Oct. 4, 1932. B. J. SAYLES ET AL 1,881,064

CARBURIZING BOX

Filed May 28, 1929

Fig. 1.

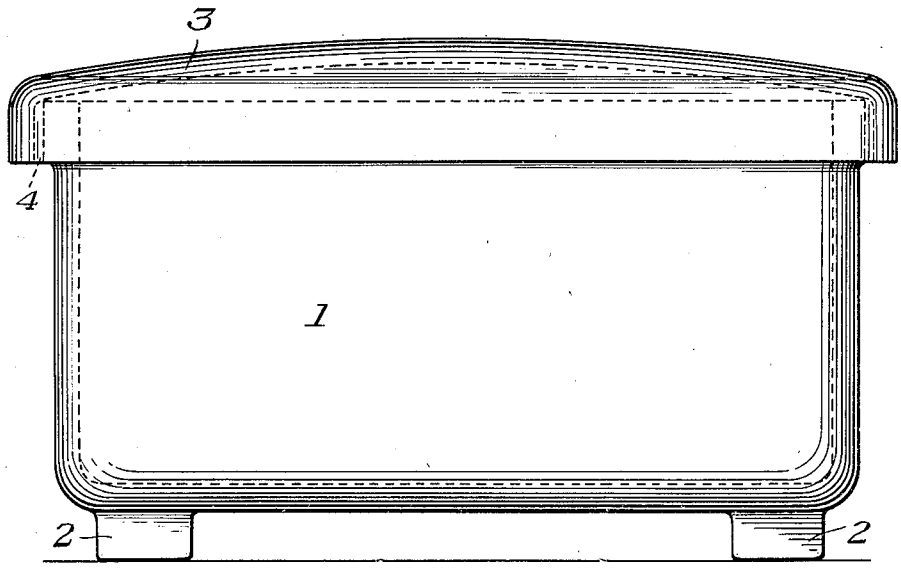
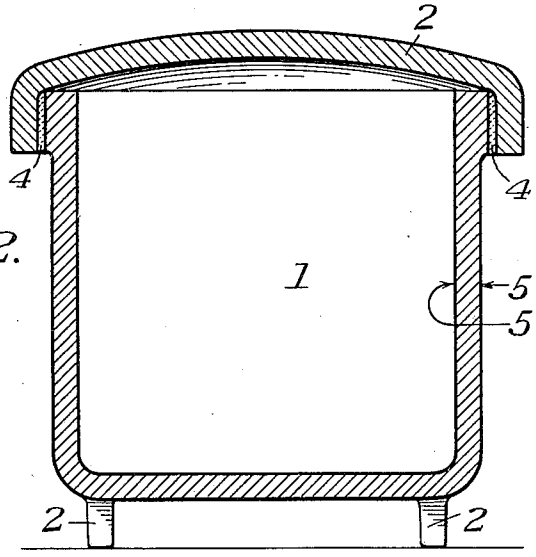


Fig. 2.



INVENTORS

Bertram J. Sayles
Harry Schultz
by their attorneys
Byrnes, Stebbins & Pannell

Patented Oct. 4, 1932 1,881,064

UNITED STATES PATENT OFFICE

BERTRAM J. SAYLES AND HARRY SCHULTZ, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO THE CALORIZING COMPANY, OF WILKINSBURG, PENNSYLVANIA, A CORPORATION OF DELAWARE

CARBURIZING BOX

Application filed May 28, 1929. Serial No. 366,748.

The present invention relates to carburizing boxes and more especially to a carburizing box made of an alloy which, of itself, is not resistant to carburization but which is rendered resistant to carburization by surface aluminizing. Carburizing boxes are used for the case-hardening of steel. The articles to be case-hardened, together with carbonaceous material, are enclosed in a hermetically sealed carburizing box which is placed in a heating furnace and held at 1200° to 1700° Fahrenheit for a period of four to twenty-four hours. These boxes are subjected on the outside to the oxidizing effect of the furnace gases, as well as to the action of sulphur compounds frequently present in the furnace gases, and also to chipping and abrasion due to handling. The inside of the box is not ordinarily subjected to severe mechanical abuse, but is subjected to the carburizing effect of the carbonaceous compounds used for case-hardening the enclosed articles.

