Dec. 16, 1952 M. S. ROUSH 2,622,043

CHROMIZING PACK AND METHOD

Filed Sept. 30, 1949

Fig. 1

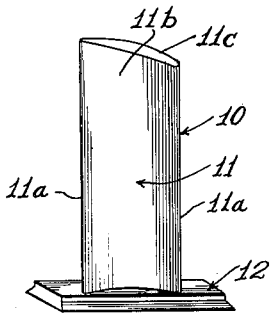


Fig. 2

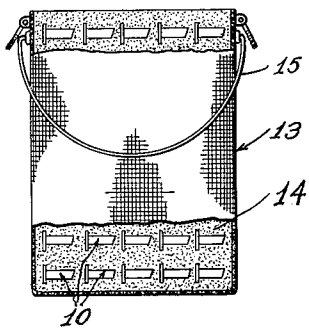


Fig. 3

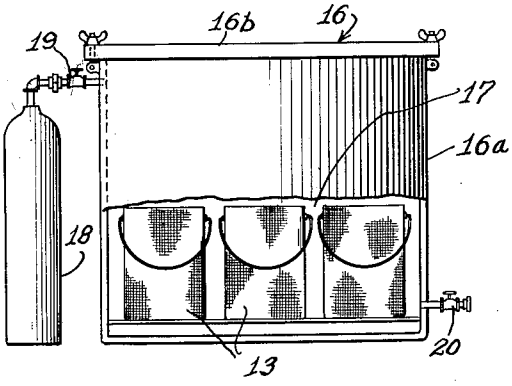


Fig. 5

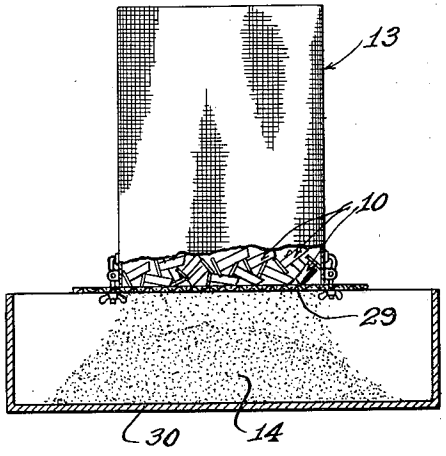


Fig. 4

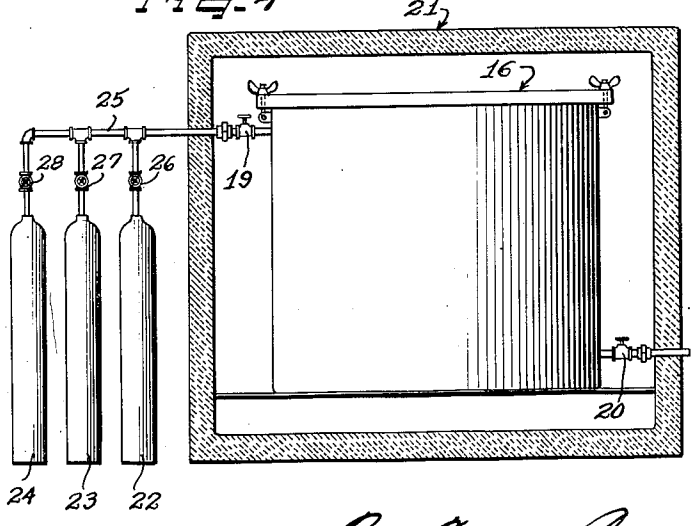
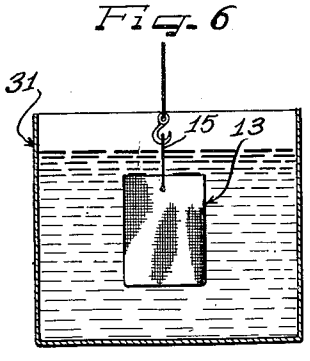


Fig. 6



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CHROMIZING PACK AND METHOD

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8 Claims. (Cl. 117—107)

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This invention relates to the chromium cementation or chromizing of ferrous metal articles while protecting the articles against pitting or erosion.

