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RUSTLESS IRON

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3 Claims. (Cl. 148—31)

This invention relates to rustless irons and steels and to products and articles of manufacture of the same.

Among the objects of my invention is the provision of inexpensive rustless or corrosion-resistant alloy irons and steels that lend themselves to ready conversion into bars, rods and wire of round, square, hexagonal, octagonal or other section, which are readily cold-headed or otherwise cold-upset or formed cold, as in the manufacture of bolts, screws, pins, valve needles or the like, which are satisfactorily cold-punched, as in the production of nuts, which may be welded, as in the production of welded articles of manufacture and which are readily machined, as by turning, milling, cutting, drilling, threading, and especially which lend themselves to automatic machining operations, and grinding and polishing in the finishing of such articles of manufacture.

My invention accordingly consists in the combination of elements, composition of ingredients and mixture of materials, in the articles, products or manufactures of the same and in the several steps and the relation of each of the same to one or more of the others, as more particularly described herein, the scope of the application of which is indicated in the following claims.

As conducive to a clearer understanding of certain features of my invention it may be noted at this point that the stainless, rustless or corrosion-resistant alloy irons or steels are becoming increasingly employed in the chemical, automotive, aeronautical and other industries as nuts, bolts, screws and studs, pins, shafts, pump rods and fluid valve parts, as well as other fastening devices and machine parts where strength, toughness, corrosion-resistance and heat-resistance are required. In general, these alloy irons and steels analyze approximately, 12% to 16% chromium, .10% to .4% carbon and the balance substantially iron for the ferritic rustless irons and steels, about 18% chromium, 8% nickel, less than .20% carbon and the balance iron for the austenitic chromium-nickel steels. These alloy irons and steels may or may not include various additional ingredients such as aluminum, copper, molybdenum, manganese, nickel, silicon, tungsten and vanadium as desired in small amounts. In each case, however, the resistance to corrosion and scaling under a variety of corrosion-fostering media and throughout a wide range of variations in temperature are largely due to the presence of chromium in the ferritic irons and steels and to chromium and nickel in the austenitic irons and steels.

These various fastening devices and machine parts are made up from rustless iron or steel bar, rod or wire stock by numerous hot and cold forming operations and/or machining operations such as sawing, turning, milling, drilling and threading. Because of the high chromium and high nickel contents of these irons and steels the machining operations are difficult, slow and expensive due to the great toughness of the metal. The cutting tools burn and become dull readily and frequently a high tool breakage is encountered. Likewise, the machined finish is rough and scored and the chips or turnings are tough and wiry so that they obstruct the operation. In many instances these disadvantages and difficulties offset the advantages gained by the use of alloy irons and steels which are completely corrosion-resistant.

While the difficulties in machining chromium and chromium-nickel rustless irons and steels have been solved in a measure by adding to the analysis of these irons and steels the ingredients selenium or tellurium or abnormally large amounts of sulphur or phosphorus the use of the first two ingredients is expensive and the use of the last two results in the sacrifice of certain of the hot and cold working characteristics of the metal. The presence of abnormally high quantities of sulphur results in hot shortness which causes tearing in hot working, and fibrous structure which causes splitting in hot working and in cold forming as in cold-heading, upsetting and the like. Moreover the normal ductility of the metal is somewhat reduced and its corrosion resistance in some media is adversely affected. These difficulties are said to be alleviated by various means, as by adding sulphur as iron pyrites, zirconium sulphide and the like but these additions are not altogether satisfactory in achieving the desired results.

Similarly, other attempts have been made to improve the machining characteristics of rustless irons and steels by including in the analysis of the metal both the ingredients molybdenum and sulphur and at the same time maintaining the manganese content of the metal at a very low value. It is claimed that with a low manganese content and with comparatively high contents of molybdenum and sulphur, molybdenum sulphides are formed which become dispersed throughout the metal lending to the metal a desired free machining quality. These rustless irons and steels, however, similarly suffer in hot-working, cold-working and various forming operations.

