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3,136,664

STEEL TRANSMISSION CHAIN

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Fig. 1

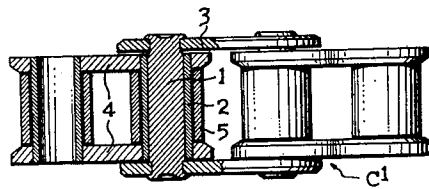
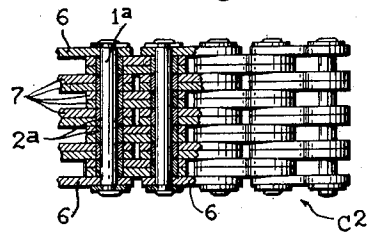


Fig. 2



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STEEL TRANSMISSION CHAIN

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The present invention relates to power-transmission chains and to the manufacturing thereof, and its object is to considerably increase the wear resistance of such chains.

It is known that in all such chains, whether of the sprocket type or of the so-called "noiseless" type, the pivotal interconnections of the links are achieved by means of a loosely rotatable pin, which is generally solid, within the bore of at least one hollow member, the so-called "false roller," said members being rigidly secured to plane spacers forming the cheeks of the sprocket chains or the plate members of the "noiseless" chains; the journalling of the pin within the false roller is effected by sliding one of said members on the other, resulting in a substantial wear. It is known that the actual pitch of a chain is defined by the distance between the pins of two consecutive pivotal connections, when their component members are in tight engagement with each other. Accordingly, the wear of a chain results in an increase of its actual pitch.

The occurrences of wear can be divided into two general categories (wear with abrasion and wear without abrasion) in accordance with the operative methods which are clearly distinct from each other.

In case of wear in the presence of an abrasive substance, said substance can be deemed as being a hard body with sharp edges. In accordance with definition, the rate of wear by an abrasive body is a function of the cutting power of its edges, the wear of an element taking place by removal of material, somewhat in the fashion of a chipping tool.

In case of wear without any abrasive substance, the wear occurs in a completely different manner. Here, the wear is predominantly a function of the specific unitary pressure exerted on the interengaged surfaces. Under the action of this pressure and for a certain value thereof, the lubricating film breaks up and the two interengaged surfaces are seized. The wear is then due to a tearing-off of metal particles from the interengaged surfaces. There is actually a creepage and intergranular surface decoherence. The temperatures to which localized areas and the other layer of the metals are raised, may become extremely high and even reach the melting point of the involved metals.

These two types of wear, which are already very different from the point of view of their occurrences, also differ in the consequences resulting therefrom. Thus, where the wear is of the abrasive type, the torn-off metal particles, if they are hard as is most frequently the case, act, in turn, as an additional abrasive, accelerating the effective abrasion rate. In the latter case, should one of the metals be sufficiently soft to enable the abrasive grains to be embedded therein, this particular member will play the part of a grinder with respect to the other member. In the non abrasive wear, it may on the contrary be said that the metal particles torn-off the interengaged members are substantially amorphous.

The object of the present invention is to provide an articulation device for a transmission chain, which device, involving at least two mutually-engaged members movable relative to each other, is improved so as to

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considerably reduce the occurrences of wear, either in the presence or without the presence of an abrasive substance. In this improved articulation device the mutual engagement surfaces of its two component members are provided with a surface coating of a grain-free relatively soft, truly homogenous, solid solution, having dispersed therein excessively hard, very small, rounded globular particles, essentially consisting of metal carbides.

10 Preferably, the coating further includes particles consisting of metal nitrides.

Owing to the fact that said excessively hard particles, of generally round shape and of very small dimensions, are more or less embedded in the non granular and homogeneous solid solution, this arrangement provides the following advantages from the point of view of the wear rate thereof:

These particles offer a good resistance to tearing stresses, owing to their smallness and rate of dispersion, and also owing to the particular structure of their metal environment, which has no breaks of continuity therein since it is comprised by a non granular, homogeneous solid solution;

The interspersed particles in the surface coating become slightly projecting from their respective surfaces upon friction between said surfaces and they cause very rapidly the sharp edges of the abrasive bodies to become notched, and thus ineffective; moreover, under the action of the specific unitary pressure exerted on the interengaged surfaces, the abrasive bodies are very rapidly crushed to ineffective and amorphous fine elements;

The slight part-spherical projection provided by each particle relative to the supporting metal results in a highly reduced wear of the interengaged elements, as the latter come only into contact with one another through the projecting portions of metal carbide and nitride particles, this feature further promoting the favourable results due to the extreme smallness and to the substantial dispersion of the particles whose density in the surface coating is relatively small; thus, any seizure is prevented as well as the destruction of the surface layer of the articulation means, which surface layer is comprised by a relatively soft, grainless, homogenous solid solution, and the friction between the articulation members is confined to the sliding of hard particles upon one another.

