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ALLOY AND MANUFACTURES

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This invention relates to chromium-nickel alloy irons and steels and to articles and manufactures of the same.

One of the objects of my invention is the provision of high-grade alloy irons and steels, which are strong, tough and durable and which lend themselves to a variety of working and forming operations into a great number of articles, products and manufactures, which are peculiarly adapted to high temperature duty for long periods of constant use under a wide variety of corrosive or corrosion-fostering media.

Another object is the production of alloy irons and steels of the character described which lend themselves to simple, direct and economical working, as by forging, upsetting and hot and cold rolling into bar, rod, sheet and strip stock, which lend themselves to a number of working and forming operations, such as drilling, cutting, threading or other machining or bending, pressing, punching, or blanking, to achieve many commercial articles and manufactures, such as fluid valves, flanges and bolts, pans, trays and vats, internal combustion engine valves, valve seats and exhaust manifolds and stacks, all for high temperature duty in the presence of corrosive vapors and gases.

Another object of my invention is the production of alloy irons and steels of the character indicated, which lend themselves to ready fabrication as by welding into various tubes and pipes as used in oil cracking stills, condensers, boilers and the like in a number of chemical industries.

The invention accordingly consists in the combination of elements, composition of ingredients and mixture of materials, and in the articles, products and manufactures of the same, as 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 austenitic chromium-nickel irons and steels containing approximately, 10% to 25% chromium, 7% to 15% nickel, and the balance substantially iron, are used in the production of a wide variety of corrosion-resistant and mildly heat-resistant products or articles of manufacture. These austenitic irons and steels, especially the 18–8 irons and steels containing approximately, 18% chromium, 8% nickel, and the balance substantially iron, are used in a number of interior or exterior architectural applications, such as decorative trim, ornamentation and fixtures. Similarly, these irons and steels are employed for a variety of kitchen, soda fountain dairy and hospital applications, as in cooking and serving utensils, containers and appliances, counter and furniture trim and the like, where permanently bright corrosion-resistant metal capable of withstanding the corrosive action of various vegetable and fruit acids, is desired. Likewise, these irons and steels are widely adapted for various chemical plant apparatus and equipment where metal resistant to the corrosive attack of acids, alkalies and salts at room temperature, or slightly elevated temperatures, is required.

These austenitic chromium-nickel irons and steels, however, are not especially adapted for extremely high temperature duty, particularly high temperature duty under strongly oxidizing or corrosive conditions, or conditions of friction, abrasion and wear, largely because of the susceptibility of these irons and steels to intergranular corrosion.

One of the outstanding objects of my invention is the production of strong, tough and durable chromium-nickel alloy irons and steels, which are especially resistant to grain growth and embrittlement, scaling, pitting and intergranular corrosion, wear and abrasion, all at high temperatures, which may be worked or formed into a variety of articles, products and manufactures, a number of which are illustratively set forth above, and which are adapted to reliably withstand long periods of continuous high temperature duty under the many varying conditions of shock, vibration, corrosive attack and the like, as encountered in actual, practical use.

As illustrative of the practice of my invention, chromium-nickel alloy iron or steel analyzing approximately, 18% chromium, 8% nickel, 2.5% to 3.5% tungsten, .5% to 1% titanium, .07% to .1% carbon, and the balance substantially iron, with the usual percentages of manganese, silicon, sulphur and phosphorus, is conveniently produced in an electric furnace in any suitable manner, as described in Patent No. 1,925,182 granted September 5, 1933 to Alexander L. Feild and entitled Process for the manufacture of rustless iron. The alloy iron or steel is poured into suitable ingot molds where it is permitted to cool after which the molds are stripped from the formed ingots. In accordance with known methods the ingots are fashioned into blooms, or billets, and conveniently hot worked or hot and cold worked into plate, sheet, strip, bars, rods and wire of desired dimensions. Where desired, these converted products are annealed to free the metal of working strains. The cold-rolled sheet and strip, however, are preferably used without benefit of the

final annealing treatment in order to fully retain the high strength, hardness and other physical properties imparted by the cold working operation.