Heretofore the carburizing boxes have been of two general classes; first, boxes of plain steel or steels containing small amounts of alloying elements, and second, boxes of alloys containing iron as a minor constituent and consisting principally of nickel and chromium. The first class of boxes while cheap have a short life due to both the carburizing attack on the interior, and also to oxidation on the exterior. The second class of boxes while quite resistant to carburization and oxidation, are very expensive.

We have developed a carburizing box which can be made at a moderate cost and which has carburizing resisting properties as great as, if not superior to, the high priced boxes made of alloys containing principally nickel and chromium.

In the drawing,—

Figure 1 is an elevation of a carburizing box embodying our invention; and

Figure 2 is a vertical section along the line II—II of Figure 1.

Referring to the illustrated embodiment of the invention, the carburizing box consists of a body 1 supported on legs 2 to allow the heating gases to pass beneath it. A cover 3 is applied to the top of the box and the joint between the body and cover is luted with some material, such as fireclay 4, to hermetically seal the articles to be carburized. An aluminum alloyed surface is indicated by the thickened lines 5 in Figure 2. The illustrated box is shown as being of cast metal, although the box may be fabricated from plates. The material is an alloy steel or iron preferably containing sufficient alloying elements to render the metal resistant to corrosion and scaling by the furnace gases at the temperatures encountered. The alloy, however, consists principally of iron and does not contain enough of the alloying elements to render the box resistant to the carburizing action on the interior.

The preferred material is an alloy steel containing about 70% iron, about 20% chromium, about 8% nickel and about .45% carbon. The manganese and silicon contents are those usual in steels of this character, say, about .40% to .60% manganese and about .70% to .90% silicon. The sulphur and phosphorus are preferably low. This steel, while highly resistant to oxidation at high temperatures, is not resistant to carburization at high temperatures. The chromium and nickel may be lowered below the proportions above given and the box will still have a fairly good resistance against oxidation.

The box is surface aluminized on the inside and preferably on the outside by any of the usual surface aluminizing processes. By "surface aluminizing" we mean the application of aluminum and the driving of it in to the surface so as to form a high content aluminum surface alloyage. We have found that such aluminum alloyed surface not only protects the steel against oxidation, but also effectively protects it against carburization by the case-hardening carbonaceous compounds used in such boxes. The carburizing action to which the interior of a carburizing box is subjected is particularly severe, since the carbonaceous compounds chosen and the temperatures employed are those which will result in effective carburizing of the enclosed articles. We have found that a carburizing box

produced as herein described will resist such severe carburizing influences.

There are various processes of surface aluminizing. One of the most common processes is the so-called "calorizing" process. The calorizing may be carried out by the so-called "dip process" in which the metal is cleaned and dipped in a bath of molten aluminum which wets the surface, leaving a thin layer of aluminum on the surface after the article is withdrawn from the molten bath of aluminum. The article is then subjected to heat which drives the aluminum into the surface, forming a surface alloyage of the aluminum with the iron.

Calorizing is also carried out by the powder process in which the articles to be calorized are placed in a rotary heated retort containing powdered aluminum and aluminum oxide for several hours, during which a surface alloyage of the aluminum with the iron takes place. Methods of calorizing are disclosed in the following patents: Van Aller 1,155,974; Gilson 1,091,057; Ortiz 1,409,017; Dantsizen 1,381,085, and Ruder 1,346,062. The Ortiz Patent 1,409,017 describes dip calorizing.

