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ALLOY STEEL.

No Drawing.

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To all whom it may concern:

Be it known that I, W NORMAN BRATTON, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Alloy Steel; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in alloy steels and provides a commercial composition of alloy steel presenting many advantages.

The improved alloy steel of the present invention is a manganese steel containing a relatively high content of manganese, e. g. from 1 to 2.5%, and also containing nickel and molybdenum.

It has heretofore been proposed to add nickel to manganese steels, but with nickel and manganese alone, the steel has a limited range of treatment which it is necessary to control carefully, and segregation often reduces or nullifies the improved physical properties.

The improved alloy steel of the present invention is an improvement upon nickel-manganese steels, possessing improved physical properties, and making these improved properties available for commercial uses. The limitations and disadvantages of nickel-manganese steels are overcome, the range of treatment is widened out, and danger of segregation relieved, through the incorporation of molybdenum in the nickel-manganese steel.

The new alloy steels in general contain from 1 to 2.5% manganese, from a fraction of a per cent up to about 1.25% of molybdenum, and from a fraction of a per cent up to about 3.5% nickel. The steel may contain varying amounts of the other usual ingredients such as carbon, silicon, etc., and may also contain other alloying metals.

The new alloy steel has the advantage from a manufacturing standpoint that two of the elements, molybdenum and nickel, are practically loss proof with both basic and acid slags so that the molybdenum and nickel may be added at the outset and may remain in the molten metal throughout the manufacture of the steel, or they may be

added during the process of manufacture and before the process is completed. Consequently, when the steel is ready to be tapped, and when the molybdenum and nickel have been already added, the only calculations and additions necessary are for giving to the steel the desired content of manganese, and the desired content of other ingredients such as carbon and silicon. These additions at the time of tapping simplify the steel making process and make it similar to a plain carbon steel process. That is, the molybdenum and nickel can be added in the desired amounts during the furnace process, and the manganese, carbon and silicon can be added as the result of a final calculation similar to that employed in the case of plain carbon steel. This simple process nevertheless enables the desired molybdenum-nickel-manganese steel to be produced with a high manganese content and with the desired content of molybdenum and nickel, while it also permits the content of other ingredients such as carbon and silicon to be regulated and controlled.

Nickel toughens the steel and manganese strengthens it, while the nickel and manganese throughout the steel amplify the toughness, strength and resistance to wear-producing properties of the highly active molybdenum, or vice versa, or these three metals otherwise interact with each other and with the other ingredients of the steel to give the improved physical properties, such as toughness and strength. Nickel and manganese lower the temperature at which the carbon changes from one state (austenite) to another state (pearlite), which action is one of the responsible causes for setting and deepening of the hardening effect; while molybdenum strongly intensifies the hardening effect. Molybdenum and manganese are also highly powerful elements in delaying the dissociation of the hardening carbon condition.

One of the advantages of the stability of this carbon condition in the steel is the resistance to wear of the surface of the steel, especially under conditions where the surface is heated. Another advantage of the stability of this carbon condition in the steel is that cooling strains within the steel are relieved by the time and heat necessary to dissociate this carbon condition. Another important advantage is the finely divided