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STAINLESS STEELS

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This invention relates to stainless steels and in particular it concerns such steels as are used in decorative applications in which corrosive conditions are encountered.

A major object of the present invention is to provide novel stainless steel alloys and shapes thereof, including strip and sheet that are characterized by being particularly resistant to corrosion.

Stainless steels of the type exemplified by the American Iron and Steel Institute Type 430 are widely used in the automobile, appliance, and utensil industry. Generally, such steels are formed to the desired shape and highly polished.

Articles such as automotive trim, appliance parts and trim, kitchen utensils, and the like, when made from regular Type 430, are subject to attack by various corrosive agents, detracting from their decorative appearance.

Exterior automobile trim is especially exposed to corrosive attack. In the summer months, this may be due to moisture or rain which has absorbed corrosive agents from the atmosphere, particularly in the industrial and coastal regions. By far, the most corrosive conditions for automobile trim are those encountered in the winter months, due, more recently, to the extensive use of various salts combined with other materials which are applied to road surfaces to reduce hazardous driving conditions, such as snow and ice. Since such salts and the like are always present with moisture, they are continuously splashed on the exterior automobile parts. The composition of the salt varies in different localities. In addition, the salt is mixed with ashes, slag, sand, and like substances so that the actual corrosive agent can be of quite varying compositions. The combination is especially corrosive, and the industry had the problem of finding a material resistant to these corrosive conditions.

Kitchen utensils are exposed to many corrosive acids. All of these items are subjected to the corrosive attack of cleaning agents, soaps, and detergents.

Highly alloyed materials are available which would meet the corrosion resistance requirements, but these are too expensive for the applications considered here.

The present invention relates to alloys as well as products formed therefrom, and it is the primary object to provide such alloys and products that are particularly suited for the foregoing purposes in that they are corrosion resistant and yet are not unduly more expensive than the alloys which have been in use for these applications. The resulting products can be used in the same manner as Type 430 and analogous stainless steels are now used, but with the advantages just specified.

The stainless steels that comprise the present invention are substantially straight chrome steels. For example, and except for the variations hereinafter noted, the AISI Type 430 steels are representative of one particular analysis within the invention.

The straight chrome stainless ferritic steels embodying the present invention and by which its stated objects are attained contain, by weight, about 14 to 25 percent of chromium, up to a maximum of about 0.30 percent of carbon, up to about 1.25 percent of manganese, a maximum of 1.1 percent of silicon, 0.25 to 1.25 percent of molybdenum, with the remainder iron and incidental impurities. Where such elements as phosphorus and sulfur are present, they do not exceed about 0.04 and 0.03 percent respectively.

In addition, alloying constituents can be included to develop special characteristics as desired provided they do not detract from the corrosion resistant characteristics of the resulting products.

Within the foregoing broad range, intermediate ranges are definitive of steels that are of particular interest, usually as a consequence of an intended application. A suitable intermediate range of straight chrome ferritic stainless steel compositions in accordance with this invention includes, by weight, 14 to 18.5 percent of chromium, 0.15 percent maximum of carbon, a maximum of 1 percent of manganese, a maximum of 1.10 percent of silicon, a maximum of 0.04 percent of phosphorus, a maximum of 0.03 percent of sulfur, 0.40 to 1.10 percent of molybdenum, and the remainder iron and incidental impurities.

It will be evident that all products within the foregoing ranges are not equivalent for all purposes. The particular analysis chosen is usually indicated by known conditions of the end use.

The steels of the present invention are prepared in the same general manner that Type 430 steels and its variations are now prepared. Similarly, the manner of forming shapes from the resulting products that are presently used is satisfactory in producing products in accordance with this invention.

The invention will be described in conjunction with the following examples in which the details are given by way of illustration and not by way of limitation.

A heat of stainless steel in accordance with the invention was prepared by melting in an electric furnace used for the commercial production of steel. The heat, as cast, weighed approximately 15 tons. Ingots were poured from the heat and, when solidified, were cooled, hot worked, and subsequently were cold worked to strip and annealed in accordance with standard practices for Type 430 steel. The analysis of this heat was as follows, in weight percent:

C	0.065
Mn	0.57
Si	0.44
S	0.007
P	0.018
Cr	18.41
Mo	0.89
Fe	Balance

Samples of strip in the "mill finished" condition were subjected to corrosion tests established by the automobile manufacturing industry as criteria to meet their requirements. A description of these tests and the results obtained follow.

