

UNITED STATES PATENT OFFICE

HEINRICH LINDHORST, OF BERLIN-GRUNEWALD, GERMANY

PROCESS FOR THE HARDENING OF IRON AND THE LIKE WITH THE AID OF A GAS GENERATED IN THE HARDENING FURNACE

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This invention relates to the hardening of iron or the like with the aid of a gas generated in the hardening furnaces.

For the hardening of iron and the like it has already been proposed to surround the material to be hardened with a hardening powder and heat it in a hardening furnace. It was necessary in this process that the article to be hardened should remain in intimate contact at all points to be hardened with the hardening powder as otherwise the well-known soft spots were formed. This process had several disadvantages. To begin with the carbon is set free too slowly so that the hardening process requires a relatively long time. Attempts have been made to shorten the duration of the process by employing a higher temperature than that normally selected (about 700 to 1000° C.) but this was found to be unsuitable as the higher temperatures render the hardened layer brittle and frequently even cause it to scale. A further disadvantage of this process consists in the uneven heating of the article to be hardened, for as the heating of a muffle furnace cannot be so regulated as to progress evenly at all parts the article to be hardened was frequently heated first on one or another side whilst yet another side or the centre remained at a cooler temperature for a considerable time, consequently the hardening powder can only operate for varying periods of time at varying portions of the article and consequently an uneven hardening of one and the same article results. Yet another disadvantage of this process resides in the fact that the depth of hardening can only be inaccurately determined in advance because the depth of hardening depends on the exact maintenance of a definite temperature for a definite time, whilst the heating up of muffle furnaces does not always take place at a uniform speed. Finally another disadvantage of the process consists in the fact that a very large quantity of hardening powder (about 20 to 30% by

weight of the article to be hardened) is required as well as a considerable period of time (2 to 5 hours) which means a considerable amount of fuel.

It has also been proposed to harden iron and the like more particularly mass production articles such as screws, balls and the like, in rotating carbonizing drums. These furnaces consist of heated rotatable drums into which the articles are inserted and into which ammonia which has previously passed over benzene, benzine or gasolene, is led from a closed device shown as the carburator. This process also has disadvantages. On the one hand graphite is separated from the ammonia benzene mixture at high temperatures. This material is useless as combined carbon for hardening purposes. Further it adheres to the article to be hardened in the form of flakes, particularly as during the rotation of the drum individual iron articles fall over each other and thus press particles of graphite more firmly on to the iron which prevents the gas acting on the graphite covered places. This likewise leads to the well-known soft spots. A further disadvantage of the process consists in the fact that the hardening depends to a considerable extent on the quality of the benzene, benzine or gasolene employed. Thus a good hardening effect can only be achieved with a benzene of a specific gravity of 0.6 to 0.62. If the benzene has a specific gravity of 0.63 then the hardening is defective and the hardening effect ceases altogether if the specific gravity of the benzene reaches 0.7. It is clear that this prevents a continuous uniform hardening as it is difficult always to obtain benzene of a quite definite specific gravity. A third disadvantage of this process resides in the necessity of employing the carburator which is a not altogether simple apparatus and by the need of operating with ammonia and benzene. The carbonizing drums which are in industrial use frequently allow am-

monia and benzene vapours to escape and these are unpleasant for the workers. Finally, this process also is relatively costly as the hardening takes from 25 minutes to 3 hours according to the desired depth of hardening.

The present invention refers to a modification of the process employing a carbonizing drum. The invention consists in the fact that whereas the drum has hitherto been supplied with a gas mixture from outside it the necessary gas mixture is generated in the furnace itself by the action of heat on to a powder placed in the furnace and which completely decomposes therein. It has been found suitable to employ a hardening powder consisting of a mixture of substances which on being heated set free carbon and carbon dioxide which act on the article to be hardened. It has also been found advantageous to add to the powder a nitrogen containing component as this expedites the hardening. A suitable composition consists for example of 50% lignite coke (a coke obtained from lignite or brown coal and in the German industry usually called "Grude Koks") or some other low temperature coke, 30% barium carbonate (or some other carbonate which liberates carbon dioxide on being heated, such for example as calcium, strontium, or magnesium carbonate) and 20% of ammonia (or an ammonium salt, such as ammonium carbonate, ammonium chloride or a material which sets free ammonia on being heated such for example as urea, calcium-cyanamide, cyanamide, or dicyandiamide). It is probable that gaseous carbon compounds are formed or else that the coke favours the generation of carbon dioxide.

