Patented Apr. 28, 1925. 1,535,379

UNITED STATES PATENT OFFICE.

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QUENCHING OIL.

No Drawing. Application filed November 19, 1923. Serial No. 675,500.

To all whom it may concern:

Be it known that we, HUGH RODMAN and EARL E. BOREN, citizens of the United States, and residents of Oakmont and Penn Township, respectively, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Quenching Oil, of which the following is a specification.

This invention relates to oils to be used for quenching steel. It comprises the discovery that certain oils of low viscosity and low flash-point may have their initial quenching speed materially increased by adding thereto a comparatively small proportion of oil of high flash-point and high viscosity.

The principal object of the invention is the production of a low-cost quenching oil, of low viscosity and very rapid initial quenching speed. It is also an object to increase the initial quenching speed of an ordinary low viscosity mineral quenching oil, without materially raising its viscosity, and without materially increasing the cost. Another object is to produce an oil having a comparatively high initial quenching speed for the upper range of temperatures of the articles to be quenched, but retaining the valuable quenching characteristics of oils as compared to other liquids in the matter of slow quenching at lower temperatures of the steel.

Other objects and advantages will be apparent to those familiar with the art from the following specification.

In the heat treatment of steel, oil baths are used for two purposes. Red hot steel is immersed in comparatively cool oil to secure a rapid cooling of the steel and thereby to harden it in well known manner. This is known as "quenching." After the steel has been cooled by this quenching process it is sometimes reheated by immersing it in highly heated oil, for the purpose of reducing the extreme hardness produced by the quenching process. Oil used in the cooling process is called the "quenching bath" and that used in the second or reheating step is called the "tempering bath."

The "quenching bath" usually consists of a mineral oil having a viscosity not over 150 seconds measured at 100° upon the Saybolt viscosimeter, and a flash-point of 300 to 450° measured by the Cleveland open cup method. (Throughout this specification degrees of temperature refer to the Fahrenheit scale.) The "tempering bath" generally consists of a mineral oil having a flash-point over 550° and a viscosity of 150 or more at 212°. The art has generally used as a quenching bath an oil having low viscosity, which implies an oil of comparatively low-flash point. Oil of low viscosity is so used because less of such oil adheres to the steel parts upon removal from the bath, there being therefore less waste from drippage, and because oils of low viscosity are believed to give more rapid cooling of the steel than those of high viscosity. Tempering baths must necessarily be heated to a very high temperature for tempering steel. Therefore, oils for this purpose must have a high flash-point, which implies the additional characteristics of high viscosity.

Water quenches hot steel much more rapidly than oil. In fact the quenching time of water is only about one-third that of the oils commonly used. Or, stated another way, the heat absorption by water from red hot steel is about three times as rapid as the heat absorption by the quenching oils generally used. But oil as a quenching bath has the valuable property or characteristic of cooling the steel very slowly after the steel has been reduced in temperature to say 700 to 600°. Oil also has the desirable quenching characteristic of maintaining a substantially uniform initial quenching speed over a wide range in temperature variation of the quenching bath itself.

There have been many efforts made to produce an oil of more rapid initial quenching speed, while at the same time preserving the valuable oil quenching-characteristics just referred to, and keeping the cost of the oil within a practical commercial range. Some increase in quenching speed has been attained by adding to the usual low-viscosity mineral quenching oil a small amount of an animal oil, as lard or degras, or even some of the vegetable oils. This mixture has resulted in a quenching bath of somewhat greater initial quenching speed than the mineral oil alone, but this increase has been small as compared to that attained by our product described, and the added animal or vegetable oils are expensive.

We have discovered that the initial quenching rate of mineral oils of certain characteristics may be greatly increased by the addition of a small proportion of another mineral oil of widely different characteristics, and apparently this change is in some way connected with the respective flash-points or viscosities of the oils that are combined.

