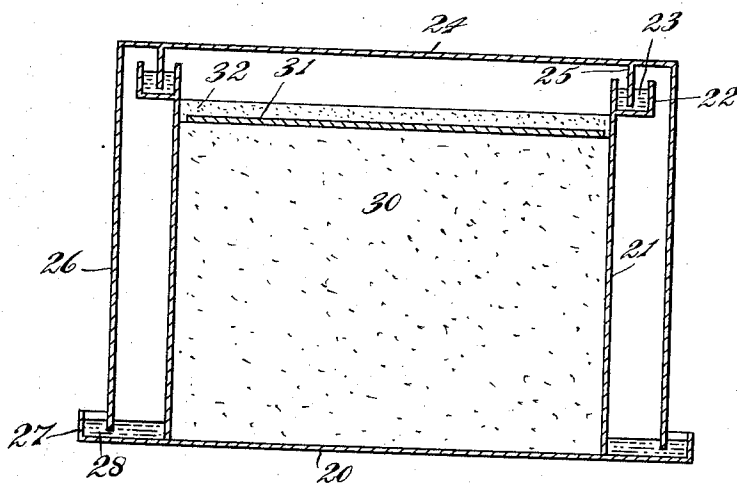


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DUCTILE CHROMIZING
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2,851,375

DUCTILE CHROMIZING

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1 Claim. (Cl. 117--50)

The present invention relates to chromized surfaces on steel articles and methods of obtaining the same.

A purpose of the invention is to increase the ductility of a chromized layer on a steel article, particularly an article of low carbon steel including alloy steel.

A further purpose is to decarburize the surface of a steel article and subsequently to chromize the same.

A further purpose is to hold the steel prior to chromizing at a temperature of 1550 to 1650 degrees F. for at least two hours in a reducing gas.

A further purpose is to promote the formation of water vapor for decarburizing.

Further purposes appear in the specification and in the claim.

The drawing is a diagrammatic center vertical section of apparatus which may be used in carrying out the invention.

Chromium cases have been applied on steel articles in order to increase corrosion resistance and heat resistance and to improve the surface characteristics for service. Due to the carbide-forming characteristics of chromium, the cases obtained are often not of maximum ductility.

By the present invention it is possible to increase the ductility of the chromium case, thus making possible more severe forming of articles after chromizing, and improved ductility in service.

For example, therefore, the present invention makes possible more severe forming of chromized low carbon steel sheet and strip. It also makes it possible to reduce the brittleness of cases obtained by chromizing medium carbon and high carbon steels including tool steels.

Since carbon acts as a block to chromium penetration, it is possible by the present invention to obtain deeper cases on medium and high carbon steels.

The invention is believed to find its widest application in chromizing of low carbon steel such as SAE 1010 and 1020, and corresponding alloy grades.

According to the invention, the steel is first decarburized and then chromized. Both the decarburization and the chromizing can be accomplished in any way desired, although it is preferable to accomplish these steps as sequential aspects of the same operation.

In the preferred embodiment, the chromizing is carried out in a box provided with suitable molten glass or other seals to exclude the atmosphere.

The drawing illustrates a chromizing box, suitably of steel or heat resisting alloy having a bottom 20, sides 21, joined to the bottom, and a sealing trough 22 at the top of the sides receiving a sealing compound, preferably glass, at 23, which is molten at chromizing temperature. A cover 24 extends over the box and has a sealing rim 25 which extends down below the surface of the sealing material 23 into the trough 22. Attached to the cover are sides 26 which extend down into an outer sealing trough 27 which contains a sealing material at 28, suitably glass molten at chromizing temperature.

The work is formed into a pack 30 consisting of work

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surrounded by chromizing compound on the interior of the box, and the pack is covered with a metallic sheet 31 and with an additional layer of chromizing compound 32 to assist in excluding air.

In accordance with the procedure of the invention, the articles to be chromized, suitably clean, are packed in the box, surrounded by chromizing powder.

