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METHOD OF NITRIDING FERROUS ALLOYS
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Fig. 1

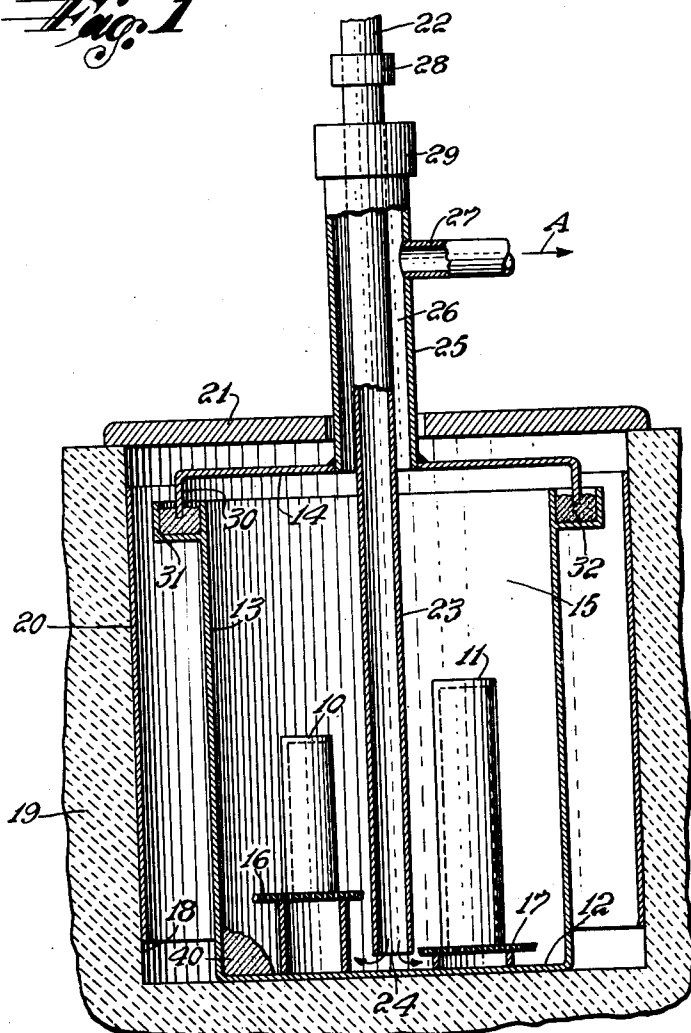
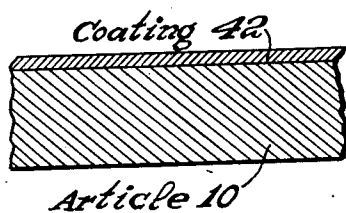


Fig. 2



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1

2,789,930

METHOD OF NITRIDING FERROUS ALLOYS

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9 Claims. (Cl. 148—16.6)

This invention is directed broadly to the art of nitriding articles of ferrous alloys having a high chrome content. Such nitriding is highly desirable as it provides a hard surface (nitriding is at this writing customarily to a depth of .0005" to .03") having excellent wear-resistance characteristics and especially desirable for precision articles such as gear teeth and other parts which are thus provided with a hardened surface and with a tough underlying core of the chrome alloy. Such ferrous alloys of high chrome content, however, have been found to be resistant to, and heretofore required special treatment to prepare the same for, the nitriding operation. One prevailing theory as to the reason for the resistance of stainless steel alloys to nitriding is that the chrome in the alloy forms a chrome oxide surface coating which serves as a barrier to nitriding. It has thus been found, in the case of articles of stainless steel, that such articles must first be treated outside the furnace to remove the coating or barrier and then immediately placed in the furnace, before there is a chance for the coating to re-form, followed by another special procedure in the furnace of several hours' duration, before commencement of the actual nitriding operation.

The foregoing objections are obviated by the novel method and apparatus of this invention, below more particularly pointed out, pursuant to which the articles to be nitrided are placed within the furnace without any special prior treatment, and then the furnace is brought up to nitriding temperature in accordance with the usual nitriding-cycle practices; the articles are automatically prepared for and nitrided without requiring special pre-treatment or special further handling or treatment in the furnace.

In the drawings:

Fig. 1 is a vertical sectional view showing an apparatus adapted for carrying out the method of this invention, and

Fig. 2 is a schematic, enlarged sectional view of an article of high chrome alloy 10, having a nitriding inhibiting film or surface 42.