In heretofore known and/or used rustless irons and steels of desired free machining characteristics the metal can not be drastically cold-worked, as by cold-heading and upsetting. Neither is it considered good practice to weld such alloys because of the extreme segregation of sulphur which takes place locally at the weld. Likewise, in heretofore known rustless irons and steels which are free of special additions such as sulphur, phosphorus, molybdenum sulphides and the like, the metal is machined only with great difficulty and with high tool breakage.

One of the outstanding objects of my invention is the provision of rustless irons and steels possessing good machining qualities, lending themselves to ready cutting, turning, threading, automatic machining and the like, in combination with good hot-working and cold-working characteristics, especially hot-rolling and forging and cold-upsetting, permitting the rapid and highly efficient production of a variety of finished products as bolts, studs, screws, nuts, pins and certain small machine parts, by automatic machining operations with a minimum of splitting or checking of the metal during hot and cold working and with minimum difficulty and expense in the operations of machining, grinding and polishing, and, with minimum seizing, binding or galling of the metal in use where relative motion between parts is encountered.

Referring now more particularly to the practice of my invention a heat of rustless iron analyzing approximately, 12% chromium, .12% sulphur, with the usual percentages of manganese, silicon and phosphorus, .08% carbon and the balance substantially iron is produced for example in a manner particularly described in my recently granted Patent 1,954,400, entitled Process of making rustless iron. The heat of metal is tapped into a ladle for teeming where it is held for a short period of time to permit a desired teeming temperature being reached and subsequently teemed into ingot molds to form ingots.

The desired sulphur addition is achieved by adding lump sulphur, iron pyrites, nickel sulphide, molybdenum sulphide or mixtures of these ingredients to the stream of metal as it is poured from furnace to ladle. The metal readily takes up the sulphur although approximately 20% to 35% of the addition is lost.

The formed ingots are soaked at a desired high temperature for a suitable period of time, after which they are rolled or forged into billets or slabs and then into bars, rods and wire of desired round, square, flat, hexagonal, octagonal or other section. These converted products are then cut and trimmed to specification and given a desired annealing and pickling treatment to free the metal from working stresses and provide a clean surface.

The products are given a desired hardness by suitable heat-treatment, or by cold-reduction or by a combination of heat-treatment and cold-reduction as desired. The various hot rolled or forged bars, rods, wire and the like are, for example, tempered by heating the products in a suitable furnace to a temperature of from about 1050° F. to 1450° F. and then cooling them, either in the air or in a suitable furnace so as to achieve a hardness of the metal corresponding to from about 180 Brinell to 250 Brinell, and preferably from about 210 Brinell to 230 Brinell. Ordinarily the desired hardness is achieved as a result of a combination of alternate cold-working operations and temperature treatments employed in finally bringing the metal to desired size. The hardened products are preferably given a desired surface finishing treatment, after which they are ready for manufacture or fabrication into a variety of articles for ultimate use.

In the conversion of my alloy iron from ingots to bars, rods and wire, the metal works well. Apparently the presence of the moderate amount of sulphur employed does not appreciably detract from the hot-working characteristics possessed by heretofore known low sulphur content irons and steels of like chromium contents. The cutting characteristics of these converted products are clearly improved over heretofore known low-sulphur rustless iron and steel products. The metal cuts well with a minimum of galling of the cutting tool. In the drawing of wire there is less sticking and galling of the dies than is encountered in the drawing of usual heretofore known low-sulphur rustless irons or steels. Furthermore, the metal has greater ductility and can be more severely drawn than heretofore known rustless irons and steels of free machining grades.

My rustless iron bars, rods and wire are strong, tough and ductile, they are resistant to the corrosive attack of a wide variety of alkali, acid and salt solutions, they are resistant to rusting and corrosion by the atmosphere and they are resistant to scaling in high temperature use. These products readily lend themselves to a variety of hot and cold working and forming operations.

