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HIGH SPEED ALLOY STEEL

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This invention relates to alloy steels and particularly those types thereof commonly known as high speed steels employed in the manufacture of cutting tools and wearing parts where extreme high surface hardness is required, and particularly to such steels which include molybdenum as an alloying element thereof, the principal object being the provision of a molybdenum containing high speed steel which is particularly resistant to decarburization of the surface thereof during the manufacture of the steel and the fabrication of tools and wearing parts therefrom when the steel is necessarily subjected to elevated temperatures as in forging, rolling, hardening, drawing, etc.

As is well known to those skilled in the art, many steel alloys, commonly referred to as steels, are subject to the phenomenon of decarburization, rendering them unfit for service in many applications. This is especially true of those steels which are used in the manufacture of cutting tools and wearing parts where extremely high surface hardness is required, which hardness cannot be obtained if carbon is lost from the surface of the tool by decarburization even to the small extent of such depth as fractions of a thousandth of an inch.

A steel is said to decarburize when, by reason of the conditions to which it is subjected, a lowering of the carbon content on the surface takes place. This lowering of the carbon content on the surface is accompanied by a change in the micro-structure which, in the case of many important tool steels, results in a soft skin.

The rate of decarburization depends upon the rate at which carbon is oxidized at the surface zone and the rapidity with which the underlying carbon diffuses into the surface oxidization zone. It has been suggested in the prior art to overcome this phenomenon of decarburization by protecting the steel, when at elevated temperatures, from decarburizing atmospheres by means of coatings. These coatings may consist of electrodeposited metal or may be formed by dipping the steel into molten salts or solutions of salt. It has also been suggested that the phenomenon of decarburization may be overcome by controlling the composition of the atmosphere to which the steel is subjected at elevated temperatures. All of these methods afford a certain amount of protection but possess many objections either by way of being prohibitively costly, incompletely protective, or hazardous in commercial practice. For example, the use of controlled atmospheres cannot be economically applied to prevent decarburization during forging or rolling. Electrodeposited coatings cannot always be conveniently employed by reason of the expense of equipment involved, in a great many places where tool steels are treated. The use of solutions of salt or molten salt, while effective in the forging operation as well as in the heat treating operation, bring about an undesirably messy condition in the heating furnace and considerably complicates the commercial handling of the steels through the fabricating processes.

As is also well known to those familiar with the art, the presence of molybdenum in high speed steels, by virtue of its inherent characteristics when alloyed with iron, promotes the rate of diffusion of carbon when the steels are subjected to elevated temperatures. It has been universally observed that molybdenum containing high speed steels are particularly subject to the phenomenon of decarburization and this objection alone prevents the universal use of compositions which otherwise are superior from the standpoint of cost and performance to compositions now widely used. Accompanying this decarburization it has been noted that molybdenum containing steels when subjected to elevated temperatures for forging, rolling, or heat treating operations emits copious white fumes which are molybdic oxide. This invention not only prevents decarburization of such steels at elevated temperatures but eliminates or materially reduces the loss of molybdenum in the surface layer through emission of this molybdic oxide.

This invention, therefore, relates to the discovery of alloy additions to high speed steels containing molybdenum, which additions overcome the effect of molybdenum in promoting decarburization. By the use of these alloy additions molybdenum containing high speed steels may be subjected to elevated temperatures without protection against oxidizing atmosphere such as ordinarily occur in furnaces, without loss of carbon from the surface and without formation of a soft skin.

More specifically, it has been found that the addition of copper in amounts of 1.5% to 5% to a high speed steel containing molybdenum, markedly retards the rate of diffusion of carbon and makes it possible to expose the high speed steel containing molybdenum and copper to oxidizing atmospheres at elevated temperatures without suffering decarburization and without the formation of the so-called "soft skin." Furthermore, it has been found that the addition of copper in the above amounts may be