A further object of the invention is to provide a chain, the articulation devices of which, comprised by pins and bushings or false rollers, or similar members, are of the aforesaid improved type.

Another object of the invention is to provide a method for the production of the aforesaid articulation devices, of the pin and false roller or of similar chain-element type. This method comprises, following the machining or the forming of the elements of the articulation device, effecting first a metal diffusion, as known per se, of at least one added metal on the outer surface of said element and in a portion of the thickness thereof and a carburizing by a conventional means to bring carbon into the surface layer, thereafter heat treating to produce a globular form of the carbide, and finally quenching to convert the iron-based alloy, due to the metal diffusion, to a homogeneous solid solution of the generally austenitic type, while the subjacent layers of the supporting metal receive their normal structures, which are most often martensitic.

According to a preferred embodiment, the method includes a carbonitriding step, i.e. a simultaneous carburization and nitriding.

In other words, the invention comprises, in said embodiment, the novel industrial application of a metal surface-diffusion treatment in combination with a carbonitrida-

tion treatment, wherein the nitrogen promotes the diffusion of carbon, to members such as pins and bushings included in an articulation device for a chain.

The surface layers having a high content of alloyed elements and also of carbon and nitrogen, are first heated to about 700° C. during several hours to effect the carbide globulisation and to enable at the same time the carbide size to be controlled by regulating the duration of the heat treatment, the size of the particles increasing with the temperature. From the latter temperature, the parts are thereafter subjected to a rapid heating bringing them to a temperature of from 900° C. to 950° C., and quenched in water or oil, in accordance with the kind of the subjacent metal. The surface layers having a high content of alloyed elements remain following this treatment perfectly austenitic and homogenous. (This is actually a solid solution without grain boundaries having an average Vickers hardness of 600 to 800.) The metal carbides formed during the heat treatment at about 700° C. are not destroyed or dissolved by the rapid heating to 900° C. As to the metal nitrides formed during the diffusion treatment, they remain stable at these temperatures and do not come into solution. (These globulised particles of metal carbides and nitrides are extremely hard and reach sometimes a Vickers hardness of 1500 to 1600.)

The added diffusion metal or metals can be selected from the group consisting of: manganese, silicon, boron, chromium, tungsten, molybdenum, tantalum, vanadium, nickel, cobalt, zirconium, titanium, uranium, glucinium, etc.

In the accompanying drawing given merely by way of an example:

FIG. 1 is a part longitudinal sectional view and part plan view of a sprocket chain provided with articulation devices according to the invention;

FIG. 2 is a similar view of a so-called "noiseless" chain.

In the case of chain C¹ shown in FIG. 1, the articulations interconnecting the various chain links, each comprises a pin 1 and a false roller 2. These are the two members which are subjected to the treatment provided by the invention.

The pins connect in the usual way the outer cheeks 3, while the bushings or false rollers 2 connect the inner cheeks 4. The false rollers 2 have preferably idly mounted thereon the rollers 5.

The noiseless chain C² shown in FIG. 2 comprises pins 1^a interconnecting the outer plates 6, whereas the intermediate plates 7 are pivotally connected to the pins 1^a by short bushings or false rollers 2^a the length of which is restricted in the illustrated embodiment to the thickness of two plates which are coupled and made integral in pairs. It will be understood that in this chain C², the treatment according to the invention will be performed on the pins 1^a and the false rollers 2^a.

Various features and advantages of the articulation devices according to the invention will be better understood on reading the following examples, given merely by way of an explanation and without any intention of limiting the invention.

Example I

The parts or members forming the chain articulation devices, such as the pins 1 or 1^a and the false rollers 2 or 2^a of the two illustrated and described embodiments, are machined from steel having a carbon content of at least 0.40% and having, for example, the following weight composition expressed as percentages, the balance being iron:

Carbon	0.40-0.45
Silicon	0.25-0.35
Manganese	0.50-0.60
Sulfur and phosphorus	0.035

These pieces are thereafter slowly heated in a closed rotary retort with a chromium-based powder (which meth-

od is known as "chromisation") consisting of ferrochrome, alumina and a small amount of a halogenated ammonium compound (maximum: 4%). The following mixture by weight can be advantageously used:

	Percent
Ferro-chrome containing 50% chromium	78
Alumina	20.5
Ammonium chloride	1.5

