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WELDING ROD.

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This invention relates to the manufacture of steel products, particularly those which in the course of their production, pass through the operations of the wire drawing mill. The objects of the invention are to increase the efficiency of such products, to provide a method whereby articles of desired composition and characteristics may be produced and to insure uniformity of production.

The invention is especially useful in the manufacture of rods and wire for metallic arc welding purposes and in the production of rivets, stapling and crimping wire and other articles requiring special physical characteristics to best adapt them for the uses in which they are employed.

Experience has proven that steel produced by the basic open hearth process provides the best material for welding rods, rivets, stapling wire and the like. In practice the molten steel is poured from the furnace into an ingot mould where it cools and solidifies. The ingot is hot rolled into a billet and the billet then hot rolled into a round wire rod from one to three-sixteenths inch in diameter and usually several hundred feet in length. This is coiled and constitutes the raw material of the wire mill.

During the process of hot rolling, the steel is necessarily exposed to the air, the result being that an iron oxide, generally called scale, is formed on the surface of the rod. This scale is very hard and brittle and must be removed before wire drawing is possible. In practice the scale is removed by treatment in a bath of hot dilute sulphuric or other acid, this step being referred to as pickling. After the scale is removed the rods may be allowed to stand until they have accumulated a rust or sull coat, which has value as a lubricant in the wire drawing operations. An additional lubricant is provided by dipping the rods in a tub of hot lime water and then baking. The drawing consists of successive passes of the rod through dies which gradually reduce the diameter and increase the length until wire of the desired gauge is produced.

Throughout these several operations the steel retains the characteristics assumed upon solidification in the ingot mould. The cross-sectional composition of the ultimate wire is the same as that of the original ingot. In many products of the wire mill, as for instance, in filler rods for welding purposes, the character of the surface portion of the article is of extreme importance.

In fusion welding, one of the common causes of weld failures is the presence of blow holes in the weld. These blow holes are said to be often caused by gas present in the filler rod, the objectionable gas being hydrogen.

In the making of steel, gas may be effectually removed by various methods, as by the addition of a degasifying agent, or by the addition of an agent plus ebullition, or by ebullition alone, the steel which results from such treatments being known, respectively, as killed steel, rimmed steel and open steel. However, in the pickling process heretofore referred to an additional source of gas is encountered. A chemical reaction takes place in the acid pickling bath during which free hydrogen is liberated from the acid. It is well known that hydrogen is most active, chemically, at the moment of its liberation from a compound. In this state it is referred to as nascent hydrogen. It is also well known that iron and steel have a strong tendency to absorb hydrogen, especially when the latter is in the nascent state.

Under ordinary conditions of wire mill operation the steel absorbs very great quantities of nascent hydrogen during the pickling operation or, at least, condenses it on the surface of the rod. This absorption tends to make the rod brittle and to render it unfit for drawing. It has been the practice to remove a portion of this hydrogen, by baking at oven temperature, but it can not be completely so removed, and it is possible that that which remains is a contributing cause of inferior results from the use of welding rods, particularly from the standpoints of irregular melting and blow holes in the weld.

It appears that the presence of sulphur, beyond a definite proportion, in the surface portion of the coiled steel rod has the effect to induce absorption of hydrogen during the pickling step, and to invite attack by the acid of the pickle solution. It also appears that if the sulphur content in the surface portion of the ingot be reduced to .025 or below, the resultant rod will be resistant to the attack of the acid, and will not absorb the free hydrogen liberated by the reaction during the pickling treatment. Further-

more that a welding rod produced from a steel of this character, other factors being correct, will insure a steady melting rod and, if properly applied, will effect an efficient, completely fused weld, free from blow holes. Whether or not the improvement in the rod is due to the resistance to the attack of the acid, or to the non-absorption of hydrogen, or to some other cause, will not be the subject of agreement and is not material. I have definitely determined, however, that in respect of wire mill operations a critical value of less than .025% sulphur in the surface portion of steel exists and that this fact can be used to advantage to improve the products of the wire mill and to bring about standardized results. I have shown how welding rods are improved by using such steel.

In the manufacture of rivets, crimping wire, stitching wire for staples and in other cold-drawn rod or wire products requiring a high surface ductility and a more rigid center, steel having a surface sulphur content below .025% and a higher central content is especially useful. In all manufacture in which such steel is used there is far less scrap in drawing, acid brittleness is eliminated and the problem of frequent breaking during drawing has been overcome.

In making steel with the desired low surface sulphur content I prefer to segregate the sulphur from the surface toward the center, rather than to eliminate it altogether. It is possible to control the casting and cooling of a heat of steel so that concentration of sulphur in the center portion of the ingot will reduce the sulphur content in the surface portion below .025%. To bring about this result I have found it desirable to employ the highest pouring temperature that is commercially practicable, to remove gas from the molten metal in accordance with the practice which produces rimmed steel, and to use the largest size of commercial ingot mould, the latter to have extremely thick walls, but not so thick as to produce a chilled casting even at the surface. For example, I may employ an ingot 20″ x 22″, having five inch walls and pour the molten metal at a temperature of about 2800° F. (1538° C.). I find that good results are obtained when the steel has a carbon content from .06 to .10%, manganese .30 to .45%, sulphur .035 to .060% and with a very low content of other impurities. The ingot may then be rolled into billets and rods. By the term "surface portion" as referred to herein, I mean to include the steel in the peripheral portion of ingots, billets, rods and wire to a depth of about 10% of the diameter thereof.

Other means of accomplishing the segregation, or disposition, or removal of sulphur to arrive at a surface content below the critical value of .025 may occur to those skilled in the art of steel making and other uses for steel of this character may be found. Alternative methods, modifications and extensions within the scope of the invention are contemplated in presenting the following claims.

I claim:

1. A ferrous welding rod having a small sulphur content below .025% in the surface portion thereof, and higher in the center portion.

2. A ferrous welding rod or wire having a distributed sulphur content which in the surface portion is less than .025% and in the center portion is more than .025%.

3. A ferrous welding rod or wire containing sulphur throughout the same, the sulphur content being greater in the center portion than in the surface portion, and being less than .025% in the surface portion.

In testimony whereof I have hereunto subscribed my name.

J BIRCHARD GREEN.