

PATENT SPECIFICATION

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(54) HEAVY DUTY SHACKLE

(71) We, AMERICAN-HOIST & DERRICK COMPANY, of P.O. Box 3128, Tulsa, Oklahoma, United States of America; a corporation organized and existing under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention lies in the field of heavy duty shackle fittings. More particularly, it concerns the design of a very heavy duty shackle, such as would be used in an anchoring system, and subjected to forces of several hundred tons or more.

In the prior art, shackles in the form of a U shape, with pins which pass through openings in the ears, have been constructed of round bar stock, which is flattened on the ends, drilled for a pin, and then bent into a U shape. Such shackles with bows having a round cross-section are unsatisfactory, since they provide a very small radius around which a heavy wire rope must bend when in use. With small size wire ropes, a thimble is often used, which will provide a surface of greater radius, to support the wire rope and utilize the full strength in the wire rope. However, for very heavy loads a thimble is not practical and there is consequently a weakness in the use of a heavy wire rope when bent around a small radius shackle.

According to the present invention there is provided a method of constructing a heavy duty shackle, for use under large loads, such as with anchors, from a selected length of round bar stock of diameter X, comprising the steps of:

(a) reducing the diameter of the end portions of said bar to a diameter X' for a selected distance not more than half the length of the bar;

(b) forging a central portion of diameter X into a broad flat U-shaped section of substantially constant thickness, with the bottom surface of the U-shaped section of part circular cross-section; the radius of said part circular cross-section being at least equal to the diameter X';

(c) forging the ends into a section broader than, and thinner than X';

(d) forging depressions in two opposed surfaces of each of said thinner ends, said depressions being approximately arcuate and extending around a central hub;

(e) forging circular depressions on each said surface of said central hubs;

(f) bending said central portion into an arc, forming an eye, with said U section extending outwardly with the remaining lengths of each end formed into two parallel ears, the spacing between said ears being less than the diameter of said eye;

(g) drilling openings through said ends concentric with said central depressions; and

(h) heat treating said shackle.

Preferably, said method includes the additional steps of:

(i) providing a pin of diameter less than that of said openings;

(j) forming a head at one end of said pin;

(k) forming at least one spur on said head adapted to fit into one of said arcuate depressions; and

(l) providing means on the second end of said pin to lock it in the openings in said ears.

Also in accordance with the present invention, there is provided a shackle bow for heavy duty use under large loads, as in anchor lines, comprising:

(a) a rein section adjacent the two ends of said shackle bow, each said rein section being between a central uniform cross-section portion and a flattened ear portion;

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(b) said central portion being of a broad, flat U-shaped cross-section with a circular bottom surface, the radius of said bottom surface being at least equal to the largest cross-section dimension of the rein section;

(c) said shackle bow including a substantially circular part with the arms of said U-section of said central portion directed outwardly around a central eye, said ears being substantially parallel, spaced apart a distance less than the diameter of said eye, and having co-axial central openings therein to receive a pin therethrough.

The invention also includes a shackle comprising such shackle bow and a locked pin through said central openings.

Also in accordance with the present invention there is provided a shackle bow having an approximately circular eye, with two rein sections leading to two substantially parallel ears; the cross-section of that part of said bow defining the eye being in the form of a broad flat U-section the arms of which extend outwardly, with the bottom inner surface facing the eye being curved; the thickness of said cross-section being substantially constant; the cross-section of said rein section being approximately circular; and the cross-section of said ears being broad and thin, with aligned central openings, and thick flanges formed by forging central depressions in said ears; and said shackle bow being heat treated. The invention also includes a shackle comprising such a shackle bow and a locked pin through said central openings.

The present invention will be further illustrated, by way of example, with reference to the accompanying drawings, in which:

FIGURES 1A and 1B represent views of the original bar rod and the bar after reducing, respectively.

FIGURES 2 and 3 illustrate plan and elevational views of the forged rod.

FIGURE 4 illustrates the various cross-sections of the forged rod at selected points along its length.

