March 21, 1939. R. J. COWAN 2,151,190

METHOD OF PRODUCING A COMPOSITE CARBIDE AND NITRIDE CASE ON STEEL ARTICLES

Filed Dec. 31, 1938

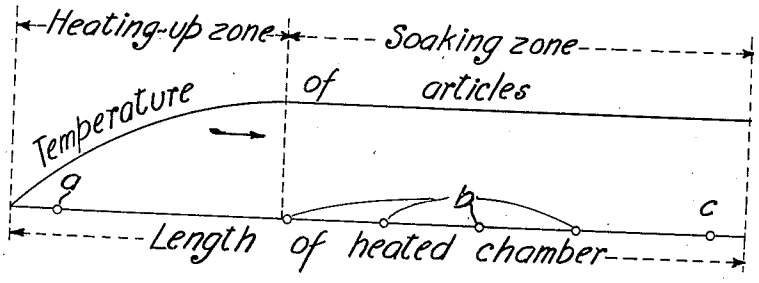


Fig. 1.

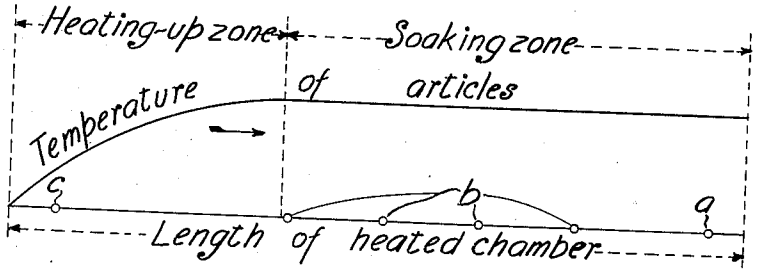


Fig. 2.

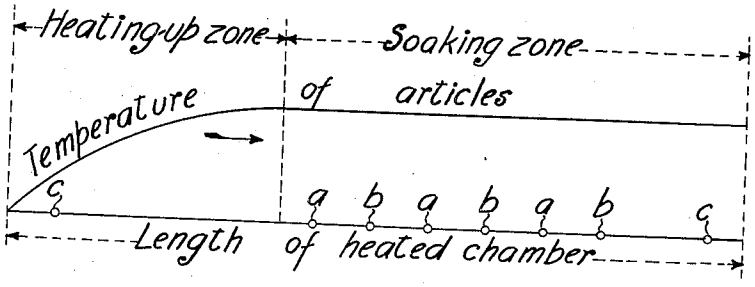


Fig. 3.

Legends

a = Inlet for carburizing gas

b = " " nitriding "

c = Bleed outlet for gases

→ = Direction of movement of articles through chamber

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Patented Mar. 21, 1939

2,151,190

UNITED STATES PATENT OFFICE

2,151,190

METHOD OF PRODUCING A COMPOSITE CARBIDE AND NITRIDE CASE ON STEEL ARTICLES

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Application December 31, 1938, Serial No. 248,753

15 Claims. (Cl. 148—16)

It has heretofore been proposed to use a carburizing gas as a diluent for a nitriding gas for the purpose of rendering an ordinary nitride case less brittle but insofar as I am aware there has hitherto not been any way of utilizing a nitriding gas like ammonia for imparting to an ordinary carbide case the desirable characteristics of a nitride case. It is, therefore, the object of the present invention to provide a commercially practical way of utilizing a nitriding gas for imparting to a carbide case the desirable characteristics of a nitride case and withal to provide a method which shall permit a variety of composite nitride and carbide cases to be obtained by simply varying, within certain limits, the relative proportions of the nitriding and carburizing gases utilized and/or by varying the furnace temperature.

The present invention may be said to be based on the discovery that by introducing the nitriding gas into the chamber of a heat-treating furnace in a certain way it becomes possible to produce a carbide case with certain of the desirable characteristics of a nitrided case. The case produced by the present invention is, therefore, a modified carburized case.

