Patented Aug. 7, 1928. 1,680,058

UNITED STATES PATENT OFFICE.

PAUL D. MERICA, OF NEW YORK, N. Y., AND THOMAS H. WICKENDEN, OF ROSELLE, NEW JERSEY, ASSIGNORS TO THE INTERNATIONAL NICKEL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

ADDITION MATERIAL FOR FERROUS METALS.

No Drawing. Application filed April 28, 1925. Serial No. 26,521.

Patented Aug. 7, 1928. 1,680,161

UNITED STATES PATENT OFFICE.

PAUL D. MERICA, OF NEW YORK, N. Y., AND THOMAS H. WICKENDEN, OF ROSELLE, NEW JERSEY, ASSIGNORS TO THE INTERNATIONAL NICKEL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

ADDITION MATERIAL FOR FERROUS METALS.

No Drawing. Application filed March 10, 1924. Serial No. 698,284.

Our invention relates to the adding of alloy and we preferably make the additions

Patented May 5, 1931 1,803,480

UNITED STATES PATENT OFFICE

PAUL D. MERICA, OF WESTFIELD, JAMES S. VANICK, OF ELIZABETH, AND THOMAS H. WICKENDEN, OF ROSELLE, NEW JERSEY, ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE INTERNATIONAL NICKEL COMPANY, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

GRAY CAST IRON

Application filed July 16, 1927. Serial No. 206,278.

Patented July 12, 1932 1,867,018

Patented July 12, 1932

1,867,018

UNITED STATES PATENT OFFICE

PAUL D. MERICA, OF WESTFIELD, AND JAMES S. VANICK, OF ELIZABETH, NEW JERSEY, ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE INTERNATIONAL NICKEL COMPANY, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

ALLOY

No Drawing. Application filed July 3, 1926. Serial No. 120,515.

Patented Jan. 22, 1935

1,988,910

UNITED STATES PATENT OFFICE

1,988,910

CHILL CAST IRON ALLOY

Paul D. Merica, New York, N. Y., and James S. Vanick, Elizabeth, and Thomas H. Wickenden, Roselle, N. J., assignors to The International Nickel Company, Inc., New York, N. Y., a corporation of Delaware

No Drawing. Original application October 21, 1926, Serial No. 143,293. Divided and this application June 6, 1934, Serial No. 729,236

20 Claims. (Cl. 75—1)

Patented Jan. 22, 1935

1,988,911

UNITED STATES PATENT OFFICE

1,988,911

CHILL CAST IRON ALLOY

Paul D. Merica, New York, N. Y., and James S. Vanick, Elizabeth, and Thomas H. Wickenden, Roselle, N. J., assignors, by mesne assignments, to The International Nickel Company, Inc., New York, N. Y., a corporation of Delaware

No Drawing. Application October 21, 1926, Serial No. 143,293. Renewed June 13, 1934

3 Claims. (Cl. 75—1)

This invention relates to alloys and more especially to chill cast nickel bearing iron alloys.

The invention relates particularly to castings formed by casting nickel bearing iron compositions against chills to form castings having extreme hardness in the chilled portion and improved toughness and strength in the chilled portion and in the gray iron adjacent the chilled portion. This material is well adapted for chilled

it states in the lower part of that page and in respect to the above sulphur content—"In this composition phosphorus is supposed to be well below .10%;" It is also to be noted that the ranges of analyses of American, as well as foreign, pig irons, are good indications of castings produced from pig irons as very often a definite and consistent type of pig iron must be used. Such

Patented Jan. 1, 1929. **1,697,130**

UNITED STATES PATENT OFFICE.

CHARLES McKNIGHT, JR., OF MONTCLAIR, AND THOMAS H. WICKENDEN, OF ROSELLE, NEW JERSEY, AND PAUL D. MERICA, OF NEW YORK, N. Y., ASSIGNORS TO THE INTERNATIONAL NICKEL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

NICKEL MANGANESE STEEL ALLOY AND METHOD OF TREATING THE SAME.

No Drawing. Application filed January 26, 1925. Serial No. 4,957.