The drawing illustrates the application of the invention to articles 10, 11 to be nitrided. Such articles may be of any miscellaneous form; those shown in the drawing are illustrative only. The articles are of a ferrous alloy having a high chrome content, such as stainless steel articles. They are placed on a supporting surface 12 or the like which, with the side walls 13 and top wall 14, define the chamber 15 within which said articles to be nitrided are positioned. The articles may be disposed on wire screen or other supports 16, 17, which in turn may be either positioned on the surface 12 or otherwise secured interiorly of chamber 15. The chamber 15 is disposed in an opening 18 of a furnace 19 which may have suitable heating elements 20; opening 18 is normally substantially closed by a cover member 21 of suitable configuration.

Ammonia gas is circulated in the chamber 15 and around the articles 10, 11 therein by suitable means, as, for example, by providing a source 22 for the ammonia

2

gas, connected to suitable ammonia cylinders, tanks or other reservoir. The ammonia gas is pumped or otherwise passed through pipe 23 and out of the discharge outlet 24 thereof preferably adjacent the bottom wall 12 of the chamber 15. The pipe 23, above chamber 15, is disposed within a housing 25 with which said pipe defines a conduit 26 through which the ammonia gas may escape after circulating through chamber 15 and into discharge pipe 27 leading to the atmosphere as indicated by the arrow "A." The pipe 23 may be coupled to the source 22 by suitable coupling 28 and sealed to the housing 25 by a collar 29. The connection between the top wall 14 and side wall 13 of chamber 15 may assume any convenient or desired form, that shown in the drawing, comprising a downturned flange 30 on the top wall 14 received within an upturned flange 31 of side wall 13 and preferably sealed therein by a suitable sealing medium 32.

It will be apparent that by this arrangement, initially the cover 21, then pipe 23, housing 25 and top wall 14 (which may be welded to the housing 25) may be lifted clear of the furnace. The objects (10, 11 etc.) to be nitrided may then be inserted into chamber 15, which would then be closed as noted in Fig. 1. Pursuant to the present invention there is placed in the furnace, along with the work, a mass 40 such as mineral wool or other light, inert material such as silicon carbide wool, previously soaked with hydrochloric acid. By way of example only of one form found convenient for the carrying out of this invention, and without limiting the same thereto, a mass 40 of wool of two or three cubic inches may be placed in a chamber 15 of three cubic feet after first moistening the mass 40 with 10 to 15 grams of 50% (mild) hydrochloric acid.

The mass 40 is preferably placed in chamber 15 adjacent the point 24 of first entry of the ammonia gases therein and preferably adjacent the wall 13 so as to be close to the source of heat. The furnace heating elements 20 are energized to bring the furnace to its operating temperature (920 degrees to 1150 degrees F.) for 1 hour to 96 hours, to nitride the articles 10 and 11 in the furnace.

It is believed that this invention operates pursuant to this phenomenon: The hydrochloric acid fumes emanating from mass 40 combine with the ammonia gas sweeping through chamber 15, forming ammonium chloride fumes or vapor which sweeps over articles 10, 11. As the furnace heating cycle is initiated, the parts 10 and 11 being dense, will come up to heat slowly, with the result that the surfaces of articles 10 and 11 will probably initially be about 35 or 40 degrees F. behind the temperature of mass 40. The ammonium chloride vapors condense on the entire surface of articles 10, 11 in a uniform fashion and attack the chrome oxide film barrier thereon. As the furnace continues to come up to heat, the ammonium chloride fumes continue to condense on the articles and attack the chrome oxide film until the articles approach their nitriding temperature, at which time the higher or increased temperature of the articles will volatilize the ammonium chloride condensate film; the article surfaces will then be cleanly exposed (without the barrier surface 42) to the continuously swept ammonia gas circulated through the chamber 15; clean nitriding of the surfaces of articles 10 and 11 is thus automatically attained as the furnace comes up to heat. The ammonia gas sweeps the volatilized ammonia chloride gas out of the discharge opening 27 of chamber 15.

It will be noted that the operation is completely automatic and dispenses with any need for special or previous handling of the articles.

The mass 40 has been described above as saturated with hydrochloric acid prior to its insertion in the cham-

3

ber, for the purpose mentioned. Hydrochloric acid has been found suitable for the purpose as (1) it is believed to readily combine with ammonia gas to form a new compound which will effectively attack the oxide coating, and (2) the newly formed compound is believed to readily condense on the articles to be nitrified prior to their being brought up to their nitriding temperature, and to effectively attack the oxide coating thereon, and (3) the newly formed compound is believed to readily volatilize off said articles as they approach their nitriding temperature so as to enable the nitriding operation to be proceeded with. Compounds and compositions other than hydrochloric acid may be used for the purpose pursuant to this invention provided they meet the requirements specified above.