The chromizing powder may to advantage be a mixture of a source of chromium such as metallic chromium or ferrochromium, an inert bodying agent such as calcined kaolin, and a carrier, the preferred carrier being the reaction product of ammonium bifuoride and chromium.

It will, however, be understood that any other suitable chromizing compound may be used.

Example 1

In a typical example, the chromizing compound has the following composition:

	Parts
Ammonium bifuoride	200
Water	250
Chromium metal powder	100

The ammonium bifuoride is dissolved in the water which is heated to boiling. The chromium powder is added slowly to the boiling ammonium bifuoride solution, taking precaution against personal injury from an explosion, and preferably using remote control techniques. A violent reaction occurs which generates steam and tends to reduce the powder to dryness. Heating is continued until the powder is dry and then is stopped.

The final chromizing powder composition is desirably as follows:

	Parts
Ferrochromium (65% of chromium 7% silicon, low carbon, balance iron)	70
Calcined kaolin	30
Reaction product of ammonium bifuoride and metallic chromium as above	0.045

Wide variations in the composition can be used, for example the ferrochromium can vary from 20 to 80 parts, the bodying agent such as calcined kaolin or alumina can vary from 10 to 50 parts and the reaction product of ammonium bifuoride and chromium can vary from 0.0045 to 10 parts by weight.

In forming the reaction product of ammonium bifuoride and metallic chromium powder, excess of chromium is not harmful, but unreacted excess of ammonium bifuoride should be minimized to avoid etching of the work.

The work and chromizing powder are first heated to a temperature of 1550 to 1650 degrees F. and held in this temperature range for at least 2 hours, and preferably for at least 6 hours. The complex compound of ammonium bifuoride and chromium breaks down, liberating hydrogen, nitrogen and halogen, and the gas sweeps out air from the box and maintains reducing conditions. The effect is to decarburize the surface of the steel, the carbon passing out of the box as hydrocarbon gas.

The above example is one procedure for decarburizing. If preferred the work can be heated in a muffle in a stream of hydrogen.

At the end of the decarburizing step, if performed in the box, the temperature is increased to a temperature in the range of 1650 to 2300 at which temperature chromizing occurs. The preferred temperature is 1750 to 2100 degrees F. Chromium diffuses into the steel and because of the decarburization the chromium case is of much increased ductility.

Example 2

The chromizing powder composition of Example 1 is made up, except that in addition to the ferrochromium,

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calcined kaolin and the reaction product of ammonium bifluoride and metallic chromium, one part by weight of iron oxide is incorporated.

It is then no longer necessary to hold the box at a temperature in the range between 1550 and 1650 degrees F. and the procedure is simply to heat up to 1850 degrees F. in normal course. The reaction product of the ammonium bifluoride and metallic chromium breaks down and liberates hydrogen, which reacts with the iron oxide to form water vapor, thus promoting decarburizing of the steel of the work during the heating and before the work reaches chromizing temperature.

By the time the work reaches chromizing temperature the work is extensively decarburized, and chromizing takes place with improvement in ductivity of the chromized layer.

It is undesirable to increase the quantity of iron oxide greatly beyond the concentration given, as it is best to maintain strongly reduced conditions in the chromizing box.

If the decarburizing is accomplished by some other procedure other than heating in contact with the carburizing compound, chromizing may be accomplished after completion of decarburizing using any well known technique, as desired.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention with-

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out copying the method and composition shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claim.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

The method of producing a ductile chromium layer on steel, which comprises placing the steel in a closed retort and in contact with a chromizing composition comprising a source of chromium, and a chromizing catalyst which, at elevated temperature, decomposes and liberates hydrogen and a halogen, heating the contents of the retort to a temperature of 1550° to 1650° F. and holding the contents of the retort at that temperature range for at least two hours and thus decarburizing the steel, and then heating the contents of the retort to a temperature of 1650° to 2300° F. and diffusing chromium into the steel through the decarburized surface.

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