Patented Mar. 21, 1950 2,501,138

UNITED STATES PATENT OFFICE

2,501,138

GLOBULAR INCLUSION CONTROL FOR STEEL MAKING

James T. Parker, Indianapolis, Ind., assignor to W. J. Holliday & Company, Inc., Indianapolis, Ind., a corporation

No Drawing. Application November 17, 1948, Serial No. 60,619

2 Claims. (Cl. 75—129)

1

This invention relates to the control of manganese sulphide inclusions in the production of steel.

In the making of low carbon steel, it is known that free machining steels capable of case hardening and having high ductility and tensile strength can be produced by suitable additions as by increasing the sulphur and manganese content. High carbon steels are suitable for heat treatment.

Such steels may be produced generally in accordance with the teachings of U. S. Letters Patent No. 2,157,673 and No. 2,157,674. This invention also applies to alloy steels. Such steels, however, have had variable microstructures including elongated stringy inclusions.

The object of the invention is to stabilize said properties with the result that the longitudinal and transverse microstructures have greater uniformity and are of a type conducive to better machinability and reduction in rejects.

The feature of the invention resides in the attainment of said objectives by controlling the manganese sulphide inclusions through the method of introducing manganese and sulphur in the heat, and the form of such additive material. In other words, this invention relates to the method of manganese sulfide inclusion control.

Steel of this character will be more uniform as to microstructure, type and distribution of nonmetallic inclusions resulting in better machinability, hardening ability, surface condition, ductility, transverse properties, elongation, reduction of area, rolling conditions in the hot mill, and easier working conditions at the hot mill, especially at the open hearth floor.

Such steel will enable the hot mill to obtain a better yield. Also, the cold drawing mill may thereby produce a better yield; i. e. less rejections from each heat.

Since the steel is sounder, when magnafluxed the number of rejects will be greatly reduced, if not eliminated. It also has better machinability because of such control and again there are less rejects.

Heretofore in steel making to resulphurize steel, it is the practice to add sulphur to the bottom of the ladle preferably before tapping the furnace, or adding the calculated sulphur to the ladle before it is one third full, and then filling with steel. In either practice there is violent toxic fuming. Sulphur added in either manner reacts with the iron to form predominantly iron sulfide, other sulfides and low temperature manganese sulphide to a limited degree. Such low

2

temperature manganese sulfide appears in the stringy or elongated inclusion form after hot working.

The present invention contemplates the addition of manganese and sulphur in such form and at such a time that there results a lesser degree of iron sulfide in the (MnFe) S solid solution with the result that the inclusions are of the high temperature type and are of small globular form. Also the fuming is reduced.

Such addition is made immediately after the open hearth or electric furnace has made a melt of steel in which there has been added the necessary alloying material. Thereafter the sulphur or sulphur in combined form may be added as desired or required. The control additive may be a manganese sulfide alloy, such as sold by Metalloy Corporation, and which has a melting point of about 2880°–2900° F. Such manganese sulphide has a nominal content of manganese 56.7%, sulphur 36.0%, iron 7.0% and silicon 0.3%. This material is preferably introduced in lump form and of a size about an inch or more in lump form and of a size about an inch or more in diameter.

The sulphur introduction at this time (after melting is effected) results in the manganese of the melt uniting with the sulphur to produce manganese sulfide nuclei that starts grain growth points in the ingot upon subsequent cooling and, being a high temperature manganese sulfide, tends to assume a globular form.

The result is a subsequent low production of low temperature manganese sulfide and but little production of the iron sulfide comparatively speaking. Thus in the subsequent hot rolling of the steel there does not result the usual objectionable elongated and long, stringy inclusions.

It is to be noted that sufficient manganese is supplied to the melt in the manganese and the sulphur addition to provide the required amount of manganese and sulphur which is readily determinable by analysis of samples. The manganese and the sulphur thus supplied is normally in excess of that used in the conventional steel melt practice, such excess being incorporated in the slag.

It has been determined that furnace heating after such initial addition has been made, may be continued ten to twenty minutes longer. The manganese and sulphur of the high temperature type serve as seeds or nuclei to form the high temperature inclusions. The manganese, having under these conditions a greater affinity for

sulphur than the iron, forms manganese sulfide in preference to the formation of iron sulfide, to the end that the formation of the iron sulfide is reduced to a minimum. The loss of sulphur incident to excess inclusion in the slag or vaporization of the sulphur is thereby reduced.

The resultant metal product (the melt) is a sulphurized alloy steel wherein additional amounts of sulphur may be added in the ladle, if desired for resulphurization. Subsequent addition, upon the melt being substantially complete, of high temperature manganese sulfide or manganese and/or sulphur results in the continued formation of globular inclusions because of the high temperature manganese sulfide nuclei in the melt. Thus low temperature (stringlike) manganese sulfide inclusions do not develop in the steel.

The particular material mentioned is used in an amount to meet the sulphur chemical requirements of the steel, any aluminum present being infinitesimal. The manganese sulfide so used is in preponderance in this addition material, but of such low order, relative to the total metal mass, that the steel has the desired percentage of sulphur therein necessary to attain the properties desired in the steel.

The usual care and control of oxygen, chromium, titanium, aluminum, phosphorus, silicon, carbon and the like is exercised in the present process to produce the desired type of steel with or without such last mentioned materials or combinations thereof as well understood in the steel producing art. Preferably phosphorus and silicon is intentionally kept very low, that is in the order of .02%.

Steel having this low phosphorus and silicon content is more susceptible to the inclusion of manganese and sulphur in solid solubility form.

The manganese sulfide seeding and growth has a very beneficial effect on the machinability of the steel as a lubricant due to the inclusion of the sulphur.

Steel produced in accordance with this invention facilitates the hot rolling thereof by reason of the hot shortness being cut down resulting in the reduction of snakes, slivers and seams. Hence a higher and more profitable yield is obtainable from a given heat.

Furthermore, such steel being homogeneous in character, permits more uniform production by having less seams and cold shuts, and having an improved surface condition which results in less rejections from the cold drawing mill and consequently a higher yield.

The invention claimed is:

1. The process of making sulphurized and resulphurized steels of the character described comprising making the melt, pouring into a ladle, and teeming, characterized by the addition to the melt, prior to pouring into the ladle, of a high temperature manganese sulfide alloy composition in lump form for high temperature manganese sulfide globular inclusion seeding purposes.

2. The process of claim 1 characterized by the manganese sulfide alloy composition having a melting point in excess of 2700° F.

JAMES T. PARKER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,120,894	Haag	June 14, 1938
2,225,511	Soler	Dec. 17, 1940