Patented Mar. 7, 1933 **1,900,125**

UNITED STATES PATENT OFFICE

PAUL D. MERICA, OF WESTFIELD, JAMES S. VANICK, OF ELIZABETH, AND THOMAS H. WICKENDEN, OF ROSELLE, NEW JERSEY, ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE INTERNATIONAL NICKEL COMPANY, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

GRAY IRON ALLOY

No Drawing. Application filed October 21, 1926. Serial No. 143,294.

This invention relates to gray iron alloys sections, and a range of compositions is there-

Patented Jan. 22, 1935 **1,988,912**

UNITED STATES PATENT OFFICE

1,988,912

CHILL CAST IRON ALLOY

Paul D. Merica, New York, N. Y., and James S. Vanick, Elizabeth, and Thomas H. Wickenden, Roselle, N. J., assignors to The International Nickel Company, Inc., New York, N. Y., a corporation of Delaware

No Drawing. Original application October 21, 1926, Serial No. 143,293. Divided and this ap-

Patented Jan. 5, 1937 2,066,848

UNITED STATES PATENT OFFICE

2,066,848

CHILL CAST IRON ALLOY ROLL

Paul D. Merica, New York, N. Y., and James S. Vanick, Elizabeth, and Thomas H. Wickenden, Roselle, N. J., assignors to The International Nickel Company, Inc., New York, N. Y., a corporation of Delaware

No Drawing. Original application October 21, 1926, Serial No. 143,293. Divided and this application December 26, 1934, Serial No. 759,316

15 Claims. (Cl. 80—58)

This invention relates to alloys and more especially to chill cast nickel bearing iron alloys.

The invention relates particularly to castings formed by casting nickel bearing iron compositions against chills to form castings having extreme hardness in the chilled portion and improved toughness and strength in the chilled portion and in the gray iron adjacent the chilled portion. This material is well adapted for chilled iron wearing parts which require strength and toughness, for example, hot or cold rolls for glass and metal working, cams, gears, dies, stamps and like parts subjected to impact or heavy pressure. Our improved composition is characterized by its strength, hardness and toughness—qualities desirable in wearing parts.

We have obtained good results in practice with compositions within the following general ranges:

	Per cent
Carbon	2–4
Silicon	.25–2
Manganese	.25–2
Nickel	2–10
Chromium	Up to 4

Phosphorus and sulphur may be present within the ranges usually found in cast iron, as for instance, phosphorus .03 to 1.15% and sulphur .03 to .25%. See any edition of Kent's handbook, 1900 and later; Moldenke, Principles of Iron Founding, edition of 1917, page 198, Hatfield, Cast Iron in the Light of Recent Research; and others. In respect to the ranges of phosphorus and sulphur in chilled, white and gray iron castings such as for rolls, cams, brake shoes, gears, plow points, etc., phosphorus ranges from, under .10 to 1.0% and sulphur .04 to .25%. See particularly pages 196, 182, 183, 199 and 198 in their order of Moldenke's Principles of Iron Founding, 1917, where both the phosphorus and sulphur for chilled rolls must be, under .3 and .08% respectively, and for chilled castings in general. As indicated on page 183, the phosphorus and sulphur shall be, below .20 and .06% respectively. On page 199, it is shown "Again, the sulphur and phosphorus percentages given—except where wanted high, can be anything below the figures". In addition, page 198, there is a statement as to the percentages in the tables on the pages noted that "The tables of analyses given in the above classification of castings must, as was said at the outset, be considered only as typical". Again, in Kent's Mechanical Engineers Handbook, edition printed in 1923, attention is called to page 434, wherein sulphur is recited from .05 to .20% and it states in the lower part of that page and in respect to the above sulphur content—"In this composition phosphorus is supposed to be well below .10%. It is also to be noted that the ranges of analyses of American, as well as foreign, pig irons, are good indications of castings produced from pig irons as very often a definite and consistent type of pig iron must be used. Such ranges are to be found in Appendix II of Hatfield's Cast Iron in the Light of Recent Research, second edition 1918 and third edition 1928.

