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J. L. GRAY

METHOD OF HEAT TREATING SUCKER RODS

Filed Jan. 8, 1927

Fig. 1.

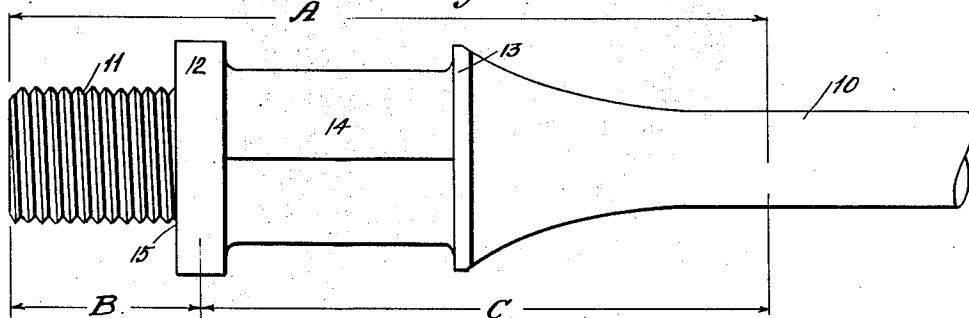


Fig. 2.

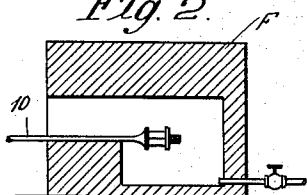


Fig. 3.

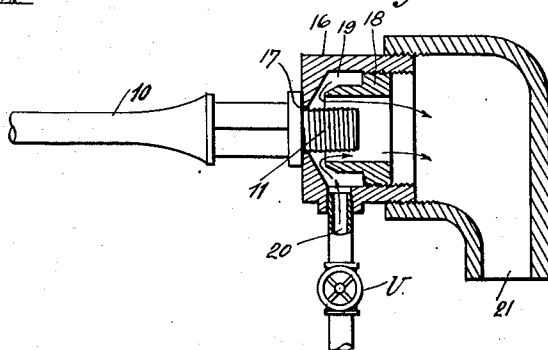
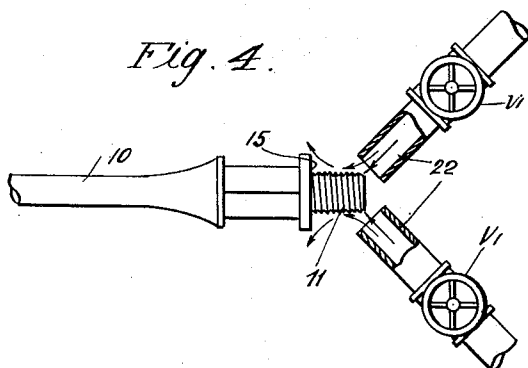


Fig. 4.



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UNITED STATES PATENT OFFICE.

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METHOD OF HEAT-TREATING SUCKER RODS.

Application filed January 8, 1927. Serial No 159,852.

This invention has to do with the heat treatment of sucker rods used for reciprocating plungers of deep well pumps, and the general object of the invention is to provide a treatment which will render said rods capable of withstanding the severe stresses and strains to which these heavily loaded rods are subjected. The serious consequences resulting from rod failure are too well known to those skilled in the art to necessitate a discussion of them here.

The stresses and strains, and particularly fatigue stresses, most often occur at the junction of the threaded pin and annular flange provided on these rods for coupling purposes, and therefore it is this particular point which needs treatment, and is treated by my process, to give the desired results.

By heating rods made of usual sucker rod steel at a temperature greater than the transformation point, that is, between 1400° and 1600° Fahrenheit and then quenching them rapidly, the steel is hardened but at the same time becomes more brittle or "martensitic." In this condition the steel has low shock resisting strength and therefore is unsuited to stand the severe service conditions imposed on sucker rods.

However, if the steel is reheated to about 750° Fahrenheit the martensite is transformed to troostite which gives the steel much greater shock resisting strength. If the temperature be raised to about 1150° Fahrenheit the troostite is changed to sorbite and the steel in this condition has very superior shock resisting as well as fatigue resisting properties. Steel of either troostitic or sorbitic structure is very well suited for pump rod purposes.

However, if the rods first be heated to hardening temperature, quenched, and then reheated to draw the temper, it will be seen that they must be passed through the furnace twice and this double handling adds materially to the cost of manufacture. I have provided a method whereby this double handling is avoided and the cost of manufacture thereby reduced to a minimum. How this is done will be set forth in the following detailed specification, reference being had to the accompanying drawings, in which:

Fig. 1 is a fragmentary view of a sucker rod;

Fig. 2 is a conventional view of a furnace used in my process; and

Figs. 3 and 4 show variational types of quenching devices.

