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UNITED STATES PATENT OFFICE

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IRON ALLOY

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The present invention relates to an improvement in the manufacture of cast iron, or ferrous alloys having the chemical characteristics of cast iron, that is, which have carbon in excess of 2.25%. The cast iron embodying my invention may be in the form of gray iron, or chilled cast iron or acid resisting iron and is particularly useful for the manufacture of chilled rolls for rolling mills and similar articles which are subjected to heavy strains or loads, and to sudden changes of temperature over a wide range. Such rolls must have a hard surface to resist the wear to which they are subjected, and have great strength, particularly when they are of considerable length and diameter. The tendency in modern rolling mill practice is towards increased production with the same amount, or even a less amount of equipment, through increased speed on the part of the mill rolls, and greater reduction in each pass. At the same time, efforts are being made to reduce power losses through friction, particularly in the bearings of the mills, and as a result of this effort there has been created a demand for rolls having smaller necks than those heretofore used. For these reasons, together with the fact that the rolls of a mill are being continually subjected to increased stresses, strains, shocks and vibrations as the output of the mills is stepped up, and the fact that mill rolls must stand up under peculiarly rough usage, the metal of which the rolls are composed must have extraordinary strength, toughness and durability, without sacrificing those characteristics of the roll surface which are required for the most satisfactory results on the product of the mill, and further without prejudicially affecting the cost of the roll or the facility with which it can be manufactured. Such rolls can be made of steel but cast iron is much more desirable as the cost of finished rolls may be anywhere from a half to a fifth of the cost of steel rolls of the same dimensions. However it has been found in the past that cast iron rolls of large dimensions frequently break in service, or crack or split. This has been thought to be due to the loads to which they are subjected and attempts have been made to overcome this by increasing the thickness in the case of hollow rolls or by strengthening the material in the case of solid rolls, or by using steel.

I have discovered however that by using a combination of proper amounts of certain alloying elements in certain definite proportions, a cast iron alloy is produced having entirely novel characteristics and at a cost only slightly in excess of ordinary cast iron and that chilled rolls and other similar articles subjected to heat and stresses and made from my novel cast iron are much stronger and more durable and are not subject to the defects heretofore commonly observed in such rolls.

The invention is based in part on the discovery that the breakage of chilled rolls is not ordinarily due to the stresses to which they are subjected by their loads but is due to the different rate of expansion of the chilled and gray iron (unchilled) portions; and in part to the discovery that the presence of certain alloying elements tends to vary the co-efficients of expansion of the chilled iron and the gray iron portions respectively, and also the distribution of heat throughout the mass can be thereby varied so that it will not set up so great stresses in the article.

In practice, I find that small amounts of copper in the presence of small but sufficient quantities of molybdenum gives to the cast iron the characteristics required and that the hardness required can be attained by the use of chromium in quantities determined by the use to which the roll is to be put, without destroying the effects of the copper and molybdenum. The depth of chill required can be regulated by the amount of silicon or other suitable elements, which counteract the tendency of the copper to reduce the depth of chill and by the proper balancing of the several elements, as will be apparent to those skilled in the art. Manganese, sulphur and phosphorus will also be present in quantities according to the uses to which the finished material is to be put, it being understood that manganese is normally a hardening ele-

ment, but that in the presence of sulphur depending on the ratio of the two it tends to soften the product.

In forming the alloy and casting the same, the more or less usual process used in the production of iron for casting is not unduly complicated. The charge made up as usual of pig iron and scrap, together with the alloy additions, including silicon, is melted in a suitable furnace, or added in the ladle.

The cast iron embodying my invention in its broad aspects contains: carbon, more than 2.25%; copper, from 0.25 to 2.00%; molybdenum, from 0.10 to 2.00%; chromium, from 0.25 to 3.50%; silicon, not less than 0.25%; sulphur, from 0.02 to 0.20%; manganese, from .10 to 3.00%; the balance to make up 100% being of iron except for usual impurities. The addition of small amounts of other alloying elements may perhaps be made without affecting the essential qualities of the product.

For chilled rolls the proportions may be within the following ranges: carbon, more than 2.25%; copper, from 0.25 to 1.00%; molybdenum, from .10 to .75%; silicon, more than .25%; sulphur, from .02 to .18%, with or without chromium in quantities up to 2.50% depending on the properties required, the balance to make up 100% being iron except for usual impurities.

My preferred formula for chilled rolls for hot metal work is as follows:

	Per cent
Carbon	3.00
Copper	0.50
Molybdenum	0.50
Chromium	1.50
Silicon	1.25
Sulphur	0.07
Manganese	0.20

A suitable composition for gray iron is as follows:

	Per cent
Carbon	3.50
Copper	0.75
Molybdenum	.50
Chromium	2.00
Silicon	2.25
Sulphur	.8–.18
Manganese	.40–3.00

A suitable composition for acid resisting iron is as follows:

	Per cent
Carbon	3.50
Copper	.75
Molybdenum	.50
Chromium	3.00
Sulphur	.18
Silicon	3.25
Manganese	.40–3.00

It is manifest that various changes in these compositions, such, for example, as the use of one per cent of chromium instead of two per cent in the gray iron composition, fall within the limits hereinbefore given.

The herein described compositions while having the desired physical characteristics can be made at relatively low cost since copper is a very cheap alloying element and the amount of molybdenum required is small, the result being that the final cost even when chromium is used is exceedingly low considering the qualities of the articles produced.

I believe myself to be the first to recognize the fact that by the use of certain alloying elements and particularly those mentioned herein it is possible to control and regulate the thermal effects and properties of articles, especially chilled rolls which are subjected to heavy loads and changes of temperature over wide ranges, and thereby to overcome the defects which have been erroneously thought in the past to have been due to insufficient strength.

I do not claim herein a cast iron alloy containing coper in effective amount and more than 2.25% carbon, together with from 0.15% to 2% molybdenum, as claimed in my divisional application, Serial No. 382,837, filed August 1st, 1929.

What I claim is:—

1. A cast iron alloy containing carbon more than 2.25%, copper from .25% to 2%, molybdenum .10% to 2% and chromium in effective amount up to 3.50%.

2. A cast iron alloy containing carbon more than 2.25%, copper from .25% to 1%, molybdenum from .10% to .75%, and chromium in effective amount up to 2.50%.

3. A cast iron alloy chilled roll containing carbon 3%, copper .50%, molybdenum 0.50% and chromium 1.50%.

4. A cast iron alloy chilled roll containing carbon 3%, copper .50%, molybdenum 0.50%, chromium 1.50% and silicon 1.25%.

In witness whereof, I have hereunto set my hand this 28th day of January, 1928.

ALAN F. HILTON.