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HIGH SPEED TURNING BIT, MILLING TOOL, AND SIMILAR TOOL, AND PROCESS FOR MANUFACTURING THE SAME

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My invention relates to high speed turning bits, milling tools, dies with fine engravings and other tools more particularly tools shaped to nicety and to a process for manufacturing the same.

According to my invention I use for manufacturing such tools steel alloys suitable for high speed turning bits free from or poor in chromium having a percentage in carbon of more than 0.2% and a percentage in chromium of less than 1.5%. After the tools have been shaped to nicety they are subjected once or repeatedly to a heat treatment for the purpose of hardening them, the temperatures used in this heat treatment or treatments being such that the tools are not damaged by oxidation or formation of scale by shrinking, distortion, cracking, warping or otherwise. Therefore in accordance with my invention steel alloys as above referred to are heated to temperatures of about 700 to 1100° centigrade according to the composition of the steel and then they are chilled in water, oil, air or the like. The hardness required is imparted to the steel by again heating it to a temperature of from about 400 to 600° centigrade and thereupon chilling it. In most cases in the first heating the steel is preferably brought to a temperature of 900 to 1100° centigrade, while in the second heating, by which the required hardness is imparted to it the steel is preferably brought to a temperature of about 400 to 500° centigrade. However, I wish it to be understood that the temperatures above given are not limitative, but may be varied according to the composition of the steel used and other conditions and that for any given steel alloy and any special conditions the optimum temperatures may be readily determined by preliminary experiments bearing in mind the essential features of my present invention.

The first step or the second step or both steps of the heat treatment may be repeated and I wish it to be understood that also any repetition of either or both steps of the heat treatment is within the scope of my invention.

However, in most cases a single heating and chilling in each of the two steps will be found sufficient.

The tools may be shaped to nicety after the first step of the thermic treatment above described, but if desired the tool may be shaped to nicety prior to the said first step. If found desirable the shaped article may be annealed prior to the first step of heat treatment above described for removing any internal tensions produced in the article by shaping it.

For the purposes of my invention I may use steels which are known to be suitable for manufacturing high speed turning bits, provided the chromium contents of these steels be low. With a percentage in carbon of more than 0.5% the percentage in chromium should be between zero and 0.5%. In case of low carbon percentages of say 0.2 to 0.5%, the percentage in chromium may be higher, say from 0.5 to 1.5%, but the results obtained in this case are not so good. A percentage in carbon of 0.2% is to be understood as a percentage which is higher than the low carbon percentages which it is difficult to obtain. The present invention permits to employ steels with percentages in carbon which may be easily manufactured on a commercial scale. The results are the poorer the greater the percentages in chromium are, so that steels practically free from chromium are to be preferred.

In view of the state of the art represented by the cobalt containing high speed turning bits the percentages in other constituents of the alloy may be the following: Manganese from 0 to about 0.8%, silicon from 0 to about 1%, tungsten from 7 to 30%, cobalt from 3 to 25%, vanadium from 0 to 5%, molybdenum from 0 to 10%, titanium from 0 to 5%, tantalum from 0 to 18%, uranium from 0 to 12%, beryllium from 0 to 8%.

But the following steels with narrower limits of the percentages of the various constituents are preferred. Of the constituents named below one or more may be present besides tungsten, cobalt and carbon. The tungsten may be replaced in the well known manner more particularly part of it may be replaced by molybdenum or vanadium. The various constituents may be used within the following limits: Carbon from 0.5 to 1.20%, manganese from 0.20 to 0.4%, silicon from 0.2 to 0.4%, tungsten from 12 to 23%, chromium 0 to 0.5%, cobalt from 8 to 20%, vanadium from 1 to 2%, molybdenum from 0.2 to 3%, titanium from 0 to 0.5%, tantalum from 0 to 2%.

