May 27, 1941. E. E. STEVENSON 2,243,174

METHOD AND APPARATUS FOR HEATING AND QUENCHING SUCKER RODS

Filed May 10, 1938

Fig. 1

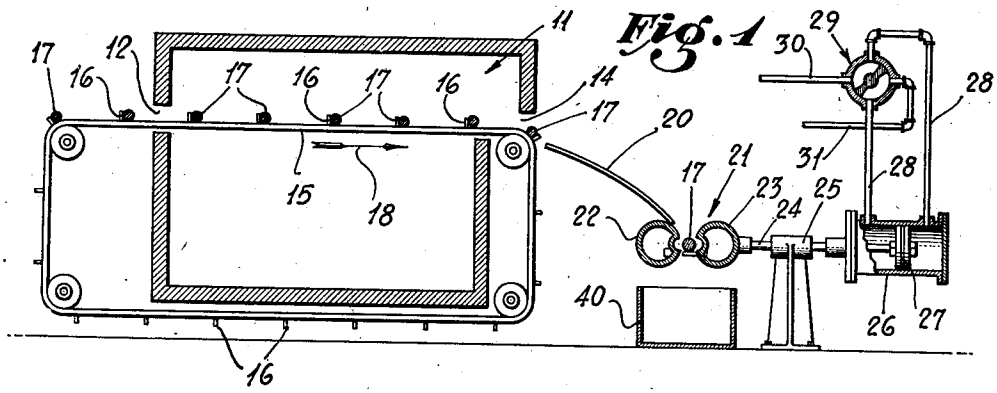


Fig. 2

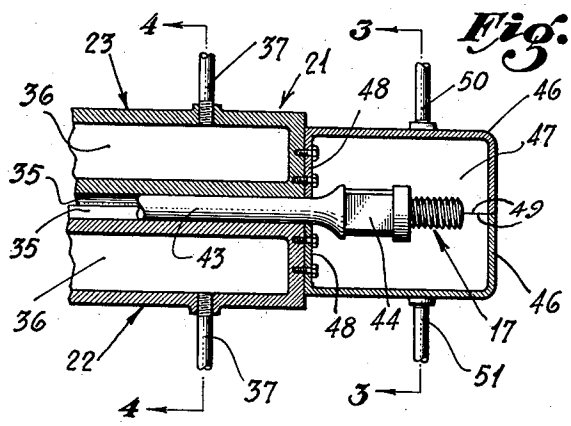


Fig. 3

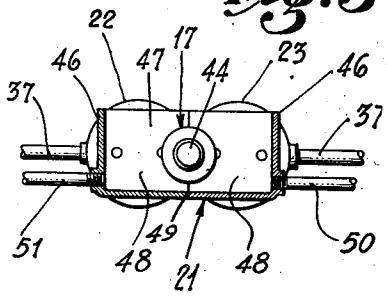


Fig. 4

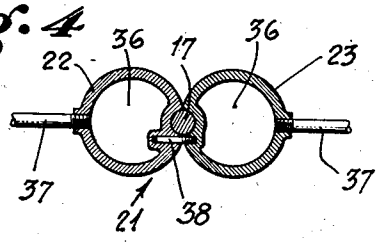


Fig. 5

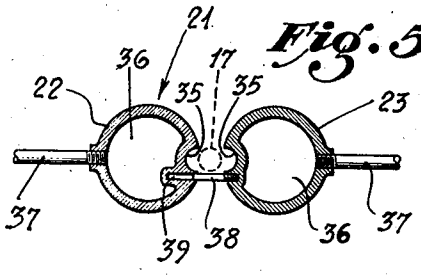


Fig. 6

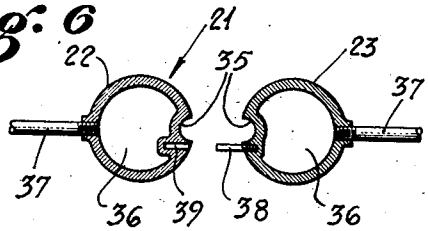
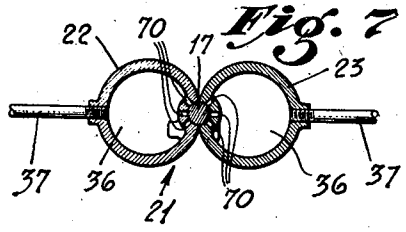


Fig. 7



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METHOD AND APPARATUS FOR HEATING AND QUENCHING SUCKER RODS

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3 Claims. (Cl. 148—21)

My invention relates to method and apparatus for heat treating a sucker rod.