In accordance with the present invention the nitriding gas is introduced into the soaking zone of a continuous heat-treating furnace through a series of inlets the first of which is located adjacent the point where the heating-up zone may be said to end and the soaking zone to begin. Moreover, the best results are obtained when the nitriding gas is introduced below its break-down temperature. It will, of course, be understood that by the term "heating-up zone" is meant that portion of the furnace chamber where the incoming articles are coming up to the prevailing furnace temperature and that by the term "soaking zone" is meant the next succeeding portion of the furnace chamber where the articles are held at heat-treating temperature.

The depth of the case produced on the articles depends primarily on the time the articles are allowed to remain in the furnace whereas the chemical composition of the case depends on the furnace temperature and on the proportions of carburizing and nitriding gases used.

In general it may be said that the operating range as regards temperature is from about 1200 to 1600 deg. F. and as regards the proportions of carburizing and nitriding gases the range is from about 10% to about 50% of nitriding gas. However, the preferred temperature is about 1450 deg. F. and the preferred proportions of said gases are about three volumes of nitriding gas to seven volumes of carburizing gas. The manner in which the carburizing gas is introduced into the furnace is of more or less secondary importance as will more fully appear hereinafter.

In general it may be said that the case produced by the present invention has characteristics similar to that produced by the well known cyanide case-hardening process in that the same range of temperatures may be used, the same quenching practice followed and comparable case depths obtained. However, the present invention gives a more positive control of case composition than the usual cyanide process since it is dependent only on maintaining the selected proportions of the reacting gases.

Attention is now invited to the accompanying drawing for a graphic illustration of certain features of the present invention, the three figures illustrating three different ways of introducing the carburizing gas into the heat-treating chamber, it being noted that in each instance the nitriding gas is introduced into the soaking zone of the heat-treating chamber.

The method of operation shown in Fig. 1 will produce a case which is somewhat similar to that produced when using the well known cyanide case-hardening bath.

The method shown in Fig. 3 will produce a case having a somewhat higher carbide concentration than is produced by the method of Fig. 1, the case in this respect being similar to that produced when using a so-called "activated" cyanide bath.

The method shown in Fig. 2 will produce a somewhat higher nitride concentration than the method shown in Fig. 1.

The nitriding gas will ordinarily be introduced into the chamber through relatively small openings and under a pressure somewhat above atmospheric pressure. Although it appears to be more or less immaterial whether the nitriding gas is introduced through the top or side walls or bottom of the chamber, nevertheless the preferred place of introduction is through the top in a direction crosswise of the path of travel of the articles through the chamber. As previously mentioned the nitriding gas is preferably introduced below its break-down temperature and this is conveniently accomplished by the use of air cooled inlet pipes.

It should be stated that the proportions of nitriding and carburizing gases above mentioned are based on the use of ammonia as the nitriding gas and on the use of manufactured city

gas as the carburizing gas. However, it is within the spirit of the invention to use other nitrogen-containing compounds which like ammonia have the property of releasing nitrogen when heated, such as formamide, hydrocyanic acid, nitrobenzene, urea and pyridine. It is also within the spirit of the invention to use other well known carburizing gases such as coke oven gas, charcoal gas, and the common hydrocarbon gases such as natural gas, propane and butane either alone or admixed with air or combustion products.

This application is a continuation in part of my application Serial No. 169,004 filed October 14, 1937.

What I claim is:

1. The method of simultaneously utilizing a nitriding gas and a carburizing gas for producing a composite carbide and nitride case on steel articles which are being progressed through a furnace chamber maintained at a selected temperature between 1200–1600 deg. Fahr. which comprises initially introducing the nitriding gas into said chamber at a zone intermediate the ends of said chamber, and introducing the carburizing gas into said chamber independently of the nitriding gas.

2. The method of simultaneously utilizing a nitriding gas and a carburizing gas for producing a composite carbide and nitride case on steel articles which are being progressed through a furnace chamber maintained at a selected temperature between 1200–1600 deg. Fahr. which comprises initially introducing the nitriding gas into said chamber at a zone beginning at about that point where the incoming articles first attain the maximum temperature prevailing in said chamber, and introducing the carburizing gas into said chamber independently of the nitriding gas.