My modified chromium-nickel alloy iron or steel is essentially austenitic in structure but contains certain new constituents in the form of complex and ferrites and complex carbides. The metal is resistant to the corrosive effects of various industrial gases, vapors, fumes, liquids, acid, alkaline or salt in character, and is resistant to grain growth and embrittlement, pitting, scaling and intergranular corrosion and is highly resistant to impact, shock and fatigue under high temperature operating conditions over long periods of constant use. For example, a bar of my alloy iron or steel analyzing approximately, 18% chromium, 8% nickel, 3% tungsten, .3% titanium, .10% carbon and the balance substantially iron, has a life of about 350 hours under stress of 8,000 pounds per square inch at a temperature maintained at 1500° F. under ordinary atmospheric conditions. Under like operating conditions the usual 18–8 chromium-nickel iron analyzing approximately, 18% chromium, 8% nickel, .07% carbon, and the balance substantially iron, has a life of about 12 hours.

My alloy iron or steel in addition to having a life under severe operating conditions of high tensile stress at high temperatures in the presence of a variety of corrosive or corrosion-fostering agents, greatly in excess of heretofore known and/or used austenitic chromium-nickel alloy irons and steels, is strong, tough and durable and lends itself to a variety of working and forming operations. The metal may be upset, as in the production of bolts, or it may be punched and threaded forming nuts. Likewise, the metal lends itself to a variety of hot and cold working or forming operations, either from sheet, strip or bar stock, such as punching, bending, and the like. In addition, the metal may be cut, drilled, turned, threaded and otherwise machined to desired specification. Furthermore, the metal may be readily welded using the oxy-acetylene torch or the electric arc (employing welding rods for the electric welding operation of approximately the same analysis as the stock welded). In the production of welded parts, articles or manufactures, these are preferably heat-treated in accordance with well known methods, after the welding operation is completed, in order to establish a stable structure and assure maximum chemical resistance and minimum embrittlement, intergranular corrosion and other deterioration in actual, practical use.

My modified chromium-nickel alloy iron or steel readily lends itself to the production of a great many articles, products and manufactures of commerce, such as welded tubes, fluid valves, couplings, flanges and bolts, tanks, trays and pans, all for high temperature duty, as in boilers, condensers, oil cracking stills, evaporator units and the like, for semi-chemical use in the canning, dairy, oil and photographic film industries, or for chemical calciners, as used in the production of iron-free chemicals, such as paints and dyes. In addition, my chromium-nickel alloy iron or steel may be worked or formed, as above indicated, achieving a further variety of high temperature duty articles, parts and accessories, such as internal combustion engine valves, valve seats, exhaust manifolds and stacks, which are especially useful in automotive and aviation duty, or gas turbine buckets, nozzles and like parts, possessing great resistance to wear and erosion, in addition to strength, toughness, resistance to shock, corrosion-resistance under high temperature operating conditions where the wash and scour of hot corrosive or corrosion-fostering gases are encountered.

Furthermore, my alloy iron or steel is cast into a variety of articles, parts and accessories, such as furnace parts, ore treating and handling apparatus, high temperature conveyor parts and equipment and like machinery, subjected to corrosive and abrasive conditions at high temperatures and in the presence of a variety of corrosive agents, including sulphur-bearing ores and mattes, as well as sulphur-bearing liquids, vapors and gases.

Thus, it will be seen that there is provided in this invention modified chromium-nickel alloy irons and steels and articles, products and manufactures of the same, in which the various objects hereinbefore noted, together with many thoroughly practical advantages, are successfully achieved. It will be seen that the alloy irons and steels are strong, tough and durable, corrosion-resistant, heat-resistant and resistant to grain growth and fatigue and furthermore that the irons or steels are readily workable into a variety of articles, products and manufactures, which are especially adapted to withstand continuous high temperature duty over long periods of time and under the many varying conditions encountered in actual, practical use.