In the oil pumping industry it is common practice to employ a string of sucker rods for reciprocating the pump plunger of the pump which is located, usually, a considerable distance below the surface of the ground. The upper end of the string of sucker rods is connected by a polish rod to a reciprocating means whereby a reciprocatory motion is transmitted to the pump plunger. During the operation of this apparatus the string of sucker rods is alternately subjected to tension and compression forces and, due to the weight of the long column of oil which is raised by the pump plunger, severe stresses and strains are imposed on the sucker rods and serious consequences may result in the event of sucker rod failure.

The main object of my invention is to provide a method and an apparatus whereby a sucker rod may be heat treated to give it the desired physical properties, to produce a heat treated sucker rod which is straight and in which this may be accomplished with but a single heating of the sucker rod.

Another object of my invention is to provide a method and apparatus in which the sucker rod is heated to at least the transformation point, then quenched at such a rate as to produce a fine grained structure which is not brittle, and while simultaneously holding the sucker rod so that it will not warp during quenching operation. This enables the production of a straight sucker rod, which is fine grained, in a single heating and quenching operation.

It is a still further object of my invention to provide a method and apparatus in which the pin and wrench engaging portion of the sucker rod is separately and simultaneously quenched in a suitable quenching medium, such as oil.

It is a still further object of my invention to provide a method and apparatus in which the sucker rod is held straight while the quenching operation is performed by the use of quenching dies which absorb the heat sufficiently rapidly to produce satisfactory physical qualities.

It is a still further object of my invention to provide a method and apparatus for heat treating and quenching sucker rods in which a sucker rod is held straight without placing a tension on the sucker rod and in which the sucker rod is quenched while it is so held.

It is an object of my invention to provide a quenching apparatus for quenching sucker rods which have been previously heated to at least the transformation point which includes metal quenching dies having channels to receive the sucker rod, which quenching dies are movable into such a position that the channels surround the sucker rod in order to form a chamber therefor, and in which the quenching dies withdraw the heat from the sucker rod and during such quenching operation prevent warpage thereof.

It is found to be advantageous under certain conditions to oil quench the threaded pin and wrench receiving portion at the end of the sucker rod. It is, therefore, an object of my invention to provide a method and apparatus in which, during the quenching of the rod, the rod portion thereof may be quenched by the quenching dies of my invention, and the end portion thereof may be quenched in oil.

It is a still further object of my invention to provide an apparatus in which oil receptacles are formed to receive the end portions of the rod during the quenching process and in which, if desired, means may be provided for introducing and withdrawing oil from the receptacle.

Other objects and advantages of my invention will be pointed out in the course of the following detailed description of one form in which my invention may be incorporated.

Referring to the drawing which is essentially diagrammatic in character:

Fig. 1 is an elevational sectional view diagrammatically illustrating apparatus incorporating the features of my invention.

Fig. 2 is an enlarged fragmentary sectional view looking in a downward direction at the end of the quenching dies and at the receptacle formed at the end thereof for receiving the end portion of the sucker rod.

Fig. 3 is a fragmentary sectional view taken as indicated by the line 3—3 of Fig. 2, this view showing the position of the parts when the quenching dies are engaged around the sucker rod.

Fig. 4 is a fragmentary sectional view taken as indicated by the line 4—4 of Fig. 2 and showing the quenching dies in the positions they occupy when surrounding the sucker rod.

Fig. 5 is a fragmentary sectional view corresponding to Fig. 4 showing the position of the quenching dies when they are positioned to receive the sucker rod to be quenched thereby

Fig. 6 is a fragmentary sectional view corresponding to Fig. 4 but showing the position of the quenching dies when they have been separated so as to allow a sucker rod which has been quenched thereby to fall therefrom for clearing the apparatus for receiving another sucker rod for quenching.

Fig. 7 is an alternative form of my invention in which the cooling medium has direct contact with the rod.

Referring to the drawing in detail, the numeral 11 represents a heat treating furnace which may be of any standard design or type capable of producing the necessary temperatures which are required in the heat treatment

of sucker rods. The heat treating furnace 11 has an inlet opening 12 and an outlet opening 14. Adapted to pass through the furnace 11 is an endless belt 15 having an engager 16. Sucker rods, as illustrated by the numerals 17, when placed on the endless belt 15, may be pulled through the furnace 11 in a direction indicated by the arrow 18 at such speed as may be required to properly heat the sucker rod. As the sucker rod moves through the outlet opening 14 it is automatically delivered to an inclined plate or chute 20 which guides the sucker rod to the quenching means of my invention which is generally designated by the numeral 21.

