

UNITED STATES PATENT OFFICE

2,115,733

ALLOY AND MANUFACTURES

Vsevolod Nicholas Krivobok, Pittsburgh, Pa., assignor, by mesne assignments, to Rustless Iron and Steel Corporation, Baltimore, Md., a corporation of Delaware

No Drawing. Application June 25, 1935,
Serial No. 28,375

10 Claims. (Cl. 75—128)

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

Among the objects of my invention is the production of alloy irons and steels, which are strong, tough and durable, which are readily workable, as by forging, upsetting, and hot and cold rolling, which readily lend themselves to a variety of shaping and forming operations, such as punching and blanking and various machining operations, such as cutting, drilling and threading, which are readily welded employing known methods and equipment, all as in the production of a variety of articles, products or manufactures, such as seamless tubes and pipes, fluid valves, flanges and bolts, pans, vats and tanks, internal combustion engine valves and valve seats, exhaust stacks, turbine buckets and nozzles and like articles, products and manufactures, especially suited for high temperature duty in the presence of corrosive or corrosion-fostering agents.

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 (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. Thus, these austenitic irons and steels, especially the 18—8 irons and steels (irons and steels containing 18% chromium, 8% nickel, and the balance substantially iron) may be used in a number of interior or exterior architectural applications, such as decorative trim, ornamentation and fixtures. Likewise, these irons and steels may be 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 fruit and vegetable acids, is desired. Similarly, these irons and steels are widely adapted for various chemical plant apparatus and equipment where metal resistant to the corrosive attack of acids, alkalis

and salts at room temperature, or slightly elevated temperatures, is required.

These austenitic chromium-nickel irons and steels, however, are not satisfactorily adaptable to extremely high temperature duty, especially high temperature duty under strongly oxidizing or corrosive conditions, 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 modified chromium-nickel alloy irons and steels, which are readily worked or formed into a variety of articles, products and manufactures, which are highly resistant to scaling, pitting and intergranular corrosion and which are resistant to wear and abrasion, all at high temperatures and under a variety of corrosive conditions over long periods of use with a minimum of break-down, replacement and repair.

As illustrative of the practice of my invention, modified chromium-nickel alloy iron or steel analyzing approximately, 18% chromium, 8% nickel, 1.5% to 2.5% cobalt, 2.5% to 3.5% molybdenum, 1.5% to 2.5% manganese, .07% to .1% carbon and the balance substantially iron, with the usual percentages of silicon, sulphur and phosphorus, is produced in a suitable manner, as for example as described in Patent No. 1,925,182 granted September 5, 1933 to Alexander L. Feild and entitled Process of the manufacture of rustless iron. The metal is first produced as ingots which are fashioned into blooms or billets in accordance with known methods and converted into tube rounds or conveniently rolled into sheet bar and strip bar sizes. The tube rounds are then pierced, forming seamless tubes, and the bar sizes are annealed and pickled and, for example, cold-rolled into sheet or strip of desired thickness.

My alloy iron or steel is essentially austenitic in structure although it contains certain new constituents in the form of complex ferrites and carbides. The alloy iron is especially resistant to corrosion and scaling as well as to embrittlement and fatigue at high temperatures in the presence of a variety of corrosive agents, including sulphur-bearing gases and vapors, in addition to the agents normally present in the atmosphere, and has a life under these conditions greatly in excess of that of known and/or used austenitic chromium-nickel irons and steels. While a forged sample of alloy iron analyzing approximately, 18% chromium, 8% nickel, 2% cobalt, 3% molybdenum, 2% manganese, .10% carbon, and the balance substantially iron, has