My corrosion-resistant alloy iron bars, rods and wire readily lend themselves to the severe cold-working processes of upsetting, cold-heading and punching with a minimum of splitting, tearing or other failure of the metal. In addition, these converted products readily lend themselves to cutting, drilling, threading and various automatic machine operations, as well as grinding and polishing operations, as in the production of nuts, bolts, studs, screws, pins and similar fastening devices or small machine parts such as valve needles, heads, stems and seats or pump rods or shafting as employed in automotive, aeronautical and industrial machinery as well as certain articles and appliances employed in various dairy, hospital or household applications where strength, toughness, resistance to corrosion and where a bright surface are desired. Furthermore, these products readily lend themselves to welding in accordance with known methods, as in the production or repair of certain articles or appliances, with a minimum local segregation of sulphur at the weld and local heterogenity of structure with the consequent irregular unreliable physical and corrosion-resisting properties found in certain of the free-machining grades of rustless iron and steel referred to above.

While the reasons for these favorable cold-working characteristics combined with good machineability are not definitely known, it appears that in my free-machining rustless iron and steel sulphur is uniformly dispersed throughout the metal in a myriad of minute particles which lend excellent machining characteristics to the metal without in any way detracting from the cold-working characteristics found in the usual grades of rustless iron and steel. It appears that on an average the sulphur or sulphide particles are much finer, are more uniform in size and are more evenly dispersed throughout the metal than in heretofore known rustless irons and steels of the free-machining grades.

While as illustrative of the practice of my invention a rustless iron analyzing approximately, 12% chromium, .12% sulphur, with the usual percentages of manganese, silicon and phosphorus, .08% carbon and the balance substantially iron, is specifically described, corrosion-resistant irons and steels possessing good hot and cold working characteristics in combination with good machining characteristics are achieved where the chromium content ranges between about 10% and 25%, the sulphur content between .08% and .15% and the carbon content between .03% and .3%.

Good results are also achieved in the austenitic chromium-nickel rustless irons and steels where sulphur is employed in the amounts indicated, the metal analyzing approximately, 10% to 25% chromium, 7% to 20% nickel, .08% to .15% sulphur, the usual percentages of manganese, silicon and phosphorus, less than .12% carbon and the balance substantially iron, and where a desired hardness is given the various austenitic alloy iron and steel bars, rods, wires and the like, as by suitable cold-working operations. Best results in use are achieved where the cold reduction amounts to about 3% to 25% giving a desired hardness of from about 210 Brinell to 230 Brinell or even from about 180 Brinell to 250 Brinell. The austenitic alloy iron products are readily cold-formed as by bending, pressing, deep-drawing, punching, blanking and the like and in addition readily lend themselves to welding in the fabrication of desired articles, devices or equipment.

Likewise, while as illustrative of my invention rustless iron bars, rods and wire and articles of the same are especially described, it will be understood that both hot and cold-rolled plate, sheet and strip fashioned of rustless iron and possessing the characteristics of good cold workability combined with good machineability come within the contemplation of my invention. Such improved rustless iron plate, sheet and strip analyzing approximately, 10% to 25% chromium, .08% to .15% sulphur, .03% to .3% carbon and the balance iron (or analyzing 10% to 25% chromium, 7% to 20% nickel, .08% to .15% sulphur, .03% to .3% carbon and the balance iron for the austenitic alloy irons) and having a Brinell hardness of about 180 to 250, and especially 210 to 230, possess good forming characteristics, as bending, good machining characteristics, as punching, stamping, grinding and polishing and good welding characteristics achieving a sound, strong weld.

Certain practical advantages are achieved by including in the analysis of my rustless alloy irons and steels, in both the ferritic and the austenitic irons and steels, the ingredient manganese in the amount of from about .4% to about 1.5%, or even up to about 2.5%. Manganese in a measure supplements the desired ease of machining the metal without detracting from the cold-working characteristics. In addition, the presence of this ingredient is helpful to the melter in the furnacing, tapping and teeming of the heat of metal. Conveniently the desired high manganese content is achieved by proportionately increasing the amount of manganese ore, high carbon ferromanganese or low carbon ferromanganese over the amount employed in the example given in my patent referred to above and in accordance with the practice outlined therein.

