This application is a substitute for and continuation of my application Serial No. 297,035, filed August 2, 1928.

The invention relates to means for the heat treatment of steel, and more particularly what is known as high speed steel, incidentally to hardening the same, and has for its object the provision of means, practically usable under commercial conditions, designed to prevent the formation of any substantial oxidizing scale on the steel, while at the same time leaving without substantial change the carbon content of the steel. The preferred manner of use of the apparatus is an exemplary embodiment of a method claimed in my application Serial No. 494,995, filed Nov. 11, 1930.

What is known as “high speed” steel has a low carbon content, the amount of carbon usually approximating 7% of 1% or thereabouts. Small changes in the carbon content substantially alter the properties of the steel. High speed steel also ordinarily contains a substantial proportion of tungsten, varying from 5% to 25%, but commonly approximating 15% or 20%, with this there being frequently alloyed lesser quantities of chromium, vanadium, cobalt or manganese, although the exact constituency of the steel and the proportions of these various metals when present therein are subject to wide variations.

While ordinary carbon tool steel may be hardened at temperatures approximating 1400° F., high speed steel requires substantially higher temperatures, usually in excess of 2000° F. and commonly approximating 2300° F. or thereabouts, which is only slightly under the melting temperature of the steel. When the high speed steel is heated at the required temperature, whether heated in a gas, oil, electric or other furnace, the contact of the air with the heated steel forms an oxidizing scale of substantial depth. After the hardening operation, this scale must be removed, introducing an item of substantial expense in the heating and hardening process. In the case of finely dimensioned tools, such as taps, dies, reamers and the like, the scale must not only be subsequently removed but must be previously allowed for in the manufacture of the unhardened tool. Since the depth of the scale is subject to wide variations under slightly different conditions of heat treatment, it is difficult to carry out the heating and hardening operation with any uniformity in respect to the depth of the scale and frequently difficult to do so within the range of allowable tolerances. If the heating is carelessly done the depth of the scale may be such as to render the tool useless for its intended purpose.

Various expedients have been proposed to prevent or limit the formation of the scale in hardening high speed steel, but those herefore employed either have been impracticable for continued use on a commercial scale or have had a tendency to alter the carbon content of the steel by increasing it and thereby rendering it more brittle or diminishing it and thereby rendering it softer. High speed steel is susceptible to slight changes in the carbon content due to its relatively small amount of carbon. If any substantial amount of carbon is removed the steel immediately below the surface displays marked soft characteristics. If its carbon content is substantially increased it becomes brittle.

I have found that a neutral or non-oxidizing atmosphere may be maintained about the steel while it is being heated precluding the formation of any substantial scale or limiting it to an immaterial depth by confining the same in a chamber having walls of suitable carbonaceous material so proportioned with respect to the article being treated that a neutral atmosphere will be generated about the article and maintained thereabout in a stagnant condition during the heating operation. Any material change in the carbon content of the steel is avoided. The process and articles are such as to make them adaptable to the hardening of articles of high speed steel on a commercial scale.

The invention will be best understood by reference to the following description when taken in connection with the accompanying illustration of one specific embodiment there-
of, while its scope will be more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a cross-sectional elevation taken on the line 1—1 in Fig. 2 through a heating furnace equipped with a container embodying one form of the invention, and herein suitable for the heat treatment of small, high-speed tools; and

Fig. 2 is a longitudinal section in elevation of the furnace shown in Fig. 1 taken on the line 2—2 of Fig. 1.

Referring to the drawings and to the embodiment of the invention which is there submitted for illustrative purposes, there is shown a conventional form of furnace 5 having a heating chamber 7 within which the necessary range of temperature may be maintained for heating high speed steel incidentally to the hardening of the same.

For heat treating the steel 9, which may be taken by way of example to be drills composed of high speed steel and intended to be hardened, there is provided a protector in the form of a jacket or container comprising the block 11 in which there are drilled a series of holes 13, one for each tool, and providing for each a chamber of slightly greater length than the length of the tool. Each chamber is also of somewhat greater diameter than that of the tool thereby leaving a small clearance, so that the steel pieces may be readily inserted in place or withdrawn after they have been heated by means of a pair of tongs or a "spoon".

The jacket or container is formed of suitable carbonaceous materials substantially infusible at the temperature employed but adapted, presumably by the slow combustion of the inner wall of the chamber adjacent the article being treated, to generate a neutral atmosphere about the tool which atmosphere remains stagnant in the recess and not subject to being swept out by convection currents.