Specifically, the invention deals with the chromizing of copper-infiltrated powdered iron articles such as compressor blades for turbo-jet engines wherein the articles are packed in a mixture of chromium or ferrochromium particles and titanium dioxide particles.

While the invention will hereinafter be specifically described in its preferred embodiment of chromizing copper-infiltrated powdered iron jet engine blades, it should be understood that the invention is not limited to the chromium cementation or chromizing of any particular shape of ferrous metal article, nor to articles composed of powdered iron.

Heretofore known chromizing processes have involved the use of chromium or ferrochrome granules or powder in admixture with porous materials such as unglazed porcelain, sillimanite, or the like, for extending the particles to permit free passage of reactive gases or to absorb the liberated ferrous chloride. Such processes, however, have had a deleterious effect upon the finish of the articles being chromized and have caused these articles to erode irregularly, thereby producing roughness in the surface.

According to this invention, the heretofore encountered erosion is entirely avoided by the addition of titanium material including titanium metal, a titanium compound such as titanium dioxide (which may be in the form of titanium ore), titanium tetrachloride, or the like. If titanium metal or the liquid titanium tetrachloride is used, it should be coated on an inert carrier such as a ceramic material. To prepare the chromizing pack, the titanium material is admixed with the ferrochrome particles and is preferably coated on those particles. It thereby prevents intimate contact of the ferrochrome with the article and eliminates localized pitting of the article by diffusing the liberated chromous chloride. The pack should be porous and allow free passage of gas, and since titanium dioxide is of a sponge-like absorptive nature and causes uniform distribution of the reactive gases through the chromizing pack, it is a preferred titanium material. Further, the titanium dioxide will also act as an absorbing medium for liberated ferrous chloride produced during the chromizing reaction. The absorbed ferrous chloride will thereby be removed from the surface of the article and cannot attack the article. In the case of copper-infiltrated powdered iron articles or copper containing iron alloys, the titanium material will react with the copper and produce a corrosion-resistant alloy. Since copper-titanium alloys are resistant to chloride attacks, the article is further protected.

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It is, then, an object of this invention to provide a chromium cementation or chromizing pack containing a titanium material which will prevent erosion or pitting of an iron article embedded in the pack during a chromizing process.

Another object of the invention is to provide a method of chromium cementation wherein a titanium material is effective to preserve the original finish of the articles being treated.

A still further object of this invention is to provide a chromizing pack composed of ferrochrome and titanium dioxide.

Another object of this invention is to provide a chromizing method wherein titanium dioxide is used to protect the articles being chromized.

Other and further objects of the invention will become apparent to those skilled in the art from the following detailed description of the annexed sheet of drawings which, by way of a preferred example only, illustrates one method of this invention.

On the drawings:

Figure 1 is a perspective view of a compressor blade for a turbo-jet engine or the like which is chromized in accordance with the preferred embodiment of this invention;

Figure 2 is a vertical cross-sectional view of a chromizing basket showing the compressor blades of Figure 1 embedded in the chromizing pack of this invention;

Figure 3 is a diagrammatic cross-sectional view, with parts in elevation, illustrating a retort in which the baskets of Figure 2 are treated;

Figure 4 is a diagrammatic vertical cross-sectional view, partly in elevation, illustrating the heating of the retort in a furnace in accordance with this invention;

Figure 5 is a somewhat diagrammatic view, partly in cross section, illustrating the manner in which the chromizing pack material is removed from the basket after the heat treatment; and

Figure 6 is a diagrammatic view illustrating the washing of the chromized compressor blades in the basket.