FIGURES 5, 5A, and 6 show two views of the completed shackle, and a detail of the pin.

Referring now to the drawings there is shown in FIGURE 1A a view of a cylindrical rod of selected half length 13 and diameter 14 or X indicated generally by the numeral 12.

FIGURE 1B shows the shape of the rod after reducing, in which the diameter of the ends has been reduced from the original diameter 14 to a lesser diameter 16 or X'. The central portion 24 of the rod now extends from the mid-point a distance 23 at the original diameter 14. There is then a short portion 27 of more or less conical transitional shape, for a length 21, to a

plane 22, and then a portion 26 of length 25 of constant diameter 16.

The reduced rod, generally referenced 10, is then forged into the shape shown in FIGURES 2 and 3, and in the various cross-sections shown in FIGURE 4. The central portion 24' as at plane 18 is flattened and broadened into a section shown in A of FIGURE 4. This has on the underside a cylindrical surface 31; and on the top a flat surface 30 with a depressed central portion 28, which provides a shallow U-shaped cross-section. The radius of the cylindrical portion 31 is at least equal to the diameter X'.

The depression 28 becomes shallower and narrower in the region of the rod between the planes 20 and 22', where the cross-section as plane B is shown as B in FIGURE 4. Here the width of the cross-section and its radius are reduced from that of A and the shape merges into a somewhat flattened cylinder shown by C in FIGURE 4, and indicated for the portion C of FIGURE 3.

The end of the portion 26 of FIGURE 1B is flattened and broadened in order to form a portion where there is a central opening for a pin, with sufficient material surrounding the depressions 34 to provide sufficient strength to carry the load of the shackle. In the center of this broadened portion there are depressions 34 on top and bottom surface 60, 61 which spread the metal outwardly to provide a thick rim 35. The depressions 34 are of somewhat lesser diameter than the diameter 38 of the opening that will be bored for the pin, shown in dashed lines 39.

In addition, the faces 60 and 61 of the ends that have been flattened to a thickness 64, have additional depressions 32 and 36 in each of the surfaces. The purpose is to thin the cross-section and to provide better heat treatment of the end portions of the shackle. These depressions 32 and 36, which are somewhat arcuate in shape, have an additional advantage as will be explained, in connection with FIGURES 5 and 6, that when the pin is inserted through the openings 39, that are bored in the ends of the ears, there may be spurs or projections on the inner surface of the head of the pin, which lock into the depressions 32 and/or 36 and lock the pin against rotation.

The next step in the manufacture of the shackle is, of course, to form the forged bar into a loop, which provides, as in FIGURES 5 and 6 an arcuate central portion 49 defining with rein sections 51 an eye 50, the rein sections 51 being of more or less cylindrical cross-section, leading to the broader ears 55 of the shackle which are spaced apart by distance 52 less than the diameter of eye 50. When completely bent

into shape, the two openings 39 are opposite each other, and a pin 54 can be inserted into the openings 39 in the ears and locked by any selected means such as, for example, by a threaded nut 58 and/or split pin as shown.

In the enlarged section FIGURE 5A there is shown a detail of spurs or projections 59 on the head 57 of the pin 54, which lock into the depressions 32 and/or 36.

After the shackle is formed, it is then heat treated, as is customary. The change in cross-section is advantageous in providing a more uniform heat treatment and development of the full strength of metal.

What has been described is a method of manufacture and a very heavy duty shackle, which is forged with a specific type of cross-section, from a round bar, which better utilizes the strength of the material, has a greater section modulus, reduces the overall weight of the shackle, increases the line of bearing contact between the wire rope and the shackle, and increases the radius of the contact surface, for better utilization of the intrinsic strength of the wire rope.

By creating a specialized shape with the inner radius the equivalent to the diameter of the basic stock size of the shackle, the contact length of the rope bearing surface has been increased by 58%. This increase in bearing or contact length naturally reduces the relative amount of wear on the wire rope or shackle bow by a corresponding amount.