By way of an example about 5% by weight of the gasifying powder calculated on the weight of the charge to be hardened is placed in the drum together with the charge. The drum is then hermetically closed and heated under constant rotation. The powder is quickly gasified and produces a pressure within the drum which has a favourable effect on the hardening process. This pressure can be adjusted according to the desired depth of hardening by accurately adjusting the composition and quantity of the powder employed. Thus, if more than 5% by weight of powder is used, the pressure, and therefore the depth of the hardening, is increased. The hardening takes place at between 720 and 820° C. and requires a time of from 15 minutes for a very small hardening depth to 1 hour for a hardening depth of 1 mm. in the case given above in which 5% by weight of powder is employed. The advantages of the process reside in the absolutely uniform and previously calculable nature of the hardening, in the cheapness of the gasifying powder, which is only used in small quantities, in the shortness of the time required for the hardening and in the absence of the carbura-

tor as well as of any trouble to the working due to gases.

Another suitable hardening substance consists of leather charcoal, barium carbonate and ammonia which completely gasifies in the drum and effects the hardening simply by means of the gases evolved and therefore, as opposed to the packing system, the powder is used in quite small quantities, small accurately measured quantities however, according to the size of the drum, the quantity of material to be hardened, and the depth of the desired hardening, the drum being then closed and heated. The powder, then completely gasified, sets free in the drum a hardening gas of accurately calculable composition and at accurately calculable pressure. If, for example, a number of charges of identical toothed wheels is to be hardened, and it is desired to produce an entirely identical hardening, then for each single charge, which naturally must be hardened in the same or an identical drum, a hardening powder of definite composition is employed, and is added in exactly the same quantities to each single charge. If now each charge is kept in the drum for the same length of time, then all the toothed wheels, hardened in the different drums will be of exactly the same degree of hardness.

In particular it has been found to be of advantage in view of the various large drums and charges employed as well as for the particular kind of hardening desired, to form the quantities of powder to be measured into briquettes and to add the hardening powder of each charge in the form of one or more briquettes. The briquetted hardening powder ensures a lengthy and therefore uniform gasification. In particular, the briquetting of the hardening powder avoids a sudden evolution of gas, which would cause a non-uniformity in the hardening of the different charges, since on account of the suddenly occurring pressure, gas escapes from the drum through the excess pressure valve, and consequently less gas acts upon the iron. There is also the advantage that the briquetting of the hardening powder prevents any evolution of dust and an accurate charging is permissible, so that an almost automatically uniform cementation is ensured.

It will be understood from the consideration given above that the difficulties met when hardening bodies of any kind according to any of the elder processes, were mainly due to the fact that the composition or the quantity or the pressure of the hardening gases was not sufficiently under control, and that every variation of the gases effected the degree of hardening.

It is further obvious that the process which has been described with reference to a carbonizing drum can also be employed in a fixed

furnace and the process shows exactly the same advantage in the latter case.

It is obvious that where a fixed furnace is employed the arrangement of the charge to be hardened must be such that those portions which are to be hardened are not prevented from being acted on by the gases due to contact with the furnace. This may be effected for example by suspending the articles to be hardened by means of wires, or hooks or suspending them on other suitable supports, as will be at once apparent to those skilled in the art.

I claim:

1. A process of hardening metals to a predetermined depth comprising placing a load in a container, placing in the container at a point remote from the load a charge comprised of approximately 50% of a carbon substance, approximately 30% of a carbonate of a metal of the group of metals comprising barium, calcium, strontium and magnesium and approximately 20% of a material which produces free ammonia upon being heated, the proportion by weight of the charge to the load being extremely small, heating the said container, substantially completely vaporizing the charge while in the container, and uniformly treating the entire surface of the load with the vapor.

2. A process of hardening metals to a predetermined depth comprising placing a load in a container, placing in the container at a point remote from the load a charge comprised of approximately 50% of a carbon substance, approximately 30% of a carbonate of a metal of the group of metals comprising barium, calcium, strontium and magnesium and approximately 20% of a material which produces free ammonia upon being heated, the weight of the charge being approximately 5% of that of the load, heating the said container, substantially completely vaporizing the charge while in the container, and uniformly treating the entire surface of the load with the vapor.

3. A process of hardening metals to a predetermined depth, comprising placing a load in the container, placing in the container at a point remote from the load a charge comprised of approximately 50% of lignite coke, approximately 30% of carbonate of metals of the group comprising barium, calcium, strontium and magnesium, and approximately 20% of a material liberating free ammonia upon heating, heating the said container, substantially completely vaporizing the charge while in the container, and uniformly treating the entire surface of the load with the vapor.

4. A process of hardening metals to a predetermined depth, comprising placing a load in the container, inserting in the container at a point remote from the load a charge comprised of approximately 50% of a carbon

substance, approximately 30% of a carbonate of a metal of the group comprising barium, calcium, strontium and magnesium, and approximately 20% of a material which produces free ammonia upon being heated, heating the said container, substantially completely vaporizing the charge while in the container, and uniformly treating the entire surface of the load with a vapor at the temperature of approximately 720° C. to 820° C. for a period of from fifteen minutes to an hour.

In testimony whereof I affix my signature.
HEINRICH LINDHORST.

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