As shown on the drawings:

As shown in Figure 1, a compressor blade 10 composed of a vane or air foil portion 11 and an anchoring root 12 is suitably chromized in ac-

cordance with the preferred embodiment of this invention. The blade 10 is composed of powdered iron infiltered with copper. The blade 10 preferably has an iron content of about 70 to 90% and a copper content of about 10 to 30%. The blade is produced by compacting iron powder in a die at high pressures to form the molded iron compact in the shape of the blade. The compact is then heated in contact with copper in a dry, protective atmosphere and the copper is quickly infiltrated throughout the body of the compact. The resulting copper-infiltered compact can then be coined to the desired shape and heat treated to impart desired metallurgical properties thereto.

It will be noted that the vane portion 11 of the blade 10 has very thin leading and trailing edges 11*a*, 11*a*, a concave face 11*b*, and a convex face 11*c*. In addition, the blade is twisted along its length to the desired pitch formation. The resulting complicated shape must be accurately maintained, and heretofore known chromizing processes have resulted in erosion of the very thin leading and trailing edges 11*a*, 11*a* and pitting of the faces 11*b* and 11*c*.

In accordance with the process of this invention, the blades 10 are packed in open mesh baskets such as 13 shown in Figure 2 and are embedded therein in the chromizing pack 14. The pack 14 is preferably composed of a uniform mixture of ferrochrome containing 30% iron and 70% chromium, and unglazed porcelain in a one-to-one ratio by volume. The ferrochrome has a particle size of less than 8-mesh but more than 20-mesh. The mesh of the basket 13 is smaller than this particle size so that the particles will be retained in the basket. In accordance with this invention, 10% by volume of titanium dioxide is blended into the mixture. The titanium dioxide may be in powdered form, for example, 100-mesh or smaller, but since it will coat the ferrochrome particles and be retained thereon it will not sift through the basket 13.

The blades 10 are packed so that each portion thereof is completely embedded in the pack 14 and is isolated from an adjoining blade.

Each basket is preferably equipped with a bail 15 or other type of handle for ease in manipulation.

As shown in Figure 3, the packed baskets 13 are placed in a retort 16 composed of a solid impervious body 16*a* and a cover 16*b* adapted to be sealed to the body to create an air-tight compartment 17 receiving the baskets.

The compartment 17 is purged with dry hydrogen supplied from a cylinder 18. The retort 16 has an inlet tube 19 and an outlet tube 20 each equipped with a valve. Hydrogen is passed through the retort until all air has been removed from the compartment 17. The valves in the inlet and outlet of the retort are then closed and the retort is positioned in a furnace 21, shown in Figure 4.

As shown in Figure 4, the inlet 19 of the retort 16 is selectively connected to three cylinders 22, 23 and 24 by means of a valved pipe 25 having valves 26, 27 and 28 therein respectively controlling flow from each cylinder. The first cylinder 22 contains hydrogen, and the valve 26 is opened while the valves 27 and 28 remain closed so that hydrogen will again be flowed through the retort 16 as the retort is heated in the furnace. When the furnace reaches about 1750° F., the heat is continued to maintain this temperature for about four hours while the hydrogen gas continues to flow through the retort. After about four hours, the temperature is dropped slightly to about 1720° F. and the valve 27 is opened to admix hydrogen chloride from the cylinder 23 with the hydrogen from the cylinder 22. The mixed hydrogen chloride and hydrogen flow through the retort maintained at 1720° F. for about ten hours. The valve 27 is then closed, the heat supply is shut off, and the retort is allowed to cool down in the furnace for about one hour during which time the hydrogen continues to flow through the retort. After the retort is cooled down, the valve 26 is closed and the valve 28 is opened to purge the retort with nitrogen from the cylinder 24. The retort is then removed from the furnace, opened up, and the individual baskets 13 are covered with a coarse screen 29 (Figure 5) and are inverted to sift the pack 14 through the screen into a collecting pan 30. The chromized blades 10 are retained in the basket. The basket, freed of the pack, is then immersed in a tank 31 of water, as shown in Figure 6, to wash the blades.