By doubling the radius of the contacting surface this, in effect, means that the contacting wire rope is not bent around as small a radius and it increases the usable rope strength by a factor of 15%.

By utilizing the special shape section, the section modulus is increased by 36% over what the normally-used round bar section would be.

By using a relatively constant cross-sectional thickness and keeping this dimension the same as the normally-used round bar diameter, better metallurgical properties are achieved in the quenched and tempered material to the extent of 6%.

The overall gain by the utilization of the shaped section is an increased strength in the bow section of 42% over the conventionally-used round bar diameter section.

Utilizing the special-shaped section and taking advantage of the beforementioned strength increase in the section, achieves a 30-40% weight reduction over the same capacity shackle utilizing a round bar section of the same nominal configuration dimensions.

WHAT WE CLAIM IS:—

1. A method of constructing a heavy duty shackle, for use under large loads,

such as with anchors, from a selected length of round bar stock of diameter X, comprising the steps of:

(a) reducing the diameter of the end portions of said bar to a diameter X' for a selected distance not more than half the length of the bar;

(b) forging a central portion of diameter X into a broad flat U-shaped section of substantially constant thickness, with the bottom surface of the U-shaped section of part circular cross section; the radius of said part circular cross-section being at least equal to the diameter X';

(c) forging the ends into a section broader than, and thinner than X';

(d) forging depressions in two opposed surfaces of each of said thinner ends, said depressions being approximately arcuate and extending around a central hub;

(e) forging circular depressions on each said surface of said central hubs;

(f) bending said central portion into an arc, forming an eye, with said U section extending outwardly with the remaining lengths of each end formed into two parallel ears, the spacing between said ears being less than the diameter of said eye;

(g) drilling openings through said ends concentric with said central depressions; and

(h) heat treating said shackle.

2. A method as claimed in claim 1, including the additional steps of:

(i) providing a pin of diameter less than that of said openings;

(j) forming a head at one end of said pin;

(k) forming at least one spur on said head adapted to fit into one of said arcuate depressions; and

(l) providing means on the second end of said pin to lock it in the openings in said ears.

3. A method of constructing a heavy duty shackle, as claimed in claim 1 or 2, substantially as hereinbefore described.

4. A heavy duty shackle, whenever constructed by a method as claimed in claim 1, 2 or 3.

5. A shackle bow for heavy duty use under large loads, as in anchor lines, comprising:

(a) a rein section adjacent the two ends of said shackle bow, each said rein section being between a central uniform cross-section portion and a flattened ear portion;

(b) said central portion being of a broad, flat U-shaped cross-section with a circular bottom surface, the radius of said bottom surface being at least equal to the largest cross-section dimension of the rein section;

(c) said shackle bow including a substantially circular part with the arms of said U-section of said central portion



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into shape, the two openings 39 are opposite each other, and a pin 54 can be inserted into the openings 39 in the ears and locked by any selected means such as, for example, by a threaded nut 58 and/or split pin as shown.

In the enlarged section FIGURE 5A there is shown a detail of spurs or projections 59 on the head 57 of the pin 54, which lock into the depressions 32 and/or 36.

After the shackle is formed, it is then heat treated, as is customary. The change in cross-section is advantageous in providing a more uniform heat treatment and development of the full strength of metal.

What has been described is a method of manufacture and a very heavy duty shackle, which is forged with a specific type of cross-section, from a round bar, which better utilizes the strength of the material, has a greater section modulus, reduces the overall weight of the shackle, increases the line of bearing contact between the wire rope and the shackle, and increases the radius of the contact surface, for better utilization of the intrinsic strength of the wire rope.

By creating a specialized shape with the inner radius the equivalent to the diameter of the basic stock size of the shackle, the contact length of the rope bearing surface has been increased by 58%. This increase in bearing or contact length naturally reduces the relative amount of wear on the wire rope or shackle bow by a corresponding amount.

By doubling the radius of the contacting surface this, in effect, means that the contacting wire rope is not bent around as small a radius and it increases the usable rope strength by a factor of 15%.