We have discovered that a product comprising a low-flash, low-viscosity mineral oil combined with a smaller amount of a comparatively high-flash, high-viscosity mineral oil, has an initial quenching speed much more rapid than that of either of the constituent oils separately. Specifically, we have discovered that an ordinary low-flash low-viscosity mineral quenching oil may have its initial power to absorb heat from red hot steel, that is to say its rapidity of quenching at high temperatures, greatly increased by the addition to it of a small proportion of a high flash-point mineral oil, while the viscosity of the resultant product is only slightly raised by the added oil. Perhaps it would be more accurate to say that we have discovered that when a product is made by adding to an ordinary low-flash, low-viscosity mineral oil, a small amount of a high-flash, high-viscosity mineral oil, the initial quenching speed of the resultant product is much greater than that of the low-flash, low-viscosity oil alone. The high-flash oil has viscosity and flash-point characteristics which render it alone unsuitable and undesirable as a quenching bath.

A specific example of a product involving this invention and tested and used by us with markedly successful and improved results was made by adding to an ordinary quenching oil consisting of 100 parts of a Pennsylvania neutral oil having a viscosity of about seventy seconds at 100° and a flash-point of about 350°, about ten parts of a heavy residuum oil derived from Pennsylvania crudes, having a flash-point of about 620° and a viscosity of about 200 seconds at 212°. These very high flash oils are known in the trade as "Steam refined oils", the expression meaning that the distillation of the petroleum has been carried on in the presence of steam, in order to minimize the production of tar, which would otherwise be formed at the high distillation temperatures necessary to produce oils of this character. These steam refined oils having a flash-point of approximately 620° are the residuums left in the still after as much oil as possible has been distilled off, without the formation of tar or asphaltum. Such an oil is of a consistency similar to very thick molasses. We believe no one has hitherto made use of these oils as a quenching bath or as an ingredient of a quenching bath, and we find that the addition of a small amount of such heavy, high-flash oil, will materially raise the quenching rate of the low-viscosity low flash-point mineral oil.

We have found by careful measurements that such a mixture or product of mineral oils will quench red hot steel from about 1500° down to about 1200°, in less than half the time required by any commercial quenching oil which we have been able to find upon the market. At the same time, we have determined by careful measurements that this product retains the desired characteristics of oil as a quenching medium in the way of very slow quenching after the steel has been reduced to about 700°, and also that the mixture maintains a substantially uniform initial quenching speed regardless of variations in the temperature of the oil itself. We have been able with such a product as that described to reduce the quenching time required in cooling steel from a red hot to a nearly black heat to about one-half that of any previously known oil. Or, stated another way we have succeeded in increasing the initial quenching rate of oil baths for red hot steel from about one-third the quenching rate of water to more than two-thirds the quenching rate of water, thus carrying ordinary red hot steel through its critical points at about twice the quenching speed of the oils ordinarily used. This is about the rate of quenching most desired for commercial work. At the same time we have found that such a quenching oil retains unimpaired the desirable oil-characteristics for quenching baths above referred to. In addition, our product retains the low-viscosity property of the light oil.

When we refer to "initial quenching rate" of oil we mean the first cooling of the steel from its red hot state, say 1500°, down to about 700° or 600°. The rate is much faster with oils during this initial stage than thereafter. In effect oil in quenching has a sort of cushioning effect, producing a comparatively rapid drop of temperature at first, but slowing up the cooling at the end; while water cools the steel with substantially uniform rapidity down to the temperature of the water itself. It is this slower final cooling that toughens the steel and this characteristic of oil is one of its most valuable functions in a quenching bath. Our product has a much more rapid initial cooling than oils heretofore used, but below 600° the quenching speed drops to substantially the same rate as that of the base or light oil alone.

We have found that apparently no valuable increase in the quenching rate of the resultant product is secured unless the product comprises oil which alone would

have a flash-point above 450°. In fact we think the quenching speed of the product is materially increased only when an oil having a flash-point above 475° is comprised. The rapidity of quenching action of the product appears to increase as the flash-point of the heavy ingredient increases, up to about 620° flash-point, which is approximately the highest flash-point we have found in commercially available oils. We have found that the initial quenching speed of the product secured by adding to a low-flash oil a mineral oil of a flash-point of 500° is only about two-thirds that secured by adding to a similar oil an equal proportion of a mineral oil having a flash-point of about 620°. Our experiments also lead us to conclude that the presence of any oil of intermediate flash-point value is undesirable. The presence of oil of intermediate flash-point does not appear to increase the resultant quenching speed, while such intermediate oil does raise the viscosity of the bath, which is undesirable. Therefore the preferred product comprises a mineral oil of low viscosity and flash-point, in combination with a small amount of mineral oil of very high flash-point.