The quenching means of my invention includes a stationary jaw or stationary quenching die 22 and a movable jaw or movable quenching die 23. The quenching die 23 is connected to a piston rod 24 which extends through a suitable supporting bearing 25 and which extends to a cylinder and piston arrangement including a cylinder 26 and a piston 27 operable therein and to which piston 27 the rod 24 is connected. For moving the piston 27 in either direction as desired there is connected to the opposite end of the cylinder 26 pipes 28 which are in turn connected to a four-way valve 29 which has an inlet pipe 30 and an outlet pipe 31, which pipes are connected to a suitable means for supplying fluid under pressure and receiving fluid from the hydraulic system just described. By proper operation of the four-way valve 29 the piston 27 may be moved in either direction and into any position as desired. By controlling the four-way valve 29 the jaws may be closed in quenching position around a sucker rod, may be moved into discharge position so that the sucker rod may be discharged from the apparatus and may, in addition, be moved into sucker rod receiving position so that a sucker rod may be received from the chute 20 for quenching.

In Figs. 2 to 6 inclusive I have illustrated the details of the quenching means of my invention. It will be understood that the sucker rod, which is adapted to be heat treated and to be quenched by the apparatus of my invention and in accordance with my unique method, may be as long as thirty feet and may be from ⅝ to one inch in diameter. The standard construction of a sucker rod is that it includes a rod portion and at the end of the rod portion is what may be termed an end portion. This end portion is of larger diameter than the rod portion and includes a rectangular wrench receiving portion and a threaded pin whereby the same may be connected to a coupling. In the form of my invention illustrated herein the quenching dies 22 and 23 are as long as the rod portion of the sucker rod 17 and are designed to hold the same from warping while they simultaneously extract the heat therefrom in order to produce quenching. The end portion of the sucker rod, in accordance with my present invention, may be subjected during this quenching operation to a separate quenching operation by being submerged in a suitable quenching fluid such as oil as is now a recognized standard practice.

The quenching dies 22 and 23 are each provided with a longitudinal semi-cylindrical channel 35, which channels are preferably formed on such a diameter that when the quenching dies are together, as illustrated in Fig. 4, the circumference of the rod portion of the sucker rod will be snugly engaged. When the sucker rod is at a high temperature, such as is necessary in order to produce the desired physical changes therein, it is, of course, of slightly larger diameter than after a quenching and it is necessary therefore to form the channels 35 with this fact in consideration.

In order that the quenching dies 22 and 23 may have the ability to extract the heat from the rod portion at a suitable rate of speed in order to produce the necessary quenching action these quenching dies may be provided with chambers 36 so that a cooling fluid may be circulated therethrough at a suitable rate of speed being introduced and withdrawn from the chambers 36 by suitable conduit means such as indicated at 37.

One of the quenching dies, and preferably the movable quenching die 23, includes a rod support 38 which may be in the form of the series of rod supporting pins which are spaced along the length of the quenching die 23 at suitable distances. Each of the rod supporting pins is adapted to extend into holes 39 formed in the stationary quenching die 22 when the quenching dies are in quenching position shown in Fig. 4. In Fig. 5 the quenching dies are shown in receiving position. It will be noted that the rod supports are placed very close to the lower parts of the channels 35 so that when the rod is moved into a position between the quenching dies that the same is held in a position so that when the jaws are closed the rod portion of the sucker rod will be received in the channels 35, as illustrated in Fig. 4.

In Fig. 6 I have illustrated the positions of the parts when it is desired to discharge the sucker rod from the apparatus. It will be seen at this time that there is sufficient space between the leftward end of the pin 38 and the stationary jaw 22 to permit the sucker rod to pass downwardly and at this time the sucker rod may be received in a suitable bin such as illustrated at 40 in Fig. 1.

As shown best in Fig. 2, I have designated the rod portion of the sucker rod 17 by the numeral 43 and it will be seen that the end portions 44, including the wrench receiving portion and a threaded pin, project from the end of the quenching dies 22 and 23. Secured to the ends of the quenching dies 22 and 23 are receptacle sections 46 which cooperate when the jaws are in closed position to form a receptacle 47. Inner end walls 48, lying against the end of the quenching dies or jaws 22 and 23, form a suitable seal to prevent fluid leakage at this point. Each of the receptacle sections 46 have co-engaging faces 49, which, when they meet, form a sufficiently tight seal to prevent fluid leakage. One receptacle section may be provided with an inlet conduit 50, another may be provided with an outlet conduit 51 whereby, at the desired time and in consequence of the manipulation of a suitable valve, a quenching fluid, such as oil, may be introduced through the conduit 50 to fill the receptacle 47 and thus quench the end portion of the rod and may thereafter be withdrawn through the outlet conduit 51 and before the quenching dies 22 and 23 are separated. When the quenching dies are separated the receptacle sections 46 are spread apart a sufficient distance so that they will not interfere with the discharge of the sucker rod in a downward direction.

Having described the method and apparatus of my invention, I will now point out the sequence of operation.

Sucker rods to be subjected to the method of my invention are placed on the endless belt 15 and are carried through the heat treating furnace 11 at the desired rate of speed. For sucker rods which are made of composition, including all SAE numbered steels, low carbon irons and wrought irons, plain and alloyed and copper nickel alloy steels up to 4% nickel and 2% copper content, I find it satisfactory to raise the temperature thereof to between 1250° F. to 1850° F. for a period of approximately one to two hours. Stating the temperature in another way in the heat treating furnace, the temperature of the sucker rod is raised to the transformation temperature or above.