By utilizing the special shape section, the section modulus is increased by 36% over what the normally-used round bar section would be.

By using a relatively constant cross-sectional thickness and keeping this dimension the same as the normally-used round bar diameter, better metallurgical properties are achieved in the quenched and tempered material to the extent of 6%.

The overall gain by the utilization of the shaped section is an increased strength in the bow section of 42% over the conventionally-used round bar diameter section.

Utilizing the special-shaped section and taking advantage of the beforementioned strength increase in the section, achieves a 30-40% weight reduction over the same capacity shackle utilizing a round bar section of the same nominal configuration dimensions.

WHAT WE CLAIM IS:—

1. A method of constructing a heavy duty shackle, for use under large loads,

such as with anchors, from a selected length of round bar stock of diameter X, comprising the steps of:

(a) reducing the diameter of the end portions of said bar to a diameter X' for a selected distance not more than half the length of the bar;

(b) forging a central portion of diameter X into a broad flat U-shaped section of substantially constant thickness, with the bottom surface of the U-shaped section of part circular cross section; the radius of said part circular cross-section being at least equal to the diameter X';

(c) forging the ends into a section broader than, and thinner than X';

(d) forging depressions in two opposed surfaces of each of said thinner ends, said depressions being approximately arcuate and extending around a central hub;

(e) forging circular depressions on each said surface of said central hubs;

(f) bending said central portion into an arc, forming an eye, with said U section extending outwardly with the remaining lengths of each end formed into two parallel ears, the spacing between said ears being less than the diameter of said eye;

(g) drilling openings through said ends concentric with said central depressions; and

(h) heat treating said shackle.

2. A method as claimed in claim 1, including the additional steps of:

(i) providing a pin of diameter less than that of said openings;

(j) forming a head at one end of said pin;

(k) forming at least one spur on said head adapted to fit into one of said arcuate depressions; and

(l) providing means on the second end of said pin to lock it in the openings in said ears.

3. A method of constructing a heavy duty shackle, as claimed in claim 1 or 2, substantially as hereinbefore described.

4. A heavy duty shackle, whenever constructed by a method as claimed in claim 1, 2 or 3.

5. A shackle bow for heavy duty use under large loads, as in anchor lines, comprising:

(a) a rein section adjacent the two ends of said shackle bow, each said rein section being between a central uniform cross-section portion and a flattened ear portion;

(b) said central portion being of a broad, flat U-shaped cross-section with a circular bottom surface, the radius of said bottom surface being at least equal to the largest cross-section dimension of the rein section;

(c) said shackle bow including a substantially circular part with the arms of said U-section of said central portion



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- directed outwardly around a central eye, said ears being substantially parallel, spaced apart a distance less than the diameter of said eye, and having co-axial central openings therein to receive a pin therethrough.
- 5 6. A shackle bow as claimed in claim 5, in which the outside surface of each ear has at least one substantially arcuate depression surrounding the central opening.
- 10 7. A shackle bow as claimed in claim 5 or 6, substantially as hereinbefore described and illustrated.
8. A shackle comprising a shackle bow as claimed in claim 5, 6 or 7, and a locked pin through said central openings.
- 15 9. A shackle bow having an approximately circular eye, with two rein sections leading to two substantially parallel ears; the cross-section of that part of said bow defining the eye being in the form of a broad flat U-section the arms of which extend outwardly, with the bottom inner surface facing the eye being curved; the thickness of said cross-section being substantially constant; the cross-section of said rein section being approximately circular; and the cross-section of said ears being
- broad and thin, with aligned central openings, and thick flanges formed by forging central depressions in said ears; and said shackle bow being heat treated.
10. A shackle bow as claimed in claim 9, including at least one substantially arcuate depression substantially concentric with said central openings on the outer surfaces of said ears.
11. A shackle bow as claimed in claim 9 or 10, substantially as hereinbefore described and illustrated.
12. A shackle comprising a shackle bow as claimed in claim 9, 10 or 11, and a locked pin through said central openings.
13. A shackle substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.
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