- a life of several hundred hours under the accelerated test conditions of a stress of 8,000 pounds per square inch, at a temperature of 1500° F. under the normal oxidizing atmospheric conditions, known chromium-nickel iron analyzing approximately, 18% chromium, 8% nickel, 10% carbon, and the balance substantially iron, has a life under these conditions of less than ten hours.
- 10 My modified chromium-nickel alloy iron or steel furthermore lends itself to a variety of working and forming operations, either from sheet, strip or bar stock. The metal readily lends itself to forging, as well as to hot and cold rolling into sheet, strip and bar stock, which is further worked or formed, as by punching, bending and like operations, followed by riveting or welding where desired, to achieve a great number of articles, products or manufactures, such as tubing, piping, 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. (Where a welding operation is employed the articles, products or manufactures are preferably heat-treated in accordance with well known methods after the welding operation is completed in order to assure maximum chemical resistance in use and achieve maximum life.) These various articles, products and manufactures are employed in the oil, photographic film, dairy, canning, paint, dye and like chemical and semi-chemical industries, giving long life with a minimum of inspection, replacement and repair.
- 35 In addition, my modified chromium-nickel alloy iron or steel is worked or formed, as above indicated, achieving a further variety of high temperature duty articles, products or manufactures, such as internal combustion engine valves, valve seats, exhaust manifolds and stacks, especially those used in automotive and aviation duty, where the scour of extremely hot gases bearing corrosive and corrosion-fostering agents is encountered. Likewise, the metal is employed in gas turbine buckets, nozzles and similar parts requiring strength, toughness, resistance to impact and shock and resistance to corrosion and scaling at high temperatures in the presence of strongly corrosive agents.
- 50 Thus, it will be seen that there is provided in this invention 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 irons or steels are strong, durable, corrosion-resistant and heat-resistant and that they readily lend themselves to working or forming into a variety of commercial products, a number of which are indicated above, 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.
- 65 While as illustrative of the practice of my invention, chromium-nickel alloy irons and steels containing approximately, 18% chromium, 8% nickel, 1.5% to 2.5% cobalt, 2.5% to 3.5% molybdenum, 1.5% to 2.5% manganese, .07% to .1% carbon, and the balance substantially iron, are specifically described, good results are achieved where the chromium content ranges between 10% and 25% and the nickel content between 7% and 15%. Similarly, good results are achieved where the cobalt content ranges between about .5% and 3%, the molybdenum content between .5% and 4%, the manganese between .5% and 4% and the carbon content between .03% and .2%. The steels of the higher chromium, nickel, cobalt, molybdenum and manganese contents are used especially in the production of a variety of cast articles and manufactures, such as furnace parts, ore treating and handling apparatus, high temperature conveyor parts and equipment and like machinery subjected to corrosive and abrasive conditions, all under high temperature conditions of operation.
- As many possible embodiments may be made of my invention and as many changes may be made in the embodiments 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, alloy iron or steel which possesses a good length of life under high temperature conditions, said alloy iron or steel comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, 5 per cent to 3 per cent cobalt, .5 per cent to 4 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.
 2. In a composition of matter of the class described, alloy iron or steel which possesses a good length of life under high temperature conditions, said alloy iron or steel comprising as essential ingredients, approximately, 18 per cent chromium, 8 per cent nickel, 1.5 per cent to 2.5 per cent cobalt, 2.5 per cent to 3.5 per cent molybdenum, 1.5 per cent to 2.5 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.
 3. In a composition of matter of the class described, alloy iron or steel which possesses a good length of life under high temperature conditions, said alloy iron or steel comprising as essential ingredients, approximately, 18 per cent chromium, 8 per cent nickel, 2 per cent cobalt, 3 per cent molybdenum, 2 per cent manganese, .10 per cent carbon, and the balance substantially all iron.
 4. In manufactures of the class described wrought alloy iron articles which possess good life under high temperature conditions, said articles comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, .5 per cent to 3 per cent cobalt, .5 per cent to 4 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.
 5. In manufactures of the class described cast alloy iron articles which possess good life under high temperature conditions, said articles comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, .5 per cent to 3 per cent cobalt, .5 per cent to 4 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.
 6. In manufactures of the class described alloy iron sheet and strip which possess good life under high temperature conditions, said sheet and strip comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, .5 per cent to 3 per

cent cobalt, .5 per cent to 4 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

5 7. In manufactures of the class described, alloy iron or steel tubes of good life under high temperature conditions, said tubes comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent
10 nickel, .5 per cent to 3 per cent cobalt, .5 per cent to 4 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

8. In manufactures of the class described, cold-
15 rolled alloy iron or steel sheet and strip comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, .5 per cent to 3 per cent cobalt, .5 per cent to 4 per cent molybdenum, .5 per cent
20 to 4 per cent manganese, .03 per cent to .2 per

cent carbon, and the balance substantially all iron.

9. In manufactures of the class described, cold-rolled alloy iron or steel sheet and strip comprising as essential ingredients, approximately, 18
5 per cent chromium, 8 per cent nickel, 1.5 per cent to 2.5 per cent cobalt, 2.5 per cent to 3.5 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

10. In manufactures of the class described, cold-
10 rolled alloy iron or steel sheet and strip comprising as essential ingredients, approximately, 10 per cent to 25 per cent chromium, 7 per cent to 15 per cent nickel, 1.5 per cent to 2.5 per cent
15 cobalt, 2.5 per cent to 3.5 per cent molybdenum, .5 per cent to 4 per cent manganese, .03 per cent to .2 per cent carbon, and the balance substantially all iron.

VSEVOLOD NICHOLAS KRIVOBOK.