One such test used in the automobile industry is commonly known as the Cass test. Specimens of strip, having the surface in the "mill finished" condition, were subjected to a spray of the Cass solution in a cabinet maintained at a temperature of 120° F. The Cass solution consisted of 4.2 pounds of sodium chloride, 10 grams of cupric chloride, and 10 gallons of distilled water. The pH of the solution was adjusted to 2.8 to 3.0 with glacial acetic acid. After 16 hours of exposure in the spray cabinet, the specimens were removed, visually examined, and rated according to a procedure established by an automobile manufacturing company in which a rating of 3 or higher indicated failure due to surface corrosive attack. The specimens of this material had the best possible rating of 1 and, therefore, are considered particularly resistant to corrosive conditions to which automobile parts are subjected.

Another test used to determine resistance to corrosion of automobile materials is called the Dip-Dri test. This test was devised to simulate corrosive conditions encountered in certain districts where slag, salt, and calcium

chloride are used for winter road deicing. The solution used consisted of specified quantities of sodium sulfate, sodium sulfite, sodium thiosulfate, sodium chloride, calcium chloride, and distilled water. An automatic cycle timer and elevating mechanism raised and lowered the test samples into the solution adjusted to a pH of 9.3±.05 for an 8 hour period. One complete cycle required from 98–102 seconds. This involved immersion for 1 to 2 seconds and a drying period of 98–102 seconds. The samples were dried and maintained during the dry period at a temperature of 100° to 130° F. by means of a heat lamp. After the test was completed, the samples were cleaned, dried, and visually examined for pits and red rust products. Specimens from this heat were subjected to this test and upon examination after completion of the test, were found to be entirely free of pitting or corrosive attack, indicative of the quite satisfactory corrosion resistant characteristics of the alloy.

Another test also used by the automobile industry for rating corrosion resistance of materials is the spot test, using a chloride solution. The solution used consisted of 10 grams of ferric chloride, 5 grams of sodium chloride, 2.5 ml. of hydrochloric acid (concentrated) and 200 ml. of distilled water. The test solution was applied to the test specimen by placing a drop with a clean glass dropper in a ¼ inch diameter wax ring made on the specimen with a china marking pencil. The solution temperature was maintained at 65° to 85° F. during the test. The solution was left in contact with the surface of the specimen for five minutes after which time it was rinsed off with flowing tap water and the surface dried with an air blast and a clean, soft cloth. The requirements after this test were that the material should not show any visible permanent change in appearance on the significant surface of the sample. Evaluation was made visually, normal to the clean surface immediately after completion of the test. Specimens of this heat tested and evaluated in the manner prescribed showed no evidence of change in surface appearance. The material met the requirements of this test for corrosion resistance.

The three tests just described were devised by automobile manufacturers to simulate conditions encountered during normal service. Regular Type 430 proved unsatisfactory when tested by these means. However, material of the composition of this invention satisfactorily met the requirements of all of these tests, as can be concluded from the test results just described.

A large number of heats of steels within the composition ranges of this invention were made. These heats ranged from 5 to 15 tons in size. The analyses of these heats were within the following composition limits, in weight percent: carbon, 0.049 to 0.078; manganese, 0.42 to 0.75; silicon, 0.28 to 0.51; sulfur, 0.017 max.; phosphorus, 0.023 max.; chromium, 16.59 to 18.41; molybdenum, 0.69 to 1.06; and the remainder iron. Material from these heats was subjected to corrosion tests as previously described, and was found to meet the requirements of the automobile manufacturing industry.

From the foregoing it is evident that the present invention constitutes a significant advance in providing an inexpensive straight chrome ferritic stainless steel that is highly corrosion resistant and which, at the same time, retains good physical and mechanical properties and meets all the requirements for these properties. This invention is an improvement in the art for it not only provides a material meeting the corrosion resistance requirements in a specific industry but can be used in many other applications.

In accordance with the provisions of the patent statutes, the invention has been explained with what is now considered to be its best embodiment. However, it should be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A straight chrome ferritic stainless steel consisting essentially, by weight, of 18.41 percent of chromium, 0.065 percent of carbon, 0.57 percent of manganese, 0.44 percent of silicon, 0.007 percent of sulfur, 0.018 percent of phosphorus, 0.89 percent of molybdenum and the remainder iron, said ferritic stainless steel being characterized by improved corrosion resistance.

2. A drawn decorative article for use on an automoble which is corrosion resistant, said article having a composition in accordance with claim 1.

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