can be made quite hard by heat treatment. While drill bits are made from steels of different S. A. E. numbers, the compositions which are suitable contain between about .70% and .90% of carbon, between about .40% and .60% of manganese, about .03% maximum of sulfur and of phosphorous, with the remainder being iron containing small amounts of other impurities but without any substantial amounts of alloying elements. The cutting edges are often formed on these bits when the carbides in the steel are in a spheroidized condition and the steel is soft and machinable as a result thereof. Then the steel is heated to such a temperature as will result in a complete solution of the carbides which in this case is about 1440° F. Then the dissolved carbides in the cutting edge portions are precipitated as very fine grain martensite more or less uniformly throughout those portions by quenching the cutting edges of the bit with resultant hardening of those portions. This quenching step is carried out by quickly lowering the temperature of the cutting edge portions from about 1440° F. to about 900° F. in a short space of time as by bubbling water

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at about 72° F. to 75° F. over the cutting surfaces for about 51 seconds on the average. The entire bit is cooled by the extraction of heat from the body of the bit through the surfaces in contact with the water but the cooling rate of the metal beyond the cutting edge portions is less rapid and hence the body part of the bit is more ductile and resistant to breakage than the cutting edges. The thus quickly cooled article is transferred, preferably magnetically, when at a temperature of about 900° F. into a body of water maintained, for example, at about 192° F. where it is allowed to cool for about 10 minutes. If desired, the bit may be reheated to a drawing temperature to reduce the brittleness of the cutting edge portions.

Since the cooling rate of the drill bits in tank 51 should not be too rapid, the temperature of the liquid is maintained above a predetermined minimum temperature by the heating unit 53.

Various cooling liquids may be used in reservoir 1 and stationary tank 51, as desired. Water may be used in reservoir 1 but its temperature should not be permitted to rise beyond a certain point for if it becomes too highly heated, due to heat extracted from the bits, it will not cool the bits below their non-magnetic range and hence the magnet 40 will not attract them to it. When the liquid in reservoir 1 is maintained at a temperature not in excess of about 75° F. and the speed of rotation of tank 30 and the rate of liquid flow through the spray-heads are properly adjusted, tool bits having a temperature of about 1440° F. when placed on the spray-heads will be cooled to below their non-magnetic temperature range before they reach the magnet 40 and hence will be attracted to the magnet and removed from the spray-heads. By suitably setting the thermostat 8 the temperature of the coolant in reservoir 1 may be maintained substantially constant, as above mentioned.

The coolant preferred in tank 51 is water and its temperature is preferably maintained close to its boiling point by the heating unit in the bottom of the tank, 192° F. having been found to be satisfactory.

Each bit cools to about the temperature of the water in tank 51 within about 10 minutes and may then be removed for subsequent treatment.

While the foregoing detailed description is specific to the tempering of drill bits, it will be understood that apparatus embodying the present invention may be used for tempering other articles, and that by adjusting the speed of rotation of tank 30 and the temperature of the coolant in reservoir 1 and the rate or amount of coolant flow through spray-head 31, various metal objects may be cooled throughout various temperature ranges and to various temperatures, depending on the characteristics desired in the objects and obtainable by such variations in the time, rate and nature of the tempering action. It will also be understood that by varying the kind and temperature of the coolant in tank 51, the rate of cooling of metal articles therein may be varied with some variation in the properties of the articles cooled under those conditions.

This application is a continuation-in-part of my application Serial No. 499,398, filed August 20, 1943, and abandoned on or about May 5, 1948. Subject matter disclosed but not claimed herein is being claimed in my co-pending application Serial No. 252,629, filed October 23, 1951, which is a division of this application.

Having thus described the present invention 75

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so that others skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. Apparatus for tempering metal objects comprising a rotatable tank having a plurality of spray-heads adapted to carry heated metal objects to be tempered, means to deliver cooling liquid through said spray-heads and against such objects on the latter, means including a thermostat for maintaining substantially constant the temperature of the liquid delivered against such objects, and means for removing thus cooled objects from said spray-heads, said means including a magnet in fixed position above and outside of the line of travel of said spray-heads.

2. Apparatus for tempering metal objects comprising a reservoir for liquid, a rotatable tank having a plurality of spray-heads adapted to carry heated metal objects to be tempered, means to circulate liquid from the reservoir to the tank and spray-heads and against such objects on the latter, means including a thermostat controlled liquid inlet for maintaining liquid in the reservoir below a predetermined temperature, and means for removing thus cooled objects from said spray-heads, said means including a magnet in fixed position above and outside of the line of travel of said spray heads.

3. Apparatus for tempering metal objects comprising a reservoir for liquid, a rotatable tank having a plurality of spray-heads adapted to carry heated metal objects to be tempered, means to circulate liquid from the reservoir to the tank and spray-heads and against such objects on the latter, means including a thermostat controlled liquid inlet for maintaining liquid in the reservoir below a predetermined temperature, a stationary tank for cooling liquid, and means for transferring thus cooled objects from said spray-heads into liquid in said stationary tank, said means including a magnet in fixed position above and outside of the line of travel of said spray-heads and a chute inclined downwardly from below said magnet to above said stationary tank.

4. Apparatus for tempering metal objects comprising a reservoir for liquid, a rotatable tank having a plurality of spray-heads adapted to carry heated metal objects to be tempered, means to circulate liquid from the reservoir to the tank and spray-heads and against such objects on the latter, means including a thermostat controlled cold liquid inlet for maintaining liquid in the reservoir below a predetermined temperature, a stationary tank for liquid, means to maintain substantially constant the temperature of liquid therein, and means including a magnet for transferring thus cooled objects from said spray heads into liquid in said stationary tank.

5. Apparatus for tempering metal objects comprising a rotatable tank containing cooling liquid and having a plurality of members adapted to carry heated ferrous metal objects to be tempered, means to deliver liquid from said tank against such objects on said members to cool them to below the upper limit of their magnetic temperature range, and means for transferring the thus cooled objects from said members, said means including a magnet in fixed position above and outside of the line of travel of said members and means to energize and de-energize said magnet when one of said members is moving therepast.

6. Apparatus for tempering metal objects com-

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prising a rotatable tank containing cooling liquid and having a plurality of members adapted to carry heated ferrous metal objects to be tempered, means to deliver liquid from said tank against said objects on said members to cool them to below the upper limit of their magnetic temperature range, temperature control means to maintain substantially constant the temperature of the liquid delivered against said objects, means for transferring the thus cooled objects from said members, said means including a magnet in fixed position above and outside of the line of travel of said members and means to energize and de-energize said magnet when one of said members is moved therepast.

7. Apparatus for tempering metal objects comprising a reservoir for liquid, a rotatable tank within said reservoir and having a plurality of spray-heads adapted to carry heated metal objects to be tempered, means to rotate said tank, means to circulate liquid from the reservoir through the tank and spray-heads and against such objects on the latter, means including a thermostat controlled cold liquid inlet for maintaining liquid in the reservoir below a predetermined temperature, a liquid containing stationary tank, means to maintain substantially constant the temperature of liquid therein, and means for transferring cooled objects from said spray-heads to said stationary tank, said means including a magnet adjacent to the path of

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travel of objects on said spray-heads, a limit switch connected to the magnet and to a source of electrical current, abutments connected to said revolving tank to close said switch, and a chute positioned to receive the metal objects released from the magnet when it is de-energized and to conduct them into said stationary tank.

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