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## NITRIDED ARTICLE OF MANUFACTURE

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1 Claim. (Cl. 148—31)

This invention relates as indicated to nitrided articles of manufacture and this application is a division of my copending application Ser. No. 655,861, filed February 8, 1933.

It has been known for quite some time that a hard case on a steel article may be secured by heating the metal in an atmosphere of nitrogen, ammonia usually being employed as the means for supplying the nitrogen. (See U. S. Patent No. 1,065,379 to Machlet.) It has been recognized, however, that a steel consisting of a simple alloy of iron and carbon does not absorb nitrogen during the customary nitriding process to an extent sufficient to make it useful as a body material for the production of articles having a nitrided case.

Dr. Adolph Fry made a very important contribution to this art by his suggestion to add aluminum to the alloy being nitrided in order to materially increase the rate of absorption of the nitrogen, thereby reducing the time required to secure sufficient penetration and further, a nitrided case secured in this manner is harder than a case possible on a simple alloy of iron and carbon. It has also been suggested (see Phillips U. S. Patent No. 1,697,083) to add molybdenum as an alloying element to the article being nitrided in order to make possible the rapid absorption of nitrogen and the production of a satisfactory hard case of adequate depth. The nitrided surface or case formed on alloy steel articles of the type suggested by the prior art is usually satisfactory from the standpoint of its hardness and resistance to abrasion but a principal difficulty has been encountered with the cracking and chipping of the hard and brittle nitrided surface layer or case due to the plastic deformation of the supporting steel core or body under working pressures.

The prior art has been primarily concerned with the production of hard nitrided cases upon core materials which were too weak and plastic to withstand the high chip pressures encountered with many cutting tools or the concentrated loads frequently occurring in other forms of wear-resisting articles. This is particularly true because the temperatures at which the nitriding process is customarily effected (900° F. to 1100° F.) are such as to greatly reduce the hardness and strength and increase the plasticity of the steels customarily employed as core materials if they have been previously hardened. A tool formed with a plastic core of insufficient hardness and strength, even though provided with a satisfactory nitrided case of sufficient hardness and capable of withstanding abrasion will, nevertheless, be useless for heavy duty work where the stresses to which the tool will be subjected are sufficient to deform the core to such an extent that the nitrided case will crack or chip.

It is a principal object of my invention to provide an article of manufacture such as a tool or the like having a hard and brittle nitrided surface and a supporting body of great strength and hardness.

It is a further object of my invention to provide a supporting core, underneath the hard surface layer of a nitrided case, of greater resistance to plastic deformation than is possible with the so-called nitriding steels of the prior art. This combination of properties makes possible a wearing surface which not only has great hardness and resistance to abrasion but which also has strong and rigid support from its underlying and supporting core. With this stronger support, it is possible for the nitrided case to withstand greater pressures without being cracked and broken than is possible with the nitriding steels of the prior art.

Other objects of my invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then consists of the means hereinafter fully described and particularly pointed out in the claim.

The following description sets forth in detail one product exemplifying my invention, such disclosed product constituting, however, but one of the various applications of the principles of my invention.

A preferred example of a satisfactory composition of alloy steel which has been found suitable for attaining the enumerated objects is as follows:—

| | | Percent |
|---|---|---|
| Carbon | about | 0.70 |
| Tungsten | about | 18.00 |
| Chromium | about | 4.00 |
| Vanadium | about | 1.00 |

the balance being iron together with such other alloying elements and impurities as are usual in alloy steels.

The above analysis will be recognized as a type analysis of a standard high speed steel of commerce. When treated by the usual nitriding process, this steel has been found to take a nitrided cases of great hardness. A hard case is produced whether the high speed steel is processed in the annealed or in the hardened condition.

The hardness of the case on the hardened high speed steel has been observed to be very high, in fact higher than the cases produced on some previously known nitriding steels by the same treatment. The supporting body to which the nitrided case is applied, if it has been previously hardened, maintains a high degree of hardness after the nitriding process. In fact, it has been found possible to perform the operation of tempering the high speed steel, which is usually done at a temperature between 1000° F. and 1100° F., simultaneously with nitriding. The microstructure of the high speed steel core after hardening and nitriding consists of martensite with a small amount of troosite, which is the normal structure of hardened and tempered high speed steel as employed for cutting tools. This type of high speed steel is useful for the bodies of such tools as drills and reamers, upon which, surfaces subject to abrasion have been nitrided.

As is well known to those familiar with the art, any specification for a particular alloy composition must permit of certain variations due to the fact that in making up the composition, it is extremely difficult, if not impossible, to commercially produce a composition exactly like a given specification. It is to be understood, therefore, that throughout the description and claim where I have used figures to denote definite amounts and ranges, such amounts and ranges are to be construed to include the range of variations usually permissible in making up alloy compositions to given specification.

Other forms may be employed embodying the features of my invention instead of the one here explained, change being made in the form or construction, provided the elements stated by any of the following claim or the equivalent of such stated elements be employed.

I therefore particularly point out and distinctly claim as my invention:

An article of manufacture embodying an alloy consisting of iron with about 0.70% carbon, about 18.00% tungsten, about 4.00% chromium, about 1.00% vanadium and having a surface nitrided.

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