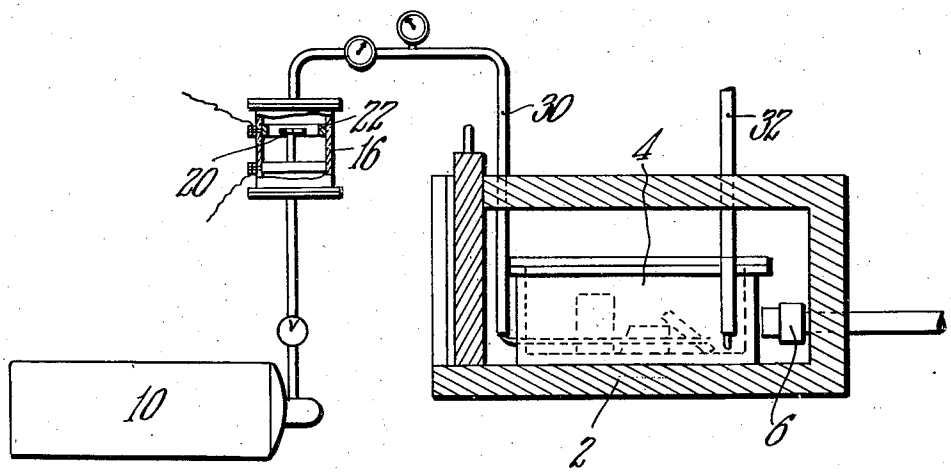
Sept. 25, 1934. V. T. MALCOLM 1,975,064

TREATMENT OF FERROUS METALS

Filed May 19, 1934




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Patented Sept. 25, 1934 1,975,064

# UNITED STATES PATENT OFFICE

1,975,064

## TREATMENT OF FERROUS METALS

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Application May 19, 1934, Serial No. 726,481

3 Claims. (Cl. 148—16)

This invention relates to improvements in the treatment of ferrous metals and is directed more particularly to improvements in the hardening of ferrous metals.

It is the principal object of the invention to provide a process for hardening ferrous metals which is more rapid and yet more efficient than any process heretofore known. It is a further object of this invention to provide a process for successfully and readily hardening ferrous materials of all kinds.

It is also a particular advantage of my new process that a wide range of temperatures may be used. That is to say, according to the process of this invention the temperatures used may vary greatly from approximately 850° F., to 1600° F., according to the depth of case desired.

Another object of this invention is to provide ferrous metals with a case which is not only hard and extremely resistant to wear but which is noncorrosive. I have found that ferrous articles treated by my process are not affected unfavorably by salt spray, steam, alkaline solutions, furnace gases or other atmospheric elements.

The process of this invention broadly consists of delivering substantially nascent nitrogen to a furnace containing the articles to be treated and maintaining the heat in the furnace at a desirable temperature until the nitrogen has combined with the metal. The nascent nitrogen is obtained by dissociating some nitrogen-containing substance, such as ammonia gas, which may be readily broken up into its constituents, nitrogen and hydrogen.

According to my new process it is possible to efficiently harden ferrous materials regardless of their alloy content. That is to say, as contrasted with the well-known nitriding process which is used only in connection with special steels having a particular combination of alloyed elements, the process of this invention is adapted to rapidly harden ferrous articles of various analyses.

Furthermore, while the nitriding temperatures are relatively low temperatures, ranging from 900° F. to 1100° F., with 950° F. being the most common, the temperature range of this process is considerably wider and it is possible to treat metals thereby as high as 1600° F. or over.

A further economic advantage of my new process is that it is not necessary to heat-treat or otherwise work upon the metals prior to the hardening operation. As is well-known, in the case of nitriding, it is not only necessary to heat-treat the metal prior to the nitriding step, but all scale resulting from forging or the heat treatment must be completely removed from the surfaces of the materials. Also, while the producing of a hardened case by means of the nitriding process takes approximately 90 hours, my process is more rapid and takes only from 4 to 10 hours.

Various other novel features and advantages of the invention will be hereinafter referred to in connection with the accompanying description of the preferred form of the invention wherein reference will be had to the accompanying drawing for illustrative purposes only. In the drawing, there is shown in a diagrammatic way one form of apparatus for carrying out the novel process of the invention. However, it will be understood that various forms of apparatus may be employed which are capable of producing the desired result.

Referring now to the drawing in detail, the invention will be more fully described.

A furnace is shown at 2 and this preferably has a pot 4 therein for containing the articles to be treated. 6 represents a nozzle or other means for supplying the heat to the furnace. The furnace may be heated in innumerable ways, of course, but gas, oil, and electricity have been found to be particularly satisfactory, with electricity the most efficient.