There are other processes of surface aluminizing. For example, in accordance with the so-called "Servarizing" process the surface is first electroplated with cadmium and then dipped in aluminum and heated to drive the aluminum into the surface and form the surface alloy. The surface aluminizing may also be had by the molten spray method, such as the Schoop metal spray process in which a thin layer of aluminum is deposited on the surface by a spray of molten aluminum, and the surface afterward heated to form the aluminum alloyed surface.

The surface aluminizing, in addition to protecting steel against oxidation at high temperatures, for which calorizing has heretofore been universally employed, seals the surface of the steel against the penetration of carbon from the carburizing compounds employed for carburizing the enclosed articles at the high temperatures to which carburizing boxes are subjected, and thus prevents the carburizing of the steel, which would result in embrittlement, warping and ultimate failure of the box.

The surface aluminizing as applied to steel containing alloying elements, such as nickel and chromium, imparts a surface which retains its non-carburizing properties even after long use under high heats. The effectiveness of the surface aluminizing in resisting carburization is apparently dependent upon the surface concentration of the aluminum which usually extends about one-hundredth of an inch or less into the metal. Continued high heat after the initial surface aluminizing tends to cause the aluminum to migrate or penetrate more deeply into the body of the steel, thus reducing the high aluminum content of the surface alloyage and weakening the resistance to carburization. The alloying elements, such as chromium and nickel, tend to prevent the continued migration of the aluminum under heat during use and to maintain the initial high aluminum concentration at the surface of the metal. For this, among other reasons, we prefer to use an alloy steel for our carburizing box.

While the surface aluminum alloyage may be secured by various processes of surface aluminization, the treatment of the box will be specifically described with reference to surface aluminizing by the well-known dip calorizing method.

The resistance of the alloy steel to the penetration of the aluminum makes it preferable to modify the usual dip calorizing process and to subject the box before use to a temperature considerably in excess of the temperature encountered in carburizing.

In ordinary dip calorizing, the articles after being cleaned and preferably fluxed with an aqueous solution of calcium chloride, are dipped into a bath of molten aluminum which wets the surface. According to the usual process the articles, if they are to be subjected to high temperatures, may be placed immediately in service, the high temperatures serving to drive the aluminum coating into the articles and to complete the surface aluminization in service. If the articles are not to be subjected to immediate high temperatures in service, the aluminum may be driven into the surface by heating in an oven or retort. The temperatures employed in such retort have been usually about 1700° Fahrenheit.

We have found that, in using an alloy steel, such, for example, as a chromium-nickel steel, if the articles are calorized in the usual way as described above where the steel is heated to a temperature of about 1700° Fahrenheit, the alloying is incomplete and the aluminum tends to flake off the surface. We believe this to be due to the resistance of the nickel-chrome steel to the penetration of the aluminum under such temperature. We therefore prefer in calorizing our carburizing box to dip the box in molten aluminum in the usual way and then before use, to place it in a retort or oven and heat it to a temperature of about 2000° to 2200° Fahrenheit for a period of thirty minutes or more. While this temperature is preferably above 2000° Fahrenheit, it may be somewhat less, as for example, 1900° Fahrenheit, but should be materially higher than the temperature to which the box is to be subjected in service. We have found that this higher temperature drives the aluminum into the surface of the chrome-nickel steel, giving the penetration usual in the calorizing of mild plain steels, say, in the neighborhood of one-hundredth

of an inch. The aluminum as thus driven in does not tend to flake off.

This superheating of the box before use seems to drive the aluminum into the surface of the nickel-chrome steel to a greater degree than it would be by the lower and usual temperatures heretofore employed in calorizing. The resistance to penetration of the aluminum afforded by the alloying metals, however, greatly retards, if not prevents, a continued penetration or migration of the aluminum into the steel at the lower temperatures to which the box is subjected in the carburizing furnace, and thus the alloying elements, such as nickel and chromium, tend to maintain the high surface concentration of the aluminum which effectively seals the surface against carburization.