This powder has admixed thereto at the moment of its introduction into the rotary retort, about 10% by weight of an agent commonly used for carbonitridation treatment. For this purpose, the following mixture by weight is perfectly suitable:

	Percent
Calcium cyanamide containing 25% nitrogen	30
Anhydrous urea	10
Barium oxalate	15
Activated carbon	45

The pieces are kept in the presence of this mixture in the rotary retort, at a temperature of from 920 to 950° C., for a period which may vary from 1 to 2 hours. They are allowed to cool in the retort, which is still rotated. Thus a surface layer having a high content of chromium in the form of an iron, carbon, nitrogen and chromium alloy, is obtained. The pieces are then installed in a rotary furnace and heated under an inert atmosphere to about 700° C., being held at this temperature for about 2 hours; thereafter, the furnace temperature is rapidly raised at the rate of about 10° C. per minute, to 920°-950° C. The pieces are then oil-quenched.

A micrographic examination following this treatment discloses at the metal surface the presence of a homogeneous, grainless, austenitic layer, having included therein a large amount of carbides and nitrides in dispersed condition but still globular, i.e. having rounded shapes. These carbides and nitrides are mainly visible with a substantial magnifying and with a black background lighting (grazing light), have an average size of about 0.5 micron, the largest particles being always less than 1 micron. These carbides are uniformly distributed in the austenitic matrix. The latter contains about 50 to 60% chromium, and its Vickers hardness is of about 600 to 800, while the Vickers hardness of the carbides and nitrides is commonly as high as 1,500 to 1,600. In any case, this hardness is very difficult to control owing to the extreme smallness of the carbide and nitride particles.

Tests carried out by the applicant have shown that pins 1 or 1^a and false rollers 2 or 2^a, obtained by the foregoing treatment and mounted on chains, are subjected during the same period and under similar operational conditions, to wears four to five times smaller than similar members having been treated by conventional known methods of simple carburization and carbonitriding.

Example II

The procedure of Example I is repeated, but the carbonitridation is replaced by cementation. A cement having the following composition by weight may be used for this purpose:

	Percent
Barium carbonate	45
Activated carbon	55

The metal diffusion can be effected by any method (metal impregnation, electroplating, dipping, etc.), this treatment being followed by a high-temperature carburization or carbonitridation treatment, ensuring, on the one hand, the diffusion of the deposited metal or metals and, on the other hand, the addition of carbon and of nitrogen required to form the metal carbides and nitrides. The pieces are then processed in a furnace at 700° C. to produce a globular form of the carbide, and thereafter, water- or oil-quenched, as aforesaid.

It is to be understood that the invention is in no way

restricted to the above examples or to the illustrated types of chains.

The various disclosed heat treatments may be efficiently effected in a rotary retort, as described, or in box-like reactors or again in continuously-operated furnace.

The invention is suitable for all steels or whatever composition.

Having now described my invention in which an exclusive desire to secure by Letters Patent is:

1. Articulation device for a transmission chain having at least two interengaged carbon steel members pivotally movable relative to each other, each of said members having a bearing surface formed by a layer of grainless, relatively soft, homogeneous solid solution constituting a generally austenitic matrix and excessively hard, very small, rounded globular particles dispersed in said layer, said particles mainly consisting of metal carbides.

2. Articulation device as claimed in claim 1, wherein said layer also contains particles of metal nitrides.

3. Articulation device for a transmission chain having at least two interengaged medium carbon steel members pivotally movable relative to one another, each of said members having a bearing surface constituted by a layer of a grainless, relatively soft, homogeneous austenitic solution of an alloy of iron and at least one other additional metal, and excessively hard, very small, rounded globular particles of metal carbides and metal nitrides dispersed in said layer, said layer constituting a matrix for said particles.

4. Articulation device as claimed in claim 1, wherein the particles have a size no greater than one micron.

5. Articulation device for a transmission chain having at least two interengaged medium carbon steel members pivotally movable relative to each other, each of said members having a bearing surface layer of grainless, relatively soft, austenitic matrix and excessively hard, very small, rounded globular particles dispersed in said matrix, said particles mainly consisting of metal carbides, and a martensitic subjacent layer.

6. Articulation device as claimed in claim 1, wherein the surface layer comprises a matrix of an alloy of iron, carbon, nitrogen and chromium, having a chromium content of 50 to 60%, a Vickers hardness of 600 to 800, the metal particles having a Vickers hardness of about 1500 to 1600.

7. Transmission chain provided with articulation devices according to claim 1.

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