In Fig. 1 is shown the end of a usual sucker rod 10, the rod terminating in a threaded pin 11 and there being an annular flange 12 adjacent this pin. Flange 13 is longitudinally spaced from flange 12, said flanges being forged and determining the longitudinal extent of a forged wrench-taking portion 14 which is usually of polygonal cross-section. It is found that most rod failures occur at the pin near or at the shoulder 15 of flange 12 where it joins the pin. Therefore, it is the pin and rod-parts immediately adjacent the pin which require treatment.

The end of the sucker rod is heated in any suitable furnace F to form 1400° to 1600° Fahrenheit, the rod being heated to this temperature for a comparatively long distance A from the end, say four or more inches. Then only the pin and shoulder 15 or the comparatively short extent B, say one and one-half to two and one-half inches, is quickly quenched in oil or other suitable medium, the quenching usually requiring about thirty seconds. After this limited extent is quenched, the rod is removed from the quenching bath and the remaining unquenched and consequently hot remaining extent C of original extent A reheats, by conductance, the quenched extent B to draw the temper.

A proper drawing temperature having been predetermined, the temper may be drawn to the proper degree by any one or a combination of any two or more of the following methods: (1) by proper regulation of the length A originally treated (2) by regulation of the temperature to which A is originally heated (3) by regulation of the "time" of quench (4) by regulation of the extent of quenched portion B, and (5) by regulation of the "speed" of quench. It will be noted that the temperature to which the quenched portion is re-heated—the drawing temperature—is determined entirely by the temperature at which the quenched portion and the unquenched portion reach a temperature equilibrium. After the quenching, the whole rod is merely laid out in the atmosphere, the quenched portion is re-heated to

equilibrium temperature and the whole rod then cools down to normal temperature. Thus, the re-heating temperature is determined by the amount of heat retained in the unquenched portion, that being dependent upon the mass and temperature of the unquenched portion at the end of the quench period; in proportion to the mass and temperature of the quenched portion, at the end of the quenching period. The mass (or length) of the unquenched portion of course depends upon the size of the whole portion initially heated. The temperature of the unquenched portion at the end of the quenching period depends upon the initial temperature and, of course, upon the length of the quenching period, during which period heat from the unquenched portion is moving into the portion being quenched. Thus, the temperature retained by the unquenched portion is influenced not only by the initial temperature, but by the length of the quenching period. But all of the controlling factors may be summed up by saying that the temperature of reheating is controlled by the mass (or length) of the unquenched part and its retained temperature; and the mass (or length) of the quenched part and the temperature of quench.

It will be seen that the hardening and tempering is accomplished by a single passage through the furnace and a single quenching operation, the cost of the heat treatment thus being reduced to a minimum.

Figs. 3 and 4 illustrate typical devices for performing the limited or restricted quenching operation, though it will be understood other devices may be employed for the purpose without avoiding my claims.

In Fig. 3 there is shown a housing 16 having an aperture 17 admitting pin 11 to the bore thereof. A bushing 18 is threaded into this bore and, with the housing, defines an annular passageway 19 into which quenching fluid, preferably under some little pressure, is admitted through inlet 20. The fluid is directed first against the base of the pin and then passes out through the bushing bore and over the peripheral face of the pin to outlet 21. By regulation of inlet valve V, the pressure of the quenching fluid may be varied to vary the "speed" of quench; that is, if by varying the amount of flow of fluid per unit time, I may vary the depth to which the pin is quenched before the adjacent part of the rod has time to cool. This capacity for rap-

id quenching is especially important when a relatively high drawing temperature is desired, as will be readily understood.

In Fig. 4 there is shown a pair of converging nozzles 22 adapted to direct quenching fluid onto pin 11 and shoulder 15. Inlet valves V' may be provided to vary the fluid pressure at the nozzles for the same purpose and with the same effect as valve V. Both types of quenching devices have been used by me with success.

I have put into use about a million feet of sucker rods heat-treated in accordance with the above method and not a single pin failure has occurred. On the other hand, untreated rods have continually given trouble by reason of pin failure.

I claim:

1. The method of heat treating a sucker rod having a threaded end portion, that includes heating the threaded portion and an adjacent portion of the rod at least to the transformation point, rapidly quenching the threaded portion, promptly removing the quenched portion from the quenching medium, and thereby allowing the retained heat of the unquenched, heated portion to flow into the quenched portion to a condition of heat equilibrium and thus to draw the temperature of the quenched portion, the drawing temperature being controlled by proper regulation of the retained temperature and length of the adjacent, heated portion in proportion to the length and quenching temperature of the quenched portion.

2. The method of heat treating a defined length of a rod or the like, that includes the heating the defined length and an adjacent additional length at least to the transformation point, quenching the defined length and allowing the remainder of the heated portion to retain a part of its heat above the temperature of quench, then allowing the retained heat of the unquenched heated portion to flow into the quenched portion to a condition of heat equilibrium and thus to reheat the quenched portion, the temperature of reheating being controlled by proper regulation of the retained temperature and mass of the unquenched portion in proportion to the mass and quenching temperature of the quenched portion.

In witness that I claim the foregoing I have hereunto subscribed my name this 15th day of Dec. 1926.

JESSE L. GRAY.