Furthermore, we have found that while the initial quenching rate of the product appears to increase with the flash-point of the heavy oil (provided the flash-point of the latter is high) it does not appear to increase with the volume of the high-flash constituent oil after the proportion of the latter reaches about ten percent of the low-flash oil. We have experimented with many different oils, and find that results vary somewhat according to the character of the particular oils used, but that in general about ten percent of a high flash-point, high-viscosity oil with the remainder a low-flash, low-viscosity oil, free from oil of intermediate flash-point and viscosity values, gives the best results.

From these observations we conclude that the best form of our invention is a quenching oil comprising a base or body of mineral oil of comparatively low viscosity and low flash-point and about ten percent of a heavier mineral oil, of high viscosity and high flash-point, and that preferably the product should be free from oils of intermediate viscosity or flash-test characteristics. Such oils of intermediate properties do not increase the quenching speed of the oil, but on the other hand have the bad effect of increasing the viscosity of the mixture, which, as above pointed out is undesirable for commercial reasons.

We claim:

1. A quenching oil comprising a low flash-point mineral oil, in combination with a lesser amount of a mineral oil of comparatively high flash-point.

2. A quenching oil comprising a low-viscosity mineral oil in combination with a lesser amount of mineral oil of comparatively high viscosity.

3. A quenching oil comprising a low flash-point low-viscosity mineral oil, in combination with a lesser amount of high flash-point, high-viscosity mineral oil.

4. A quenching oil of low viscosity comprising two mineral oils of widely different respective flash-points.

5. A quenching oil of low viscosity comprising two mineral oils of widely different respective viscosities.

6. A quenching oil comprising a mineral oil of low viscosity and low flash-point combined with a lesser amount of a mineral oil of comparatively high viscosity and high flash-point, and substantially free from mineral oils of intermediate viscosity and flash-point characteristics.

7. A quenching oil of low viscosity and low flash-point, comprising a mineral oil of low flash-point in combination with a smaller amount of mineral oil of comparatively high flash-point, the product being substantially free from oils of intermediate flash-point characteristics.

8. A quenching oil of low viscosity, comprising a mineral oil of low viscosity in combination with a mineral oil of high viscosity, the product being substantially free from oils of intermediate viscosity characteristics.

9. A quenching oil comprising in combination about one hundred parts by volume of a mineral oil having low-viscosity and low flash-point properties and about ten parts of a mineral oil having flash-point and viscosity properties high in comparison to the first mentioned oil.

10. A quenching oil comprising a mineral oil having a flash-point of less than 450° combined with a lesser amount of a mineral oil having a flash-point of over 500°.

11. A quenching oil comprising a mineral oil of a flash-point of approximately 350°, and an added mineral oil of a flash-point of approximately 620°.

12. A quenching oil consisting of about one hundred parts of a mineral oil having a flash-point above 300° and below 450°, and about ten parts of a steam-refined mineral oil having a flash point over 600°.

13. A quenching oil consisting of approximately one hundred parts of mineral oil having a viscosity of not over one hundred fifty seconds (Saybolt) at 100°, combined with a lesser amount of a mineral oil having a flash-point of over 500°.

14. A quenching oil comprising a low-viscosity, low flash-point mineral oil and a smaller amount of a high flash-point steam-refined oil.

15. A quenching oil of low viscosity and low flash-point, consisting of a low-viscosity,

low flash-point mineral oil and a smaller amount of a high flash-point steam-refined mineral oil.

16. The method of increasing the initial quenching speed of a low flash-point, low-viscosity mineral oil, consisting in adding thereto a smaller amount of mineral oil of a comparatively high flash-point.

17. The method of increasing the initial quenching speed of a low flash-point, low-viscosity mineral oil, consisting in adding thereto a smaller amount of mineral oil of a comparatively high viscosity.

In testimony whereof, we hereunto sign our names.

HUGH RODMAN.
EARL E. BOREN.

Witness to both signatures:
W. T. DIBLE.