3. The method of simultaneously utilizing a nitriding gas and a carburizing gas for producing a composite carbide and nitride case on steel articles which are being progressed through a furnace chamber maintained at a selected temperature between 1200–1600 deg. Fahr. which comprises initially introducing the nitriding gas into said chamber at a zone beginning at about that point where the incoming articles first attain the maximum temperature prevailing in said chamber, and introducing the carburizing gas into said chamber independently of the nitriding gas, the amount of nitriding gas thus introduced into said chamber comprising from about 10% to 50% of the total volume of the gases introduced into said chamber.

4. The method of simultaneously utilizing a nitriding gas and a carburizing gas for producing a composite carbide and nitride case on steel articles which are being progressed through a furnace chamber maintained at a selected temperature between 1200–1600 deg. Fahr. which comprises initially introducing the nitriding gas into said chamber at a zone beginning at about that point where the incoming articles first attain the maximum temperature prevailing in said chamber; and introducing the carburizing gas into said chamber independently of the nitriding gas, the proportions of nitriding and carburizing gases being about three volumes of nitriding gas to seven volumes of carburizing gas when the nitriding gas is ammonia and the carburizing gas is manufactured city gas.

5. In the method specified in claim 2, said nitriding gas being introduced below its break-down temperature.

6. That method of producing a case on steel articles while they are being progressed through a chamber maintained at a selected temperature between 1200–1600 deg. F. and having a heating-up zone wherein the articles are first heated up to temperature and having a soaking zone wherein the articles after leaving the heating-up zone are maintained at temperature, which comprises introducing a nitriding gas into said soaking zone at a plurality of points therealong whereby the articles in passing through said soaking zone are repeatedly subjected to the action of fresh nitriding gas, and introducing and maintaining a carburizing gas in said chamber.

7. In the method specified in claim 6, said nitriding gas being introduced into said soaking zone at a controlled temperature which is below its break-down temperature.

8. In the method specified in claim 6, said nitriding gas being introduced into said soaking zone at a controlled temperature which is below its break-down temperature and being initially discharged in a direction across the path of travel of the articles through the soaking zone whereby the nitriding gas initially flows toward the articles in that zone.

9. That method of producing a case on steel articles while they are being progressed through a chamber maintained at a selected temperature between 1200–1600 deg. F. and having a heating-up zone wherein the articles are first heated up to temperature and having a soaking zone wherein the articles after leaving the heating-up zone are maintained at temperature, which comprises introducing a multiplicity of streams of nitriding gas into said soaking zone at points along the length of the latter, said streams being initially discharged in a direction across the path of travel of the articles through the soaking zone and being introduced into said soaking zone at a controlled temperature, whereby the articles in passing through said soaking zone are repeatedly subjected to the action of fresh nitriding gas, and introducing and maintaining a carburizing gas in said chamber.

10. In the method specified in claim 6, the carburizing gas being introduced into said chamber at the heating-up zone thereof.

11. In the method specified in claim 6, the mixture of gases in said chamber being bled therefrom adjacent the article-leaving end of the soaking zone.

12. In the method specified in claim 6, the carburizing gas being introduced into the chamber at a plurality of points along the length of the soaking zone.

13. In the method specified in claim 6, the carburizing gas being introduced into the soaking zone of said chamber and the mixture of gases in the chamber being bled therefrom at a point within the heating-up zone thereof.

14. In the art of case hardening steel articles in a heat treating chamber, the steps of passing said articles first through a heating-up zone and then through a soaking zone in said chamber, maintaining said soaking zone at a temperature between 1200 deg. F. and 1600 deg. F., introducing and maintaining within said soaking zone a carburizing gas and to said gas adding at a plurality of points within said soaking zone a nitriding gas initially discharged in a direction across the path of travel of said articles through said soaking zone.

15. In the art of case hardening steel articles in a heat-treating chamber by means of gases, the

steps of passing said articles progressively through a heating-up zone and a soaking zone of said chamber, maintaining said soaking zone at a temperature between 1200 deg. F. and 1600 deg. F. and, during the passage of said articles through said chamber, subjecting said articles first to the action of a carburizing gas and subsequently to the action of a nitriding gas together with the reaction products of said gases with the said steel articles.

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