We have found that the surface aluminizing applied to the interior of the box renders the steel practically immune to carburization, making our box in this respect equal to, if not superior to, the boxes made from high nickel high chromium alloys, which, although highly resistant to carburization, are still very slowly carburized. The outside of the box is preferably surface aluminized, as well as the inside, because of convenience in treatment by the dipping process, and also in order to give the outside of the box additional protection against oxidation and attack of sulphurous gases in the products of combustion of the carburizing furnace.

The outside of the carburizing box is ordinarily subjected to severe mechanical knocks and abrasion in handling the boxes and putting them in and out of the furnace, so that in time the outside aluminized surface becomes chipped off in spots exposing the metal beneath. For this reason we prefer to use as the underlying metal a steel containing sufficient alloying elements, such as nickel and chromium, to render it resistant or at least slowly attackable by the furnace gases. Since the attack of the furnace gases can occur only in limited areas where the aluminum alloyed surface has been chipped or abraded in handling, it is not necessary, although it is preferable, to make the metal fully resistant to the attack of the furnace gases. In a low priced box a minimum amount of nickel and chromium can be used to render the oxidizing effect of the gases gradual. In fact, a box can be made of a plain mild steel surface aluminized inside and out which will give a performance much superior to a plain steel box, since the inside is rendered immune to carburization and the outside is protected against oxidation until mechanical abuse has abraded the surface, and even then the outside is protected except for the limited areas where the underlying metal is exposed. Our carburizing box may be made at a low cost because of the possibility of using low alloy steels or even plain steels. The interior of the box is rendered practically immune to carburization by the aluminized surface, which, on the interior of the box, is not subjected to severe mechanical abuse. The outside of the box is rendered immune to the attack of the oxygen and sulphurous gases by the aluminum alloyed surface, and when an alloy steel is employed it is rendered immune to such attacks even at the places where the aluminized surface may be chipped or abraded.

The copending application, Serial No. 366,747, filed of even date herewith by Bertram J. Sayles, one of the present applicants, contains claims directed to surface aluminized alloy steel oil still tubes, and particularly still tubes which are formed of alloy steel containing insufficient alloying metal to render the steel resistant to oxidation at high temperatures. The claims in the present application are directed specifically to carburizing boxes, and particularly to a carburizing box formed of an alloy steel containing sufficient nickel and chromium to render the steel, of itself, resistant to oxidation at high temperatures although not resistant to carburization.

While we have specifically illustrated and described the preferred embodiment of our invention, it is to be understood that the invention is not so limited but may be otherwise embodied and practiced within the scope of the following claims.

We claim:

1. A carburizing box having an aluminum alloyed interior surface resistant to carburization at high temperatures.

2. A carburizing box having its inner and outer surfaces aluminized and thereby rendered resistant to carburization and oxidation at high temperatures.

3. A carburizing box of an alloy steel resistant to oxidation at high temperatures and having its inner surface aluminized and thereby rendered resistant to carburization.

4. A carburizing box of an alloy steel resistant to oxidation at high temperatures but not of itself resistant to carburization at high temperatures, and having its inner surface aluminized and thereby rendered resistant to carburization.

5. A carburizing box of an alloy steel resistant to oxidation at high temperatures and having its inner and outer surfaces aluminized, whereby the interior of the box is rendered resistant to carburization, the exterior of the box being resistant to oxidation even when subjected to mechanical abrasion.

6. A carburizing box of a chrome-nickel alloy steel which is resistant to oxidation at high temperatures and having its inner surface aluminized and thereby rendered resistant to carburization.

7. A carburizing box of a chrome-nickel alloy steel containing about 20% chromium

and about 8% nickel, and having its inner surface aluminized and thereby rendered resistant to carburization.

In testimony whereof we have hereunto set our hands.

BERTRAM J. SAYLES.
HARRY SCHULTZ.