In accordance with the provisions of the statute I will state the best method now known to me for manufacturing the container. Preferably I utilize a mixture of soft graphite of the kind commonly employed in the manufacture of dynamo brushes and relatively hard coke carbon, the two materials being thoroughly mixed together and compressed into a hard body relatively impervious in the sense that it prevents any substantial passage of air therethrough under atmospheric pressure. Utilizing materials of the kinds described as obtained commercially on the market, the preferred proportions are from 10% to 80% of graphite and from 90% to 70% of coke carbon. Good results are had with 15% of graphite and 85% of coke carbon. In some instances an excess of graphite tends to increase the carbon content of the steel and render it brittle, while too little graphite, on the other hand, tends to reduce the carbon content leaving the steel soft. Carbonaceous materials, however, vary in practice and I have in some instances obtained good results with graphite omitted. The example given is therefore not to be considered as a limitation. A simple practical test will determine the adaptability of the material or mixture of materials in any given instance.

As I understand the functioning of the treatment described, when the tool is placed in a recess of the block of material of this nature with a restricted clearance between the tool and the walls of the container, there is no substantial contact which would cause a chemical reaction which would vary the composition of the steel. At the same time the slight combustion of the interior wall of the chamber generates a neutral atmosphere surrounding the steel which is maintained during the heating process obviating the formation of objectionable scale when subjected to the high temperatures required. This atmosphere will contain a considerate fraction of carbon monoxide. Tests indicate that this fraction may be in the neighborhood of about 25% or more and in volume about ten times the carbon dioxide present.

In the course of time the intense heat will gradually burn away the material, breaking down the walls or rendering them porous, and when this stage is reached, the worn-out jacket should be discarded and replaced by a new one. The effective life of the container, however, is mainly prolonged by surrounding it by a covering of refractory material minimizing combustion at the exterior surface thereof. For this purpose there is shown in the drawings a casing 15 enclosing the jacket 11 having its open end extending somewhat beyond the open end of the jacket and both open ends facing the door 17 of the furnace. Any suitable refractory material may be employed for the jacket, such, for example, as alumina. While I have shown a container in the form of a block provided with a plurality of chambers, a form which is convenient for use in simultaneously heat treating and hardening a series of small tools, each piece of steel may be encased in its own separate container, or more than one piece may be inserted in a single chamber, and the size and shape of the chamber and of the container may be varied to adapt it to the particular work to be treated.

In carrying out this process the steel is manipulated in the usual manner. The furnace door being opened, the steel pieces are inserted in the open end of the jacket by means of a spoon or pair of tongs, and the steel then heated for a period of time, which will depend on the particular object to be hardened. After a sufficient time has elapsed to bring the steel to the required tem-
temperature, the door is again opened and each 
piece of steel withdrawn from its chamber 
within the jacket and immediately plunged 
into the hardening bath.

While I have herein shown and described 
for the purposes of illustration one specific 
embodiment of the invention and one partic-
ular mode of carrying out the process, it is 
to be understood that extensive deviations 
may be made therefrom, all without depart-
ing from the spirit thereof.

Claims

1. As a new article of manufacture, a con-
tainer to receive one or more tools of high 
speed steel during their heat treatment in a 
furnace to a temperature in the neighborhood 
of 2300° F., said container consisting of a 
block of substantially infusible carbonaceous 
material chambered to provide a recess closed 
at one end and proportioned to receive the 
work with a restricted clearance providing a 
space in which a limited combustion of the 
material of the container may establish about 
the work a stagnant atmosphere containing 
a substantial fraction of carbon monoxide.

2. As a new article of manufacture, a con-
tainer to receive one or more tools of high 
speed steel during their heat treatment in a 
furnace to a temperature in the neighbor-
hood of 2300° F., said container consisting 
of a block of substantially infusible carbo-
naceous material chambered to provide a re-
cess closed at one end and proportioned to 
receive the work with a restricted clearance 
providing a space in which a limited combus-
tion of the material of the container may es-
ablish about the work a stagnant atmosphere 
containing a substantial fraction of carbon 
monoxide, said block having a refractory 
exterior cover to at least minimize combus-
tion thereof at the exterior walls.

3. A protector for heat-treating high speed 
steel comprising a body of imporous material 
composed of a mixture of a quantity of 
graphite and a greater quantity of relatively 
hard carbon, said body having a chamber 
adapted to receive the steel, said chamber be-
ing of greater size than the article to be 
treated thereby to permit the maintenance of 
a neutral atmosphere about the same.

4. A protector for heat-treating high speed 
steel comprising a body composed of approx-
imately 10% to 30% of graphite and from 
90% to 70% of relatively hard carbon, said 
body having a chamber adapted to receive the 
steel, said chamber being of greater size than 
the article to be treated thereby to maintain 
a neutral atmosphere about the steel.

In testimony whereof, I have signed my 
name to this specification.

MURRAY WINTER.