As the heat treated sucker rod leaves the treating furnace 11 it is discharged onto a chute 20 and is very quickly dropped onto a rod support pin and into the space between the quenching dies 22 and 23. At this time the quenching dies are in receiving position, as illustrated in Fig. 5. As soon as the sucker rod has reached this position the four-way valve 29 is manipulated in order to bring the quenching dies together into quenching position as illustrated in Fig. 4. This movement also brings the receptacle section 46 into the position shown in Figs. 2 and 3, so that the receptacle 47 is formed. When the dies are in this position, the surfaces of the channels 35 engage the outer cylindrical surface of the rod portion 43 and thus hold the same straight. At the same time heat is extracted from the rod portion at a suitable rate of speed by conduction and by the flow of cooling liquid circulated through the quenching dies in order that the necessary cooling rate will be obtained to produce in the rod portion a fine grained structure with the desired toughness and physical properties. At this time, by the manipulation of a suitable valve, a quenching fluid is introduced into the receptacle 47 through the inlet conduit 50, thus filling the receptacle and quenching the end portion of the sucker rod. It is standard practice to use oil as a quenching medium, and this comes within the scope of my invention. Before the movable quenching die 23 is moved in a rightward direction the quenching fluid is withdrawn from the receptacle 47 through the outlet conduit 51.

When this has been done the four-way valve is operated in order to move the movable quenching die 23 rightwardly so that the quenching dies occupy the relative positions as shown in Fig. 6. At this time the sucker rod 17 is free to pass downwardly into the receiving bin 40, as shown in Fig. 1. The sucker rod to be treated and quenched, in accordance with my invention, has the necessary and desirable physical characteristics which adapt the sucker rod for the use to which it is put in the oil producing industry. Not only does the structure have a fine grain but sufficient residual heat is left in the rod to temper and toughen the steel. Furthermore, the rod portion is straight since it has been held from any warping whatsoever during the quenching process. One of the very important features of my invention is that the rod is produced by a single heating and a timed cold metal contact quenching operation and therefore a better rod is produced in a shorter period of time and at less cost. It is an important feature of the invention that during the quenching operation the rod is not subjected to tension in order to keep it from warping. The action of the quenching dies is to hold the sucker rod in its normal straight position and to act as a restraining means to prevent warpage should such tendency occur at any point along the rod. In other words, the rod is surrounded so that it cannot move radially in any direction and this radial movement is prevented not by placing any tensile strains in the rod but by merely confining it so that it cannot move radially.

In Fig. 7 I show the die members 22 and 23 with openings, preferably staggered slots 70, for permitting the cooling medium to directly contact the rod 17.

It will, of course, be understood that my invention may be practiced without simultaneously quenching the end portion of the sucker rod or by quenching the end portion in a different manner than that illustrated herein. It will further be understood that different apparatus may be employed for practicing my invention so long as it incorporates the principle of the apparatus disclosed herein.

It is my invention, therefore, that this invention be not limited to the details illustrated herein but that the same be broadly construed in accordance with the spirit and scope of the appended claims.

I claim as my invention:

1. In an apparatus for quenching sucker rods which have been heated to at least the transformation point, the combination of: a plurality of quenching dies cooperating to form a chamber to receive the sucker rod with the ends thereof exposed; means for bringing the walls of said die members forming said chamber into pressural contact with the sucker rod; walls, supported by at least one of said quenching dies, forming a receptacle at each end of the quenching dies defining spaces surrounding the exposed ends of the sucker rod; and means for introducing a quenching medium thereinto.

2. In an apparatus for quenching sucker rods which have been heated to at least the transformation point, the combination of: a plurality of quenching dies each having a channel; means for circulating a cooling medium through said quenching dies; means for moving said quenching dies to cause said channels to surround said sucker rod in order to absorb the heat therefrom and hold same straight; and receptacle forming means supported by said quenching dies and adapted to form a quenching receptacle for receiving the end of said sucker rod when said quenching dies are in such a position that said channels surround said sucker rod.

3. A method of heat treating a sucker rod which has a rod portion and a threaded end portion at each end of said rod portion, comprising: heating the sucker rod to at least the temperature of transformation; and quenching the sucker rod so as to obtain different degrees of hardness in said rod portion and said end portions thereof, by simultaneously subjecting the rod portion and the end portions to different conditions of quenching wherein metal quenching dies are brought into engagement with said rod portion and a quenching of fluid is brought into engagement with said end portions, so that heat will be extracted from said rod portion at a slower rate than the heat is extracted from said end portions.

EDWARD E. STEVENSON.