The chromized blades produced according to this process will retain the original dimensions and surfaces of the original blades, and even the very thin leading and trailing edges of the vane section will be retained in sharp, clean condition. If the titanium material is not used in the pack, the edges and surfaces of the vane portion will be eroded and pitted.

It is not necessary that porcelain be used in the pack if the pack is porous since this material is merely an extender to increase the porosity of the pack and speed up the gas flow therethrough. An extender or carrier is used when the titanium material is not porous and sillimanite or other porous ceramic material can be used in place of porcelain. Chromium particles can be used in place of ferrochrome particles.

Since titanium dioxide is sponge-like or absorptive, it can also be used to replace heretofore required additional extenders such as porcelain to serve a multiple function in the pack of absorbing the ferrous chloride, of coating the ferrochrome to avoid pitting of the article, and to alloy with copper in the article to provide an alloy which resists the corrosive action of liberated halogens in the pack. The non-absorptive titanium materials such as titanium tetrachloride, titanium metal and the like will require the presence of an extender in the pack but will nevertheless protect the article being chromized.

The titanium material is effective in amounts as low as 1% by volume and can be used in amounts up to 50% by volume with 10 to 20% being preferred. When the porcelain extender is omitted, it is preferred to use more than 10% by volume of the titanium dioxide content.

Because the titanium material partially alloys with the copper in the copper-infiltered powdered iron blade, it may be necessary to add titanium material to the pack before it is reused to replenish the material lost through alloying.

When the titanium material and the ferrochrome particles are uniformly mixed, the titanium material actually coats the ferrochrome, and the coated ferrochrome particle is a preferred pack material.

From the above description it will therefore be understood that this invention provides an improved chromium cementation or chromizing process as well as an improved cementation or

chromizing pack containing a titanium compound such as titanium dioxide.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. The method of chromizing copper-infiltered powdered iron compressor blades for turbo-jet engines and the like which comprises packing the blades in a basket embedded in a granular mixture of ferrochrome and titanium dioxide, sealing the packed basket in a retort, purging the retort with hydrogen, heating the retort to chromizing temperatures while continuing the hydrogen purge, flowing hydrogen chloride through the heated retort, continuing the heat treatment and hydrogen chloride treatment until a desired chromized finish has been produced on the blades and until part of the titanium in the pack alloys with the copper in the blades, cooling the retort, purging the retort with an inert gas, removing the basket from the retort, sifting the ferrochrome and titanium dioxide material out of the basket, and washing the remaining blades in the basket.

2. The method of chromizing copper-infiltered iron articles which comprises packing the articles in a chromizing pack containing ferrochrome and an unglazed porous ceramic material in equal amounts and containing about 10 to 20% by volume titanium dioxide, passing hydrogen chloride through said pack, and heating the pack to chromizing temperatures for a sufficient length of time to produce a desired chromized finish on each article.

3. The method of chromizing iron articles which comprises packing the articles in a mixture of ferrochrome particles coated with titanium dioxide, passing hydrogen chloride through said mixture, and heating the pack to chromizing temperatures in an inert atmosphere.

4. The method of chromizing copper-infiltered articles which comprises embedding the articles in a mixture composed of ferrochrome particles and from 1 to 20% by volume titanium dioxide particles coating said ferrochrome particles, passing hydrogen chloride through said mixture, and heating the pack to chromizing temperatures for a sufficient length of time to produce a desired chromized finish on each article.

5. A chromizing pack comprising a mixture of titanium material coated ferrochrome particles of less than 8-mesh and more than 20-mesh size.

6. A chromizing pack comprising a mixture of ferrochrome particles, unglazed porous ceramic particles, and titanium dioxide particles.

7. A chromizing pack comprising ferrochrome particles coated with titanium dioxide.

8. A chromizing pack comprising ferrochrome particles and from 1 to 20% by volume titanium dioxide particles.

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