The composition may be varied somewhat, if desired, by the addition of other alloying materials, such as molybdenum, tungsten, titanium, copper, etc. The carbon content is within the general range usual for cast iron, from either air furnace or cupola.

Casting compositions lying within those ranges are particularly desirable in that good adjustment of nickel, chromium, silicon and carbon contents is secured to nicely regulate the depth of chill.

We find that the amount of chill in the chill cast iron may be maintained sensibly constant if nickel and chromium are added as alloying materials in about the ratio of 2 or 3 to 1, say about 2½ to 1. We also find that the amount of chill may be nicely controlled by suitably adjusting the various elements according to the rough rule that 1 part carbon equals 3 parts silicon, 1 part silicon equals 2 parts nickel, 1 part chromium equals 2½ parts nickel, and 1 part sulphur equals 10 parts silicon; increasing the silicon, carbon and nickel acts to decrease the chill, whereas, increasing the chromium and sulphur acts to increase the chill. The silicon and carbon contents may be lowered, if desired, by using a higher ratio of nickel to chromium than that mentioned above, the increased chilling tendency accompanying the lowered silicon and carbon contents being counteracted by the higher nickel content. It is to be noted that the foregoing is to be taken into consideration in connection with the statement and expression used

herein that the nickel is present in the proportion of 2 or 3 to 1 of chromium.

For ordinary work, however, we have obtained good results with a composition containing about the following percentages:

	Per cent
Carbon	3.0
Manganese	.6
Silicon	1.0
Nickel	4.5
Chromium	1.5

Phosphorus and sulphur may be present within the ranges usually found in cast iron, as indicated above.

Such a composition, if chill cast, will give a white iron having a Brinell hardness of 550, as compared with the 400–500 of ordinary chilled iron. The chilled metal under tension has a transverse strength of 8000 pounds for 1¼ inch square bars tested on 12 inch centers in comparison with about 6000 pounds for ordinary high carbon chilled iron Gray iron having this composition has a tensile strength of about 35,000 pounds per square inch in comparison with 20,000 to 25,000 psi for high carbon iron ordinarily used for chill work.

Our composition has the further advantage that it is subject to heat treatment and the hardness and toughness may be so modified, if desired.

The composition is not only extremely hard in the chilled condition, but it is strong and tough both in the chilled condition and in the gray condition. These characteristics render the composition desirable for chilled castings to be subjected to heavy pressure or impact, since such castings are less liable to breakage than ordinary chilled iron castings.

We are aware that nickel has been proposed as an addition material to reduce the chilling effect in iron alloys, and that chromium has been proposed as a hardener. We have found, however, that a proper proportion should be maintained between the nickel and chromium with respect to the silicon and carbon if the composition is to be rendered hard, and yet tough and strong. By properly proportioning the alloying elements, we have produced an improved iron alloy adapted to be chill cast to form an exceedingly hard and tough white iron with a strong, tough gray iron adjacent thereto.

We have found that the hardness of chilled cast iron castings made under our invention is due to the fact that the matrix portion of the iron is changed from the softer pearlite of ordinary chilled iron castings into the harder martensite or troostite. Martensite is often associated with austenite and hence by "martensite", we mean martensite or austenite or both in association. Hence the resulting hardness is between that of the very hard iron carbide grains and the martensite having a Brinell hardness of from 550 up to about 750 where the carbon is about 3.50%. This hardness may be regulated somewhat by proportions of the alloy or the use of equivalents.

A further important advantage of our invention resides in the provision of an improved chill casting alloy wherein the depth of chill may be nicely controlled by suitable adjustment of the addition elements. Cast iron of our composition may be made either in the air furnace or cupola, and we intend to cover such composition of cast iron made in either type of furnace.

The present application is a divisional case of our co-pending application, Serial No. 143,293, filed October 21, 1926.

We claim:

1. A high carbon chilled iron alloy roll having a definite chill and containing a small amount of silicon to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the silicon being not to exceed .65 and being in such small quantity as to offset or compensate the chill destroying or reducing effect of the large amount of nickel.

