

UNITED STATES PATENT OFFICE.

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MANUFACTURE OF STEEL.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ALADAR PACZ, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a new and useful Improvement in the Manufacture of Steel, of which the following is a specification.

My invention relates to improvements in the manufacture of steel and while of general application to steel manufacture it applies more particularly to the manufacture of so-called alloy steels, in which there is incorporated with the steel one or more metals, such as tungsten, vanadium, chromium, molybdenum and uranium to produce steels suitable for tools, vehicle parts and other articles requiring metal having especial hardness, toughness, tensile strength, etc. The object of my invention is to produce steels having better physical characteristics and also to render such steels more uniform and free from defects.

According to my invention, I incorporate with the steel a certain percentage of tantalum or niobium or both and either of these or both may be incorporated in the steel alone or in combination with such metals as tungsten, vanadium, chromium, molybdenum or uranium or combinations of these, depending upon the nature of the steel desired. The incorporation of the tantalum or niobium improves the steel in any case and my invention, in its broadest aspect, comprehends the utilization of tantalum or niobium in the manufacture of steel in general. It is to be understood, however, that my invention relates more particularly to the so-called alloy steels where the production of a superior metal is the main object sought and where the cost in the steel, provided the desired qualities are secured, is not of such controlling importance as in the case of ordinary steel.

The toughening and hardening properties given to the steel by niobium or tantalum are increased as compared with those given by vanadium, tungsten, chromium, and molybdenum on account of the lower specific gravity of the niobium as compared for instance with molybdenum and that of tantalum as compared with tungsten. A given weight of niobium and of tantalum, therefore, having a greater volume will exert a greater influence. The oxides of molybdenum and tungsten, especially the

former, are more volatile than those of niobium and tantalum. In consequence of this, the effect of niobium and tantalum is more permanent when the metal is heated on account of less volatilization of the oxides which are formed. Another advantage possessed by the niobium and tantalum is the greater affinity for gases, such as hydrogen, than other metals used for hardening and toughening steel. The niobium and tantalum also combine with any nitrogen or oxygen which may be present, thus purifying the metal bath and rendering the resultant metal more uniform.

In incorporating the tantalum or niobium or both, these metals singly or together may be added directly to the steel bath or a ferro alloy containing either one or both may be added or, in case it is desired to produce a metal containing tungsten, molybdenum, chromium or vanadium, the desired percentages of these metals may be incorporated in the ferro alloy. These ferro alloys may be produced either by reducing the metals from the oxides of niobium or tantalum or both by means of carbon, a sufficient quantity of iron being added to form a desired alloy. Another method is to reduce by means of carbon the niobium or tantalum directly from the ores columbite or tantalite, in a manner similar to that followed in the production of ferro tungsten. In high speed steel, as now manufactured, the tungsten averages from 12 to 20%. According to my invention if it is desired to replace the tungsten entirely with niobium or tantalum, a less percentage of these singly or in combination may be used than the percentage of tungsten. For instance, in case of niobium the percentage may average from 6 to 12, while in the case of tantalum the percentage may run from 8 to 16. If a combination is used the proper modification of these amounts will be obvious. In case all of the tungsten is not eliminated and it is desired to retain a certain percentage of the tungsten while having present either the niobium or tantalum in less quantities than when they are used without the tungsten, the proper percentages can be readily calculated or indeed these percentages may be determined readily by experimentation. For example, about 3 to 6% niobium may be used with 6 to 10% of tungsten or 4 to 8% tantalum may be used with 6 to 10% tungsten. When all

three metals are utilized the niobium may run from 2 to 4%, the tantalum from 3 to 6%, and the tungsten from 4 to 8%.

Niobium and tantalum or both may be introduced into the steel by introducing the concentrates and a suitable reducing agent just as is done in the production of tungsten steel. Another method is to introduce them in the form of a ferro alloy produced either from the oxides or the ore, just as is in the production of ferro tungsten. Still another method which may be used when it is desired to incorporate the other metals, such as heretofore referred to, is to combine the concentrates of niobium or tantalum with the concentrates of these other metals and then to throw the whole mixture into the steel bath. In the manufacture of ferro-tungsten and ferro-chrome and other ferro alloys of this nature, the niobium or tantalum concentrate may be mixed with the concentrate of tungsten, molybdenum, chromium, etc., and incorporated with the iron to produce a ferro-tungsten, ferro-chrome, ferro-molybdenum, containing a certain percentage of niobium or tantalum. These products can be distributed as substitutes for the present ferro alloys which are added to the bath in the production of these steels.

It will be recognized that these are merely illustrations and that my invention, as heretofore stated, is not limited to any particular proportions of these metals, but comprises in its scope the use of niobium or tantalum or both in steel alone or combined with other alloying metals. In the claims I have used the expression "metal of the niobium class" to cover either tantalum or niobium.

Having fully described my invention, what I claim and desire to obtain by Letters Patent is:

1. A steel containing a small proportion of niobium.
2. A steel containing a small proportion of niobium and tantalum.

3. A steel containing a small proportion of niobium and at least one other of the rarer metals ordinarily used for alloy steels.

4. A steel containing a small proportion of a metal of the niobium class and at least one other of the rarer metals ordinarily used in alloy steels.

5. A steel containing a small proportion of a metal of the niobium class in combination with tungsten.

6. High speed steel containing a small proportion of a metal of the niobium class.

7. High speed steel containing a small proportion of niobium.

8. High speed steel containing a small proportion of niobium and tantalum.

9. A high speed steel containing a small proportion of a metal of the niobium class and at least one other of the rarer metals ordinarily used in high speed steel.

10. High speed steel containing a small proportion of a metal of the niobium class in combination with tungsten.

11. High speed steel containing a small proportion of niobium in combination with tungsten.

12. High speed steel containing a small proportion of niobium and tantalum in combination with tungsten.

13. A steel containing niobium in the proportion of three to twelve per cent.

14. A steel containing niobium and tantalum in the proportion of three to six per cent. niobium, and four to eight per cent. tantalum.

15. A steel containing tungsten, niobium or tantalum, the niobium being in the proportion of three to six per cent., and the tungsten in the proportion of six to ten per cent.

16. A steel containing tungsten, niobium and tantalum, the tungsten being in the proportion of four to eight per cent., the niobium two to four per cent., and the tantalum three to six per cent.

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