The compound to be combined with ammonia may be other than an acid, provided it meets the requirements above specified, and it may be introduced into the chamber by means other than by saturation of a mass, if desired, although the saturated mass technique, above described, has been found to be highly satisfactory.

I claim:

1. The method of preparing, for nitriding, an article of a ferrous alloy including chrome and having a film of chrome oxide serving as a nitriding barrier, comprising positioning said article in a chamber, circulating ammonia gas around said article in said chamber, moistening a mass with hydrochloric acid, positioning said mass in said chamber in spaced apart relation to said article, heating said chamber to progressively heat the article up to its nitriding temperature, whereby hydrochloric acid fumes of said mass will combine with the ammonia gas to form ammonium chloride vapors which will condense on the surfaces of said article and attack the chrome oxide coating thereof, and progressively heating said chamber to progressively bring the article up to its nitriding temperature, whereby the previously condensed ammonium chloride vapors volatilize from said article so that nitriding may be proceeded with on circulating ammonia gas onto said article.

2. In the method set forth in claim 1, the further step of so circulating said ammonia gas around said article by introducing said gas into said chamber from a point below the article and providing an exhaust for said gas above the article, to thereby circulate said gas around said article and out of the chamber.

3. In the method set forth in claim 2, the further step of disposing the mass intermediate the points of entry and discharge of the ammonia gas so that the hydrochloric vapors may combine with the ammonia gas and be swept therewith around the article in the movement of said ammonia gas through the chamber.

4. In the method set forth in claim 3, the further step of disposing the mass adjacent the wall of the chamber through which the furnace heat is passed said mass being of a material which will more rapidly absorb heat than said article.

5. In the method set forth in claim 2, the steps of disposing said article inwardly of said wall and above the bottom wall of the chamber and disposing the mass at the junction of the bottom and side walls of the chamber.

6. In the method set forth in claim 1, said mass being silicon carbide wool.

4

7. The method of preparing for nitriding, an article of a ferrous alloy including chrome and having a film of chrome oxide serving as a nitriding barrier, comprising positioning said article in a chamber, circulating ammonia gas around said article in said chamber, positioning a mass moistened with hydrochloric acid in said chamber in spaced apart relation to said article, said mass being of less density and of more rapid heat absorbing properties than said article, heating said chamber to the nitriding temperature of said article, and continuing to pump ammonia gas through said chamber, whereby said hydrochloric acid will first combine with the ammonia gas to form ammonium chloride vapors which will condense on the surfaces of said article and attack the chrome oxide coating thereof, and, as said article reaches its nitriding temperature, will volatilize therefrom so that nitriding may be proceeded with.

8. The method of preparing for nitriding, an article of a ferrous alloy including chrome and having a film of chrome oxide serving as a nitriding barrier, comprising positioning said article in a chamber, circulating ammonia gas around said article in said chamber, introducing an acid into said chamber in spaced apart relation to said article, said acid being one that will combine with ammonia to provide a new compound which will attack the chrome oxide film and which will not volatilize below the nitriding temperature of said article, heating said chamber to the nitriding temperature of said article, and continuing to pump ammonia gas through said chamber, whereby said acid will first combine with the ammonia gas to form ammonium vapors which will condense on the surfaces of said article and attack the chrome oxide coating thereof, and, as said article reaches its nitriding temperature, will volatilize therefrom so that nitriding may be proceeded with.

9. The method of preparing for nitriding, an article of a ferrous alloy including chrome and having a film of chrome oxide serving as a nitriding barrier, comprising positioning said article in a chamber, circulating ammonia gas around said article in said chamber, introducing hydrochloric acid into said chamber in spaced apart relation to said article, said acid being one that will combine with ammonia to provide a new compound which will attack the chrome oxide film and which will not volatilize below the nitriding temperature of said article, heating said chamber to the nitriding temperature of said article, and continuing to pump ammonia gas through said chamber, whereby said acid will first combine with the ammonia gas to form ammonium vapors which will condense on the surfaces of said article and attack the chrome oxide coating thereof, and, as said article reaches its nitriding temperature, will volatilize therefrom so that nitriding may be proceeded with.

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