A container or tank is indicated at 10 and this contains the nitrogen-containing substance, which, as stated above, is preferably ammonia gas. Connected to the supply tank 10 as by a pipe 12 is what may be called an ionizing or dissociating unit 14, which will now be described in a general way but is more fully disclosed in my pending application Serial No. 691,379, filed September 28, 1933.

This unit 14 is intended and adapted to dissociate the nitrogen-containing substance which is delivered thereto from the tank 10 and it preferably consists of a closed chamber 16 having an inlet at its lower side for receiving the pipe 12 and an outlet at its upper side. Inner and outer electrodes 20 and 22, respectively, are provided within the chamber the latter of which is in the form of a ring and they are connected to a source of electrical energy. The unit is preferably so arranged that the current is of such a nature that a silent discharge is obtained. By silent discharge is meant a glow or corona effect as distinguished from an arc as is set forth in my pending application referred to and this is obtained by a relatively low amperage and high voltage. In this way, the ammonia gas may be broken up into its constituent elements, namely, nitrogen and hydrogen.

The constituent gases are then led from the ionizer 14 into the furnace 2 by means of a pipe

such as 30. This pipe is preferably arranged so that it directs the gases to the lower side of the pot 4 as shown in the drawing.

It is desirable that the ionizing unit 14, which comprises an essential element of the apparatus of this invention, be located relatively close to the furnace to which the nascent nitrogen is to be delivered. It may be seen that in this way the nescent nitrogen may act most effectively upon the articles within the pot.

An outlet such as a pipe 32 leads from the pot to carry off the freed hydrogen and/or other unwanted gases.

As it has been stated above, it is a particular advantage of the process of this invention that ferrous metals of any composition may be hardened thereby. That is to say, as contrasted with prior art hardening processes, the process of this invention successfully hardens what may be called "ordinary steels" as contrasted with what are commonly referred to as "special steels". Furthermore, relatively less expensive steels may be treated by my novel process to have the hardened qualities of more expensive steels.

As one example of the results of this process, I have hardened ferrous metal containing about .35 to .45% carbon, .50 to .80% manganese, .80 to 1.10% chromium and .15 to .20% vanadium. This metal was heated to approximately 1200° F., in the presence of nascent nitrogen and a case of .015 was obtained in the short time of four hours.

As another example, I placed what is commonly referred to as low-carbon steel in the furnace above described and led nascent nitrogen thereinto. The metal was heated in the presence of the nitrogen to approximately 1200° F., and a case of .008 was obtained in four hours, a substantial decrease in the time required by prior art processes.

It may be seen then that the process of this invention more rapidly and effectively brings about a combining of free nitrogen with ferrous metal. By means of the ionizer unit, a nitrogen-containing substance is quickly dissociated so that active, nascent nitrogen may be readily brought into contact with the parts to be treated.

It may also be seen that it is a particular advantage of this process that the hardening is accomplished by a single treating step and such prior and subsequent steps as pre-heating, quenching and the like are not necessary. By obviating the need for such steps, of course, the cost of production is considerably lessened.

While I have described my invention in great detail and with respect to a preferred form thereof, it is not desired to be limited thereto since many changes and modifications may be made therein without departing from the spirit and scope of the invention.

What it is desired to claim and secure by Letters Patent of the United States is:

1. A process for surface hardening articles of ferrous metals which consists in, confining an article of ferrous metal to be hardened in a closed chamber, maintaining the same at a nitriding temperature, leading ammonia gas into said chamber and immediately prior thereto passing substantially all of said gas through a silent electrical discharge whereby the gas is substantially all dissociated and substantially free, nascent nitrogen is supplied the chamber.

2. A process for surface hardening articles of ferrous metals which consists in, confining an article of ferrous metal to be hardened in a closed chamber, maintaining the same within a nitriding temperature range from 850° F. to 1600° F., leading ammonia gas into said chamber and immediately prior thereto passing substantially all of said gas through a silent electrical discharge whereby the gas is substantially all dissociated and substantially free, nascent nitrogen is supplied the chamber.

3. A process for surface hardening articles of ferrous metals which consists in, confiing an article of ferrous metal to be hardened in a closed chamber, maintaining the same within a nitriding temperature range from 850° F. to 1600° F., leading ammonia gas into said chamber and immediately prior thereto passing substantially all of said gas through a closed chamber and a space between electrodes which are connected to a source of electric energy whereby substantially all of said gas is subjected to a silent electrical discharge and is substantially all dissociated to supply substantially free, nascent nitrogen to said chamber.

VINCENT T. MALCOLM.