While as illustrative of my invention, modified chromium-nickel alloy irons and steels, and articles, products and manufactures thereof, containing approximately, 18% chromium, 8% nickel, 2.5% to 3.5% tungsten, .3% to 1% titanium, .07% to .1% carbon, and the balance substantially iron, are specifically described above, it will be understood that good results are achieved where the chromium content ranges between 10% and 25% and the nickel content between 7% and 15%. Likewise, high temperature duty chromium-nickel alloy irons and steels of good heat resisting and corrosion resisting characteristics, in combination with good mechanical workability, are achieved where the tungsten content ranges from just above 2%, say 2.1 or 2.2%, up to about 4%, the titanium from .30% up to about 1.5%, and the carbon content ranging from about .03% up to about .20%. A somewhat higher carbon content is permissible in the irons and steels of the higher chromium and nickel contents although it is to be understood that the presence of carbon is not desired but is present only because it is commercially impracticable to rid the metal of this ingredient.

Modified chromium-nickel alloy irons and steels of especially good resistance to the corrosive attack of sulphur-bearing agents, such as hydrogen sulphide, are achieved by a supplementary addition of manganese in the amount of from about .5% to 3%. The presence of a fairly high percentage of manganese in the metal greatly facilitates the production of the alloy irons or steels in that it increases the fluidity of the molten metal. Furthermore, manganese measurably improves certain working and forming characteristics of these irons and steels.

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 in a limiting sense.

I claim:

1. In a composition of matter of the class described, high temperature duty alloy iron or steel of good hot and cold-rolling characteristics possessing long life under high temperature conditions of stress, said alloy iron or steel containing as essential ingredients. 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, 2.1 per cent to 4 per cent tungsten, .30 per cent to 1.5 per cent titanium, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

2. In a composition of matter of the class described, high temperature duty alloy iron or steel of good hot and cold-rolling characteristics possessing long life under high temperature conditions of stress, said alloy iron or steel containing as essential ingredients approximately, 18 per cent chromium, 8 per cent nickel, 2.5 per cent to 3.5 per cent tungsten, .3 per cent to 1 per cent titanium, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

3. In a composition of matter of the class described, high temperature duty alloy iron or steel of good hot and cold-rolling characteristics possessing long life under high temperature conditions of stress, said alloy iron or steel containing as essential ingredients approximately, 18 per cent chromium, 8 per cent nickel, 3 per cent tungsten, .3 per cent titanium, .10 per cent carbon, and the balance substantially all iron.

4. In a composition of matter of the class described, high temperature duty alloy iron or steel of good hot and cold-rolling characteristics possessing long life under high temperature conditions of stress, said alloy iron or steel containing as essential ingredients, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, 2.1 per cent to 4 per cent tungsten, .30 per cent to 1.5 per cent titanium, .5 per cent to 3 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

5. In manufactures of the class described, high temperature duty alloy iron or steel bars, rods or wire containing as essential ingredients, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, 2.1 per cent to 4 per cent tungsten, .30 per cent to 1.5 per cent titanium, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

6. In a composition of matter of the class described, high temperature duty alloy iron or steel of good hot and cold-rolling characteristics possessing long life under high temperature conditions of stress, said alloy iron or steel containing as essential ingredients approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, 2.5 per cent to 3.5 per cent tungsten, .3 per cent to 1 per cent titanium, .5 per cent to 3 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

7. In manufactures of the class described, cold-rolled high temperature duty alloy iron or steel sheet and strip possessing exceptional life under high temperature conditions of stress containing as essential ingredients approximately, 18 per cent chromium, 8 per cent nickel, 2.5 per cent to 3.5 per cent tungsten, .3 per cent to 1 per cent titanium, .5 per cent to 3 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

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