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RIVET OF HIGH-GRADE STEEL

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1 Claim. (Cl. 85—37)

This invention relates to an improvement of rivets of an ingot steel, which is produced by melting in the usual manner and is free from slag content. This forms a division from the copending application Serial No. 706,149 filed January 10, 1934.

Highly stressed structures such as bridges of a steel which is known in Germany as "St 52" (that is a steel having a tensile strength of more than 50 kilograms per square millimeter and a yield point of at least 36 kilograms per square millimeter with good elongation and notch tenacity) require, for connecting the structural elements, rivets having a shearing strength corresponding to that of the material to be united in order that the loading capacity of the steel shall be fully and economically utilized. According to existing experience, this object is achieved, though only by putting up with other drawbacks, by selecting a rivet steel of similar composition to the St 52 steel employed in each case but having a strength of about 48 kilograms per square millimeter.

The applicant's researches have now revealed that the alloyed rivet steels compounded in accordance with the above considerations have a relatively low binding power during the riveting process. If, for example, nickel or manganese steels be employed as such alloyed rivet steels, the riveted joints exhibit a very low resistance to slip, owing to the low binding power of said alloyed rivet steels, so that the danger arises of the joints soon working loose, especially when alternating stresses occur. If, on the other hand, unalloyed rivet steels be employed, with a tensile strength of 34 or 42 kg. per sq. mm., then, although the binding power is satisfactorily high, the shearing strength, in the case of St 34 steel, is lower than that of the plate material, while in the case of rivets of St 42 steel the shearing strength is not always satisfactory and the tenacity is lower than in alloyed rivets.

According to the present invention, the various conflicting requirements that must thus be imposed on a high-grade rivet steel for highly-stressed structures can be fulfilled by selecting a low carbon and manganese content and such alloying components that do not (or only to a slight degree) lower the temperature at which the iron is transferred from the so-called γ-condition into the so-called α-condition. Alloying components of said kind are silicon, molybdenum, copper and vanadium. By using said alloying additions in the amounts and combinations hereinafter specified it is possible to obtain valuable rivet steels with a relatively high temperature of the γ/α transformation which simultaneously possess a low hysteresis and a raised yield point in the range between 450 and 650° C.

The effect of a high transformation point is that the contraction which the rivet is left to undergo after the riveting operation is completed, is not disturbed by any transformation. A low hysteresis of transformation prevents the production of a hardening structure during the accelerated cooling of the hammered rivet by the steel masses surrounding it. The formation of a hardening structure causes, as is known, an increase of volume and an insufficient toughness and would thus diminish the binding power and the tenacity of the hammered rivet. The high limit of thermal ductility aimed at by the present invention enables one to obtain a high binding power at higher temperatures as well as after the rivet has been cooled. Therefore, according to the invention, the preliminarily hammered rivet steel is chosen in such a manner that by the riveting process which is carried out under otherwise normal conditions, rivets are produced which possess not only the same values of yielding limit, tensile strength and elongation as the surrounding plate material, but which also possess a high binding power, a high shearing strength and tenacity.

The rivet according to the present invention consists of a steel containing carbon from trace to 0.13%, manganese from trace to 0.5%, silicon between 0.35 and less than 0.5%, copper from trace to 1%, molybdenum from trace to 1%, and vanadium from trace to .1%. A rivet composed in such a manner possesses, after the mechanical treatment of riveting, a tensile strength of at least 50 kilograms per square millimeter, a yield limit of at least 40 kilograms per square millimeter and a notch-bar tenacity of at least 10 kilograms per square centimeter.

The following composition and strength properties are given, by way of example, together with the binding power of 25 millimeter rivets after hammering, for characterizing the most essential properties of an alloyed rivet steel produced according to the present invention:

Composition

C	Si	Mn	Cu	Mo	V
0.09	0.48	0.45	0.42	0.18	0.02%

Remainder iron with the usual impurities.

Bundles of five 25 millimeter plates were riveted with rivets of said steel, by means of a pneumatic hammer (air pressure 6.5 atmospheres) in about 18 seconds. The binding power of the hammered rivets was determined by the method of C. Bach and found to lie between 33 and 40 kilograms per square millimeter, with a mean of 37 kilograms per square millimeter. The strength properties of the hammered rivets

were ascertained from tensile specimens 10 millimeters in diameter and 50 mm. measurement length, the shearing strength with doubly notched test pieces, the notched-bar tenacity on test pieces measuring 10 x 10 x 60 millimeters with a rounded notch 3 millimeters in depth and 2 millimeters in diameter.

The mean results are given below:

Yield point	Tensile strength	Elongation	Constriction	Shearing strength	Notched-bar tenacity
Kgs. 42	*Per sq. mm.* 56	*Percent* 28	*Percent* 65	*Kgs. per sq. mm.* 44	*M. kgs. per sq. cm.* 23

The results of these tests show the hammered rivets to be a material of high yield point and shearing strength, and of medium tensile strength accompanied by high elongation and notched-bar tenacity. The binding power, with the mean value 37 kg. per sq. mm., is situated near the yield point and is about 40 to 50% higher than in rivets of St 34 steel, riveted under the same conditions. Other suitable rivet steels produced according to the present invention had the following composition:

C	Si	Mn
0.08 to 0.13%	0.35 to 0.49%	0.35 to 0.45%
Cu	**Mo**	**V**
0.25 to 0.40%	0.1 to 0.3%	0.01 to 0.3%

The high binding power of the rivets also influences of course, the resistance of riveted joints to slip. Thus, in the micro-measurement test of double-row riveted joints of steel with a tensile strength of 55 kg. per sq. mm., the rivets of the present invention gave a resistance of 14 to 16 kg. per sq. mm. to slip, whereas with rivets of unalloyed carbon steel with approximately 0.08% C., the resistance was only 7 to 8 kg. per sq. mm.

Permanent stress tests of rivet joints made with rivets produced according to the present invention, under increasing permanent stress, showed an original strength 25% greater than joints made, under otherwise equal conditions, with rivets of soft carbon steel. If hard rivets of, for example, 3% nickel steel were employed in place of the soft rivets of carbon steel, the binding power and original strength would be substantially lower than with rivets produced according to the present invention.

For the workshop, the low sensitiveness to overheating and the relatively small formation of scale, of the rivet steel according to the present invention, also proved a considerable advantage.

What I claim is:

A rivet of an ingot steel alloy containing carbon from trace to 0.13%, manganese from trace to 0.5%, silicon from 0.35 to less than 0.5%, copper from trace to 1%, molybdenum from trace to 1%, vanadium from trace to 1%, said rivet being adapted, after the mechanical treatment of riveting, to assume the following properties, tensile strength at least 50 kg. per square mm., yield point at least 40 kg. per square mm. and notch-bar tenacity at least 10 m. kg. per square cm.

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