It is very surprising, that these steels are still workable after heating them according to their composition to a temperature of 700 to 1100° centigrade and then chilling them in oil, water, air and the like. In any case the upper limit of this temperature should be such, according to the composition of the steel, that after so heating the steel and then chilling it, the steel does not cease to be workable. By heating the steel to temperatures above 1100° centigrade and then chilling it, the workableness of the steel is greatly reduced or the steel may even become unworkable. Moreover by heating the steel to temperatures above 1100° centigrade a further most important advantage of the invention is lost, namely that for a given composition of the steel substantially the same hardness is imparted to any blank made of such steel by the present process.

If now these steels after having been so heated and chilled and, if desired, subjected to any working are again heated to a temperature up to about 600° centigrade, but preferably to a temperature

of about 450 to 520° centigrade and chilled thereafter, it will be found that thereby an increase in hardness of the said steels is obtained which heretofore could be obtained only by heating these steels to temperatures of 1200 to 1250° centigrade and subsequently chilling them. But it is well known that by heating the steels to such high temperatures and then chilling them the nice shape of the tools so treated is invariably changed or the tools are otherwise damaged. On the other hand according to my invention the high degree of hardness required for tools of the kind above referred to is obtained at comparatively very low temperatures. It is obvious that this is an exceedingly important new effect realized by my invention. The most delicate shapes such as cutting edges of milling tools and other complicated details such as engravings in dies may be readily produced while the steel is comparatively soft and thereafter the degree of hardness required for the use of the tools may be imparted to the latter without exposing them to temperatures which might impair the exact shape or the most delicate details of cutting edges of the tools.

The advantages secured by my present invention are the more marked, the lower the percentage in chromium is. With percentages in chromium of 1 to 1.5% the advantages just referred to rapidly diminish, that is to say the increase in hardness produced by the second heating to temperatures up to about 600° centigrade becomes less marked while the steels become less workable after the first heating to temperatures from 700 to 1100° centigrade. The upper limit of the permissible percentage in chromium is the higher, the more the percentage in carbon is below the normal value of 0.5%. Most surprising and advantageous is the effect of my present invention with higher percentages in carbon, above 0.5% and low percentages in chromium, below 0.5% and preferably of 0.2% or less down to the absence of chromium. In the latter cases the percentage in carbon may be of the order usual in high speed turning bits namely about 0.6 to 0.8%, but is may be even higher according to the composition of the steel.

The advantages above set forth may therefore be obtained by applying the invention to a large number of steels taking into account the conditions of any given particular case.

I shall now describe two examples of carrying my invention into practice.

Example I

A steel containing 0.92% of carbon, 0.2% of manganese, 0.61% of silicon, 0.22% of chromium, 20.72% of tungsten, 2.04% of vanadium, 0.45% of molybdenum, and 18.65% of cobalt, the balance being iron, is first annealed at a temperature of 830° centigrade. It then has a hardness of 35 to 37 of the Rockwell scale. On then heating it to 1000°, 1050° and 1100° centigrade and subsequent chilling this steel shows a hardness of 55 to 57, 57 to 59 and 59 Rockwell respectively. After a second heating to 540 to 570° centigrade and subsequent chilling the hardness of this steel is 62, 64 and 64 to 66 Rockwell respectively.

Example II

A steel containing 0.97% of carbon, 0.35% of manganese, 0.16% of silicon, 0.10% of chromium, 19.82% of tungsten, 1.64% of vanadium, 1.06% of moylbdenum, 10.81% of cobalt and 0.18% of tantalum the balance being iron is first annealed at a temperature of 830° centigrade. It then has a hardness of 37 Rockwell. On then heating this steel to 1000, 1050 and 1100° centigrade and subsequent chilling the steel shows a hardness of 54 to 55 Rockwell. After a second heating to from 540 to 570° centigrade and subsequent chilling the hardness of this steel is 63 to 64 Rockwell.

For the sake of comparison I shall now give the results of experiments with two steels differing from those in the examples by a larger percentage in chromium but otherwise similar to them.

