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FERROUS ALLOYS

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The invention relates to ferrous alloys and more particularly to a hard-facing ferrous alloy which is especially adapted for use in the form of welding rods or in castings.

The practice of hard-facing equipment subject to severe abrasions or impact, or both, is well known in those industries which are continuously confronted with the high cost of replacing certain parts that wear out rapidly. However, because of the high cost of good hard-facing metals, this practice has been confined in some industries, such as earth removing equipment, to a relatively small number of parts where extreme abrasion is encountered and where the area to be coated is quite small.

On larger surfaces that require considerable hard-facing metal, the high cost of the expensive hard-facing metals now in general use, together with the labor of making the applications, is too high for the average operating man to gamble with, even though he believed that hard-facing would eventually show a saving.

For this reason hard-facing is not used in many cases where it is badly needed and would increase the efficiency of equipment by maintaining the original dimensions for a much longer period of time in service.

The high cost of the alloy types of hard-facing rods is due to the large amounts of a number of expensive alloys contained therein. This has come about because these welding rods were developed not only to resist ordinary abrasion and impact, but also wear caused by other feature such as high temperatures, corrosion, the erosive action of super-heated steam and the like, requiring certain combinations of such alloys in order to obtain all of the properties required for such a wide range of applications.

Hard-facing alloys are generally grouped and rated by the alloy content, and the service expected is usually measured by the amount of alloys contained in the welding rod or casting.

The A. S. M. Metals Handbook, 1948 edition, at page 722, groups hard-facing alloys as follows:

Group 1. Alloy steels that contain less than 20% of alloying elements.
Group 2. Ferrous alloys that contain more than 20% of alloying elements.
Group 3. Nonferrous alloys.
Group 4. So called "diamond" substitutes.
Group 5. Crushed tungsten carbides of various screen sizes.

The present invention is not concerned with the last three groups. Group 1 contains less than

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20% of alloying elements and has greater toughness and resistance to shock than the alloys of group 2, although it is not as hard and has less resistance to abrasion than the higher priced alloys of group 2.

The present invention contemplates the provision of a ferrous alloy with less than 20% of alloying elements, which will retain the inherent toughness and resistance to shock of the alloys of group 1 and will at the same time have equal or better resistance to abrasion than the alloys of group 2 so as to combine the best features of both groups 1 and 2.

Another object is to provide ferrous alloys for hard facing and casting purposes that have resistance to both wear and abrasion on hot and cold applications.

A further object is to provide a low-priced ferrous alloy for hard-facing and casting purposes which has a high resistance to wear and abrasion as well as to impact.

A still further object is to provide a ferrous alloy for hard-facing and casting purposes which has a high resistance to wear and abrasion and which contains considerably less than 20% of alloying elements.

The above, together with other objects, which will be apparent from the following description or which may be later referred to, may be attained by carrying out the invention in the manner hereinafter described in detail.

The improved hard-facing ferrous alloy to which the invention pertains is a lower priced alloy for the general abrasive field, produced by limiting the use of the expensive alloys ordinarily used for such purpose so as to produce a metal that will give excellent service at a reasonable cost.

This ferrous alloy has sufficient red hardness to withstand the heat generated by friction, and is also suitable for ordinary steel mill applications where moderate high temperatures are encountered, beside having excellent resistance to abrasion and great toughness, which will withstand severe shock and impact.

This alloy has the following analysis range.

carbon	chromium	nickel	molybdenum	vanadium
Percent 1 to 3.75	*Percent* 1 to 3	*Percent* 1 to 3	*Percent* .25 to 4	*Percent* .25 to 3

This alloy has a hardness of 35 to 60 Rockwell C. and the hardness can be controlled by varying the amounts of the ferrous alloys to meet the

conditions in different industries. It has been found that the addition of a small amount of silicon increases the hardness of ferrous alloys made within the above range, and although excellent results have been obtained by the use of the above alloys only, the remainder being iron, the addition of about 1.5% silicon to the above gives excellent results.

It is also desirable in some cases to add a small amount of copper to the above analysis, either with or without the silicon, the amount of copper varying from .50% to 2%.

An example of an alloy made in accordance with the invention, which actual service tests have proven has given longer life than metals in the above mentioned group 2 is of the following analysis:

chromium	nickel	molybdenum	vanadium	carbon
Percent 3	*Percent* 3	*Percent* 1	*Percent* .50	*Percent* 3

An alloy of this analysis has given excellent results for hard-facing the hammers of hammer mills.

This alloy can be used efficiently in the general abrasive field, such as earth moving machinery, coal crushing machinery, brick and clay machinery, steel plant applications where heat and abrasion are encountered, such as slag and coke handling apparatus, cement machinery and other industries where severe abrasion and impact are encountered.

The addition of about 1.5% silicon to this analysis will increase the hardness of the alloy, and a small amount of copper, .50% to 2% may also be added if desired with very good results.

Thus, lower priced hard-facing ferro alloys for welding rods and castings for the general abrasive field, produced by limiting the use of the expensive alloying elements generally used, produces a metal that will give excellent service at a reasonable cost.

Besides having great toughness which will withstand severe shock and impact, this metal has excellent resistance to abrasion and is thus a considerable advantage over the high priced welding rods at present in use which have great hardness but lack the toughness necessary to withstand the combination of abrasion and severe shock or impact.

I claim:

1. A ferrous alloy containing about 1% to 3.75% carbon, about 1% to 3% chromium, about 1% to 3% nickel, about .25% to 4% molybdenum, about 1.5% silicon, and about .25% to 3% vanadium, the remainder of said alloy being iron.

2. A ferrous alloy containing about 3% carbon, about 3% chromium, about 3% nickel, about 1% molybdenum, and about .50% vanadium, the remainder of said alloy being iron.

3. A ferrous alloy containing about 3% carbon, about 3% chromium, about 3% nickel, about 1% molybdenum, about 1.5% silicon, and about .50% vanadium, the remainder of said alloy being iron.

4. A ferrous alloy containing about 3% carbon, about 3% chromium, about 3% nickel, about 1% molybdenum, about .50% to 2% copper, and about .50% vanadium, the remainder of said alloy being iron.

5. A ferrous alloy containing about 3% carbon, about 3% chromium, about 3% nickel, about 1% molybdenum, about 1.5% silicon, about .50% to 2% copper, and about .50% vanadium, the remainder of said alloy being iron.

6. A ferrous alloy containing about 3% carbon, about 3% chromium, about 3% nickel, about 1% molybdenum, about .50% vanadium, up to 2% copper, up to 1.50% silicon, the copper when present being at least .50% and the silicon when present being in an amount of about 1.50%, the remainder of said alloy being iron.

7. A ferrous alloy containing about 1% to 3.75% carbon, about 3% chromium, about 3% nickel, about 4% molybdenum, about 3% vanadium, the remainder of said alloy being iron.

8. A ferrous alloy containing about 1% to 3.75% carbon, about 3% chromium, about 3% nickel, about 1% molybdenum, about .50% vanadium, the remainder of said alloy being iron.

9. A ferrous alloy containing about 3% carbon, about 1% to 3% chromium, about 1% to 3% nickel, about .25% to 4% molybdenum and about .25% to 3% vanadium, up to 2% copper, up to 1.50% silicon, the copper when present being at least .50% and the silicon when present being in an amount of about 1.50%, the remainder of said alloy being iron.

10. A ferrous alloy containing about 3% carbon, about 1% to 3% chromium, about 1% to 3% nickel, about .25% to 4% molybdenum, and about .25% to 3% vanadium, the remainder of said alloy being iron.

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