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FREE MACHINING STEEL

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4 Claims. (Cl. 75—129)

This invention relates to the production of free machining steels.

As is well known, sulfur is added to steels to improve their machining properties. A common practice has been to add the sulfur either in elemental, or uncombined, form or as a sulfur compound of iron, usually iron sulfide. Although free machining properties are thus conferred upon the steel, experience has shown that both elemental sulfur and iron sulfide tend to cause the steel to develop surface imperfections such as tears, checks or cracks. More recently sulfur has been added to steel for this purpose in the form of molybdenum sulfide, for instance as molybdenite, and although this does not cause the production of surface imperfections it is not applicable to all steels because the presence of molybdenum is undesirable in some steels, at least for some purposes. A further disadvantage of prior practice involving the addition of sulfur to steel has been due to the fact that in general it has involved the use of amounts of sulfur in excess of those normally present or permitted by steel specifications such as those of the Society of Automotive Engineers (S. A. E. steels), which may be undesirable either from the fabricating standpoint or because of its effect upon certain properties of the steels.

It is among the objects of this invention to provide steels combining normal sulfur content with free machining properties while repressing or eliminating the disadvantages referred to above.

A further object is to provide steels of free machining grades in which surface imperfections are reduced or minimized without the use of molybdenum or molybdenum sulfide, and which possess free machining properties equivalent to those obtained heretofore by the use of sulfur, iron sulfide or molybdenum sulfide.

Yet another object is to provide a simple, easily practiced and economical method of producing free machining steels without the objections heretofore attendant therein, which does not interfere with standard steel making practice and requires no special or unusual heat treatment of articles made therefrom, which is applicable both to electric and open hearth steels, and which permits meeting the sulfur specifications of S. A. E. steels.

A further object is to provide a method of making manganese sulfide which is easily performed, efficient, and does not require elaborate or expensive apparatus or materials.

Other objects will appear from the following description.

The invention is predicated upon my discovery that the addition of sulfur in the form of manganese sulfide to steel confers free machining properties upon the steel with suppression or minimizing of the disadvantages heretofore encountered in making steels of free machining grades. For instance, the tendency to form surface imperfections which attends the use of iron sulfide or sulfur is greatly reduced, yet in this manner steels may be provided having machining qualities equivalent to those produced by the use of sulfur and iron sulfide. No molybdenum is added to the steel so that the invention is applicable to those in which that element is undesirable, but free machining qualities like those due to the use of molybdenum sulfide are obtained. Again, the manganese sulfide reagent supplies not only sulfur to the steel, but also manganese which is necessary or desirable in substantially all steels.

The invention is applicable as far as I am now aware to substantially all steels whose machining properties are improved by the use of sulfur, for example the so-called S. A. E. steels, not only of the plain carbon, but also of the alloy grades. It is applicable also to steels containing molybdenum as well as to those in which molybdenum is undesirable for any reason. The invention has been applied, by way of example, to various types of steels. For instance, a heat of steel made to a specification of 0.2 per cent of carbon, 0.15 to 0.25 per cent of molybdenum, and 0.6 to 0.9 per cent of manganese was treated with manganese sulfide in the ladle to produce a final sulfur content of 0.037 per cent. This steel was heat treated to produce a structure comprising blocky sorbitic pearlite at a hardness of about 170 to 179 Brinell, and its machining qualities were comparable to those of free machining steel made to this specification by prior practice. It has been applied also, by way of further example but not of limitation, to steels such as S. A. E. 4615 and 4620.

In the practice of the invention the manganese sulfide is preferably added to the steel in the ladle after it has been tapped from the furnace, either open hearth or electric, and the steel is then cast into molds and treated according to usual practice. The amount of manganese sulfide added will depend upon the particular steel being treated and the results sought, but in any case sufficient manganese sulfide is added to confer free machining qualities in the steel. For

most purposes it is added in an amount such that the finished steel will contain from about 0.02 to about 0.06 per cent of sulfur. This makes it possible to produce steels of free machining grades while meeting the sulfur specifications of S. A. E. steels which, except for the class identified as "free cutting steels," fix the maximum sulfur content at from 0.03 to 0.055 per cent, depending upon the particular type of steel. In such preferred practice the amounts of manganese and sulfur added are too low to cause segregation, or unusual segregation, because both elements are present in normal amounts. It is possible, of course, to use larger amounts of sulfur in special instances.

The free machining qualities provided by the invention are not, so far as I am aware, superior to those heretofore obtainable although they are in general equivalent to those obtained in prior practice. However, particular advantages of the invention reside in the provision of such free machining qualities without the development of surface imperfections, or with repression of such defects, coupled with the ability to provide such qualities without the use of molybdenum and without exceeding the sulfur specifications for S. A. E. steels.

Steels produced in accordance with the invention do not require any specific heat treatment in consequence thereof but rather are heat treated in accordance with ordinary practice depending upon the particular alloy and the uses to which it is to be put.

The invention provides also a method of making manganese sulfide, particularly for use in the practice of the process. Experience has shown that this material can not be made, at least satisfactorily or economically, by the addition of sulfur to molten ferro-manganese. I have discovered, however, that by locally igniting a mixture of pulverulent manganese or material rich in metallic manganese, for example a rich ferro-manganese, with elemental sulfur, there is initiated an exothermic reaction which proceeds throughout the mixture with production of manganese sulfide. Preferably the sulfur is mixed with the manganese material in an amount equal to the weight of the manganese present, to insure complete reaction of the two. This provides an excess of sulfur over the theoretical ratio (56 parts Mn, 32 parts S), as some sulfur is lost by oxidation during burning. As an example, 90 parts of 80 per cent ferro-manganese crushed to 20-mesh size are mixed with 72 parts by weight of flowers of sulfur. The mixture is touched with a hot poker to initiate reaction. Examination by the X-ray diffraction method of product made in this way has shown it to be largely manganese sulfide.

The method of making manganese sulfide disclosed herein is disclosed and claimed in a divisional application filed January 3, 1940, Serial No. 312,225.

According to the provisions of the patent statutes, I have explained the principle and method of practicing my invention and have described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. In a method of making free machining steel by the addition of sulfur to the steel, the steps comprising supplying said sulfur by mixing with the steel manganese sulfide in an amount to confer free machining properties upon the steel but less than the carbon content of the steel.

2. In a method of making free machining steel by the addition of sulfur to the steel, the steps comprising supplying said sulfur to the steel by mixing with it manganese sulfide in an amount to provide the finished steel with from about 0.02 to 0.06 per cent of sulfur said sulfur content being less than the carbon content of the steel.

3. In a method of making free machining steel by the addition of sulfur to the steel, the steps comprising mixing the steel in a ladle with manganese sulfide in an amount to confer free machining properties upon the steel but less than the carbon content of the steel, and casting said steel into a mold, and thereby producing steel having free machining qualities and of improved surface quality as compared with steel of the same composition made by adding sulfur as such or as iron sulfide.

4. In a method of making free machining steel by the addition of sulfur to the steel, the steps comprising mixing the steel in a ladle with manganese sulfide in an amount such as to provide the finished steel with from about 0.02 to 0.06 per cent of sulfur said sulfur content being less than the carbon content of the steel, and casting said steel into a mold, and thereby producing steel having free machining qualities and of improved surface quality as compared with steel of the same composition made by adding sulfur as such or as iron sulfide.

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