First comparative experiment

A steel containing 0.63% of carbon, 0.11% of manganese, 0.26% of silicon, 4.28% of chromium, 18.12% of tungsten, 0.94% of vanadium, 0.58% of molybdenum and 10.09% of cobalt the balance being iron, was annealed at a temperature of 830° centigrade and then showed a hardness of 32 Rockwell. On then heating this steel to 1000, 1050 and 1100° centigrade and chilling it, it showed a hardness of 62 to 65 Rockwell. After a second heating to 540° centigrade and subsequent chilling this steel showed a hardness of 56 to 64, 57 to 58 and 62 to 64 Rockwell respectively. The last named sample first heated to 1100° centigrade was found to be cracked after the second heating and chilling.

Second comparative experiment

A steel containing 0.83% of carbon, 0.14% of manganese, 0.24% of silicon, 0.74% of chromium, 17.92% of tungsten, 1.84% of vanadium, 0.52% of molybdenum, 21.24% of cobalt and 0.81% of tantalum was annealed at 830° centigrade, was then first heated to 1000, 1050 and 1100° centigrade and then chilled and it showed a hardness of 57 to 60, 60 to 62 and 61 to 63 Rockwell respectively. After a second heating to 540° centigrade and subsequent chilling the steel showed a hardness of 60, 62 and 63 Rockwell respectively.

From the above it will be seen that in the Experiment I above described the steel containing 4.28% of chromium was not only not hardened by the second heating to 540° centigrade and subsequent chilling, but on the contrary became softer. Furthermore the hardness of 62 to 65 Rockwell imparted to this steel by first heating and chilling renders it quite unworkable. In the second experiment with a steel containing 0.74% of chromium and 0.83% of carbon the hardening of the steel by the second heating and chilling is not appreciable and that after the first heating and chilling the steel is workable only with great difficulty if at all, but the hardness of different pieces was more uniform after the second heating. The steels referred to in the examples above given are not only sufficiently workable after the first heating and chilling, but they also show an essential increase in hardness after the second heating and chilling.

What I claim is:

1. An iron alloy containing cobalt from 3 to 25%, silicon from .05% to 1%, manganese from .05% to 0.8%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the

alloy again whereby the alloy obtains the requisite hardness.

2. A process for manufacturing an iron alloy containing cobalt from 3 to 25%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

3. A process for manufacturing an iron alloy containing cobalt from 3 to 25%, manganese from .05% to 0.8%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

4. A process for manufacturing an iron alloy containing cobalt from 3 to 25%, silicon from .05% to 1%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

5. A process for manufacturing an iron alloy containing cobalt from 3 to 25%, silicon from .05% to 1%, manganese from .05% to 0.8%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

6. A high speed cutting tool manufactured from an iron alloy containing cobalt from 3 to 25%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

7. A high speed cutting tool manufactured from an iron alloy containing cobalt from 3 to 25%, manganese from .05% to 0.8%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

8. A high speed cutting tool manufactured from an iron alloy containing cobalt from 3 to 25%, silicon from .05% to 1%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

9. A high speed cutting tool manufactured from an iron alloy containing cobalt from 3 to 25%, silicon from .05% to 1%, manganese from .05% to 0.8%, carbon from .2% to 1.5%, chromium from a trace to 1.5% and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

10. An iron alloy containing cobalt from 3 to 25%, manganese from 0.5% to 0.8%, carbon from .2% to 1.5%, chromium from a trace to 1.5%, said carbon and said chromium varying in inverse ratio within the percentages specified and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely, heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

11. A process for manufacturing an iron alloy containing cobalt, from 3 to 25%, carbon from .2% to 1.5%, chromium from a trace to 1.5%, said carbon and said chromium varying within the percentages stated in inverse ratio and 7 to 30% tungsten and the balance substantially iron comprising the following steps, namely, heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

12. A high speed cutting tool manufactured from an iron alloy containing cobalt from 3 to 25%, carbon from .2% to 1.5%, chromium from a trace to 1.5%, said carbon and said chromium varying within said stated percentages in inverse ratio and 7 to 30% tungsten and the balance substantially iron which has been obtained by heat treatment comprising the following steps, namely, heating the alloy to a temperature of about 700 to 1100° C. according to the composition thereof, then chilling the alloy, thereafter heating the alloy again to a temperature of about 400 to 600° C. and thereupon chilling the alloy again whereby the alloy obtains the requisite hardness.

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