2. A high carbon chilled iron alloy roll containing a small amount of chromium to ensure the definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the chromium being not to exceed .35 and being in such small quantity as to ensure the definite chill notwithstanding the substantial quantity of nickel.

3. A high carbon chilled iron alloy roll containing a small amount of manganese to ensure the definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the manganese being not to exceed .27 and being of such small quantity as to ensure the definite chill notwithstanding the substantial quantity of nickel.

4. A high carbon chilled iron alloy roll containing small amounts of silicon and chromium to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the silicon being not to exceed .65 and chromium not to exceed .35 and both being in such small quantities as to ensure the definite chill notwithstanding the substantial quantity of nickel.

5. A high carbon chilled iron alloy roll containing small amounts of silicon and manganese to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the silicon being not to exceed .65 and manganese being not to exceed .27 and both being in such small quantities as to ensure the definite chill notwithstanding the substantial quantity of nickel.

6. A high carbon chilled iron alloy containing small amounts of chromium and manganese to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the chromium being not to exceed .35 and the manganese being not to exceed .27 and both being in such small quantities as to ensure the definite chill notwithstanding the substantial quantity of nickel.

7. A high carbon chilled iron alloy roll containing small amounts of silicon and chromium and manganese to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the silicon being not to exceed .65, the chromium being not to exceed .35 and the manganese being not to exceed .27 and all being in such small quantities as to ensure the definite chill notwithstanding the substantial quantity of nickel.

8. The method of making chilled iron alloy rolls which consists in ensuring a chill by using small quantities of silicon, manganese and chromium and securing hardness of said chill by employing carbon and nickel from about 3.25 to about 3.35 carbon and from about 4.75 to about 5.0 nickel.

9. The method of making chilled iron alloy rolls which consists in ensuring a chill by using small quantities of silicon, manganese and chromium and securing hardness of a varying degree

by using carbon and nickel in varying amounts from about 3.25 to about 3.35 carbon and from about 4.75 to about 5.0 nickel.

10. A chilled iron alloy roll having a definite chill and containing a hardening and toughening agent such as carbon and nickel, in an amount within certain limits to produce a desired degree of hardness and toughness and also containing a chill affecting ingredient such as silicon in amount between certain limits to cooperate with the amount of hardening and toughening agent employed and not to exceed 1.0, and also containing a further hardening agent.

11. A chilled iron alloy roll containing a hardening and toughening agent such as carbon and nickel, in amount between certain limits to secure a desired degree of hardness and toughness, and also containing other ingredients to retain the chill and give it desired characteristics such as silicon and manganese, said other ingredients being in amounts between certain limits to cooperate with the amount of hardening and toughening agent employed and not to exceed 1.0 silicon and .40 manganese, and also containing a supplemental hardening agent.

12. A chilled iron alloy roll containing a hardening and toughening agent such as carbon and nickel, in amount between certain limits to give a desired degree of hardness and toughness, and also containing silicon, manganese, chromium and sulphur in amounts between certain limits, so that the silicon and manganese will act to control the chill and the chromium and sulphur to give the desired qualities in view of the amount of hardening and toughening agent employed the silicon being not to exceed 1.0 and the manganese not to exceed .40 and the chromium not to exceed .65, and also containing molybdenum to act as a hardening agent in cooperation with the other ingredients.

13. A high carbon chilled iron alloy roll having a definite chill and containing a small amount of silicon to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the silicon being not to exceed about 1.0% and being in such small quantity as to offset or compensate the chill destroying or reducing effect of the large amount of nickel.

14. A high carbon chilled iron alloy roll containing a small amount of manganese to ensure the definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the manganese being not to exceed about .6% and being of such small quantity as to ensure the definite chill notwithstanding the substantial quantity of nickel.

15. A high carbon chilled iron alloy roll containing small amounts of silicon and manganese to ensure a definite chill and also containing a substantial quantity of nickel to secure toughness of said chill, the silicon being not to exceed about 1.0% and manganese being not to exceed about .6% and both being in such small quantities as to ensure the definite chill notwithstanding the substantial quantity of nickel.

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