A pin for a steel chain of a medium carbon alloy steel blank, a surface of which blank comprising a surface layer comprising a ferrite phase having at least one element diffused and permeated, and fine and globular compound particles of said element dispersed in said surface layer, said blank being quenched and tempered.

2 Claims, 2 Drawing Figures
With the recent tendency of various machineries being small-sized, light weighed, and improved in efficiency, roller chains and chains integral with rollers (hereinafter called merely chains) are required to have a higher efficiency, and particularly in case of high speed operation, there is a tendency of using a small pitch chain in order to avoid an influence effected by the centrifugal force or noises caused by the chain perse, gradually increasing tension exerted on the chain, and further in machineries of some kind, which repeat rapid acceleration, rapid reduction, or reverse, instantaneous tension acted at that time is extremely great. On the other hand, when tension is applied to the chain, a pin acts as a shearing and bending member, thus requiring a strength and a toughness, and the pin constitutes a bushing and a bearing, thus requiring also the wear resistance, and particularly in case of high speed operation, lubrication is scattered and is difficult to be reached the bearing portion, and also, even if lubrication is applied, the surface pressure of the bearing is inevitably increased due to the high tension. Chains are very often used under the extremely bad condition such that the chains are merely applied with grease once before being put in use and never applied thereafter, and therefore it is important to treat them so as to have a surface hardness as high as possible and a good wear resistance. Accordingly, it is preferable for pins to employ material which has a toughness to some extent, and a low carbon case hardening steel is used in general, and this steel is substantially C <0.23% and for other alloy elements, there are Cr, Nb, Mo, Mn, etc. On the other hand, in the past the chains have been cut during their use, in most cases, due to the fatigue failure of a link plate, and the pin of the low carbon case hardening steel has scarcely been fractured. However, when the chain receives a great tension as described, there is in many cases fractured the pin in a state of approximate static fracture due to the shearing and bending before the link plate is broken. That is, in such a case the strength of the low carbon case hardening steel is not sufficient thereby proposing a method for increasing the strength in which the medium carbon alloy steel is quenched and tempered. However, the tensile strength of the chain incorporating a pin having the surface strength about equal to that of the low carbon case hardening steel by carburizing or carburizing and nitriding a blank of said medium carbon steel is considerably lower than that of the chain incorporating a pin of the low carbon case hardening steel. Various reasons for this may be considered, one is such that in carburizing the low carbon case hardening steel, quenching process is different due to the difference of carbon concentration between the surface and the core portion and producing a compression stress on the surface to prevent generation of cracks in the brittle surface while in carburizing the medium carbon alloy steel, quenching process is not so different between the surface and the core portion and there is little compression residual stress so that cracks are produced by bending stress and immediately affecting to the core portion. That is to say, in case of using the pin of the medium carbon alloy steel in order to obtain the chain having a great tensile strength, there is a fatal defect such that the surface strength can not be made greater and the wear resistance is forced to be reduced.

**SUMMARY OF THE INVENTION**

This invention relates to a pin for a steel chain in which at least one element among Si, B, Cr, W, Mo, V, Ti, Al, Be, Zr, No, etc. is diffused and permeated in the surface of a medium carbon alloy steel blank to form a surface layer of a ferrite phase, and fine and globular compound particles of said element are dispersed in said surface layer and thereafter quenching and tempering are applied thereto.

An object of this invention is to provide a pin for a steel chain which uses a medium carbon alloy steel as a blank to increase the tensile strength and to improve the wear resistance.

Another object of this invention is to provide a pin for a steel chain which is highly durable against the load at the time of high speed operation or shocks, or even in a state of inferior lubrication.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a fragmentary sectional view of a roller chain showing main portion thereof; and FIG. 2 is an explanatory view showing a section of the pin according to this invention.

**DETAILED DESCRIPTION OF THE INVENTION**

A principal feature of this invention is to obtain a pin for a chain having a tensile strength extremely greater than that of a conventional pin of a low carbon case hardening steel, by refining a medium carbon alloy steel blank wherein at least one or several kinds of elements such as Ni, Cr, Mn, Si, Mo, V, etc. is added into carbon of about 0.23 to 0.5%.

According to a second feature of this invention, a layer comprising a relatively soft and uniform ferrite phase is formed on the surface of the medium carbon alloy steel blank, and a great number of carbide or nitride particles of extremely hard, fine and globular elements such as Ni, Cr, Mn, Si, etc. as described above are dispersed in said surface layer. Thus, since these particles are dispersed in the relatively soft layer, the particles are, for example, easily embedded into the layer by pressure acted on a frictional surface between the pin and the bushing to well fit to counterpart surfaces and dispersing the pressure applied, and on the other hand, since the particles per se dispersed in the surface layer is very hard, the mud, gravel, or the like invades into a gap between the pin and the bushing are crushed and pulverized, thereby surfaces of bushing or the like being not damaged, and further these particles slightly project from the surface at an early stage of the wear, and the projection acts as a resistant body against the wear so as to remarkably reduce the wear, and portions other than the projection function as if an oil reservoir to effect lubrication, thus conveniently preventing further wear.