Likewise certain further advantages are realized by including in the analysis of the metal the ingredient molybdenum in the amount of from about .2% to .7%. Ordinarily molybdenum in the amount of about .5% gives desired results. The addition of molybdenum is preferably made by adding ferro-molybdenum, calcium molybdate or molybdenum-containing scrap to the furnace charge, or to the metal bath during the refining and finishing of the heat of metal.

Molybdenum serves to improve the resistance of the irons and steels, and products, articles and manufactures of the same, to the peculiar type of local corrosion known as pitting. The presence of molybdenum furthermore lends a certain timbre or fibre to the metal which does not adversely affect the highly desirable cold-working and machining characteristics of my alloy irons and steels and which, in fact, lends a certain improvement in the rapid and efficient automatic machining operations employed in the production of articles of the character described and in the grinding and polishing of the same.

Thus, it will be seen that there has been provided in this invention corrosion-resistant alloy irons and steels, and products of the same, which lend themselves to a combination of hot and cold working operations, including the severe cold-working operations of upsetting and cold-heading combined with the properties of ready machining, as by cutting, drilling and threading, and especially automatic machining, achieving desired devices, articles and manufactures with an ease and efficiency in no way realized in the handling of any single heretofore known grade of corrosion-resistant iron or steel. It will be seen that my corrosion-resistant alloy irons and steels, and the products of the same, are well suited to the rapid automatic production of a variety of small articles of manufacture which are well adapted to withstand the varying conditions encountered in actual practical use.

Where particularly extreme cold-heading operations are met with, it is frequently desirable to employ my alloy irons and steels in a somewhat softer condition than 180 Brinell. Excellent results are achieved in such cold-heading operations in combination with good machining characteristics where the hardness of my alloy iron and steel is about 170 Brinell or even as low as 163 Brinell.

While as a matter of convenience the desired hardness of my alloy irons and steels, and the various products of the same, is given in terms of a Brinell hardness number, it will be understood that in practice the actual realization of a desired hardness may be gauged by translating the values obtained by other convenient test methods such as Rockwell, Vickers, tensile testing and the like.

As many possible embodiments may be made of my invention and as many changes may be made in the embodiment hereinbefore set forth it is to be understood that all matter described herein is to be interpreted as illustrative and not as a limitation.

I claim:

1. In manufactures of the class described, austenitic alloy iron products of good corrosion-resistance, good cold-working properties and good machining characteristics comprising in combination approximately, 10 per cent to 25 per cent chromium, 7 per cent to 20 per cent nickel, .03 per cent to .15 per cent sulphur, .03 per cent to .12

per cent carbon and the balance substantially all iron hardened by cold-reduction to a Brinell number of from between 180 to 250.

2. In products of manufacture of the class described, bars, austenitic alloy iron rods and wire of good cold-upsetting characteristics combined with good machining properties analyzing, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 20 per cent nickel, .08 per cent to .15 per cent sulphur, .03 per cent to .12 per cent carbon and the balance substantially all iron cold worked to a reduction of between 3 per cent and 25 per cent with a hardness of from between 180 Brinell and 250 Brinell.

3. In articles of manufacture of the class described, an austenitic corrosion resistant cold-headed and machined alloy iron threaded fastening device having a Brinell hardness in excess of about 180 and analyzing approximately, 10 per cent to 25 per cent chromium, 7 per cent to 20 per cent nickel, .08 per cent to .15 per cent sulphur, .03 per cent to .12 per cent carbon, and the balance substantially all iron.

WILLIAM BELL ARNESS.

CERTIFICATE OF CORRECTION.

Patent No. 2,140,501. December 20, 1938.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 5, claim 2, strike out the word and comma "bars," and insert the same after "iron", same line; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 31st day of January, A. D. 1939.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.