According to a third feature of this invention, the surface layer described in the second feature as previously described is made difficult to change in structure in a heat treatment of the medium carbon alloy steel blank. To this end, a surface layer is formed by diffusing and permeating at least one of elements such as Si, B, Cr, W, Mo, Ti, Al, Be, Sr, Ta, Nb, etc., which enlarge a boundary in a constitutional diagram of steel, in the surface of said blank. Thus, if said element is solid-
dissolved into steel at a value in excess of some concentration, the structure becomes a ferrite phase irrespective of temperature thereby the structure of the surface layer becoming difficult to be changed and enabling the blank to be quenched and tempered, and further there is no fear of producing cracks in the surface due to the relatively soft ferrite phase even when bending load is applied to the pin, and furthermore the surface layer is never stripped off because of the provision of extremely strong adherence between the surface layer and the blank even when impact load is received.

According to a fourth feature of this invention, the fine and globular particles dispersed in the surface layer are formed in the form of compound of said element such as Ni, Cr, etc. and carbon or nitrogen. This carbon or nitrogen is originally contained in the blank or contained therein as a result of carrying out carburizing or carburizing and nitriding before or after the diffusion or simultaneously thereof, thus facilitating formation of carbides or nitrides.

The invention will be better understood from the following description in conjunction with the accompanying drawings. In the roller chain shown in FIG. 1, a bushing 2 is idly mounted on a pin 1 secured to a pin link plate 4, said pin 1 and said bushing comprise a bearing portion, and a roller link plate 5 is secured to the bushing 2 to form a bended portion of the chain, and further a roller 3 is rotatably fitted into said bushing 2 and is meshed with a sprocket not shown. In FIG. 2, (a) denotes a martensite structure, (b) denotes a dispersed surface layer of ferrite, (C) denotes a great number of fine and globular carbide particles dispersed in the surface layer (b), and (d) denotes an intermediary layer sometimes appeared being martensite instead of ferrite because of less contents of diffused elements. Generally speaking, it is not possible to obtain a better effect if the thickness of the surface layer is less than 3 μ, and the deflective strength will be lowered if it is too thick to the contrary, and therefore it is necessary to suitably define the diameter of the pin 1.

The invention will be further better understood on reading the following examples.

EXAMPLE 1

The pin 1 formed by SCM 3 in the JIS (Japanese Industrial Standard) is heated in a sealed casing filled with a mixture of the following composition expressed as percentages:

<table>
<thead>
<tr>
<th>Ferrochrome</th>
<th>65%</th>
</tr>
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<tbody>
<tr>
<td>Alumina</td>
<td>34%</td>
</tr>
<tr>
<td>Ammonium chloride</td>
<td>1%</td>
</tr>
</tbody>
</table>

This process is a technique known as a chromizing, in which when the pin is heated and held at a temperature of 950°C for three hours, a chrome diffused layer of from 5 to 10 μ is formed on the surface of the pin 1. The carbon contained in SCM3 as a blank forms a chrome compound which is dispersed in the diffused layer in the form of extremely hard fine particles. Then, the pin 1 is heated to a quenching temperature of the SCM, that is, 850°C, and after quenching, it is tempered at a suitable temperature. A pin having a section as shown in FIG. 2 is obtained by the process as described above. Estimated hardness of the surface diffusion layer of the ferrite would be Hv (Vickers' hardness) = 600 to 800, and the estimated hardness of the particles C of fine, globular carbides would be Hv = 1500 to 1700. When actually measured at 200 g micro Vickers, there is obtained Hv = 1000 to 1300 on the average, and there is further appeared the intermediary layer (d) which is martensite instead of ferrite, though chrome is dispersed to some extent.

EXAMPLE 2

In order to increase the quantity of the fine, globular carbides C in Example 1, carburizer of the following composition is added by 10% into the chromizing agent for the performance of dispersion treatment. Further processes hereinafter shall be in accordance with the Example 1.

| Barium carbonate | 45% |
| Active carbon    | 55% |

By this process, the chrome diffusion layer is somewhat reduced but fine, globular carbide particles C increase, and the hardness Hv of the diffusion surface layer (b) will be 1300 to 1500.

EXAMPLE 3

Metal nitrides are also formed by using the carburizing and nitriding agents comprising the following composition, instead of using the carburizer as described in Example 2.

| Lime nitrogen      | 30% |
| Urea anhydride    | 10% |
| Barium oxalate    | 15% |
| Active carbon     | 45% |

This formation, however, is very hard and in the form of fine particles so that the effect thereof is the same as that of the carbides.

The chain incorporating the pin 1 made of the medium carbon alloy steel as processed in the foregoing is good in wear resistance and the strength thereof is extremely improved as compared with the conventional type. Further, under the bad conditions such as high speed and heavy load or impact load or inferior lubrication, etc., the present chain has its good durability and is most suitable particularly for use of power transmission.

While the examples in which the medium carbon alloy steel is used as a blank for the pin 1 have been described in the foregoing, it will be readily understood from the aforesaid description that likewise excellent wear resistance may be attained also by using the conventional low carbon case hardening steel.

Further, while this invention has been described in conjunction with the pin 1, which is a most important part among the constitutional members for the chain, the invention may be applicable to the bushing 2, the roller 3, the pin link plate 4, and the roller link plate 5 other than the pin 1, when necessary, and in addition, corrosion resistance as a feature of the chromizing process may be provided, thus being applicable to chains in various modes including size and extensively improving quality.

What is claimed is:
1. A steel chain link cylindrical pin comprised of an alloy of iron and from 0.23 to 0.5% of a medium carbon, and having a surface layer which is at least 3μ in thickness of ferrite having hard, fine and globular chrome carbide particles dispersed therein.

2. The pin of claim 1 having a $H_v$ value of from 1000 to 1500.

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