

[72] Inventor **Roy Norton**
c/o The Wear-Flex Corp., 4111 N.
Washington Ave., Milwaukee, Wis. 53212
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Primary Examiner—Evon C. Blunk
Assistant Examiner—W. Scott Carson
Attorney—Ira Milton Jones

[54] **HOIST LINE SLING FOR LIFTING HEAVY LOADS**
17 Claims, 17 Drawing Figs.

[52] U.S. Cl..... **294/74,**
24/200

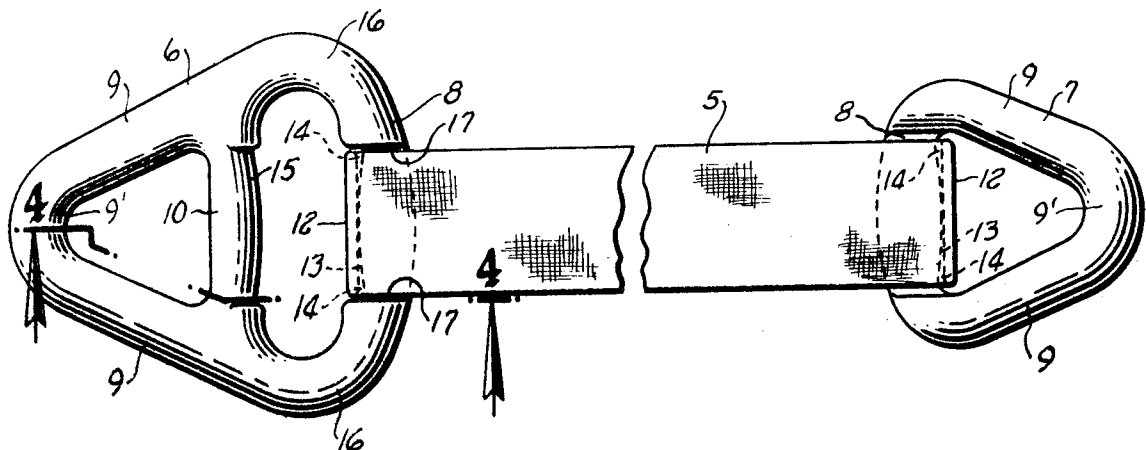
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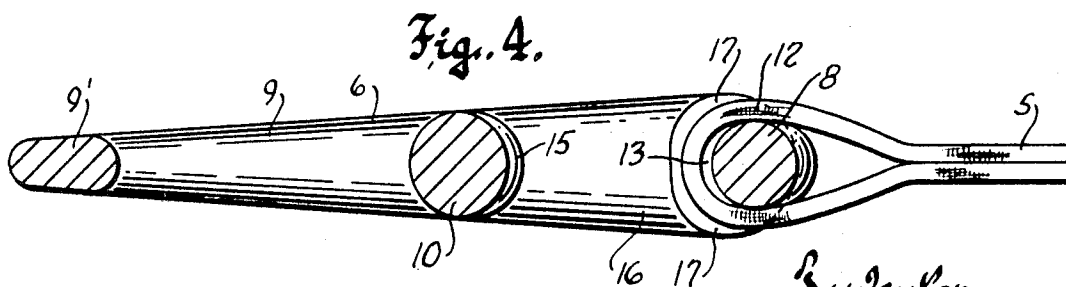
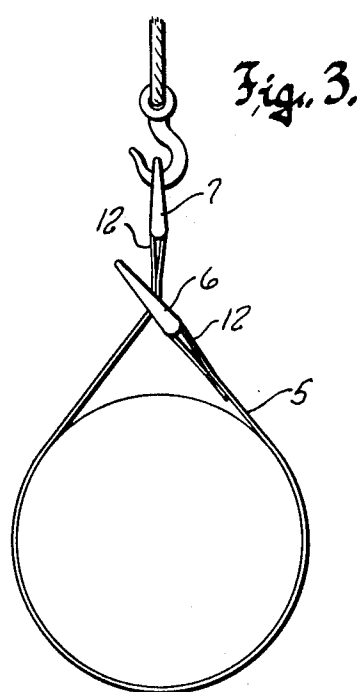
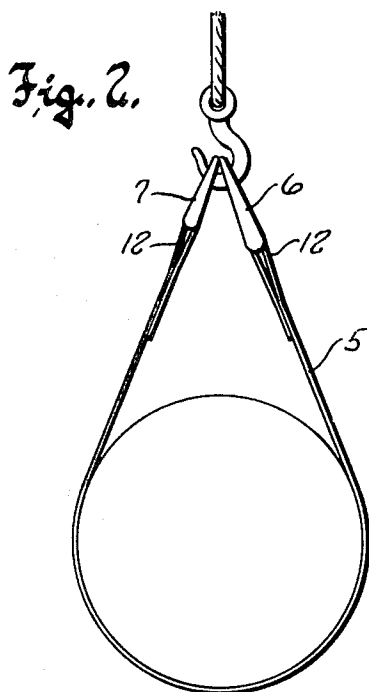
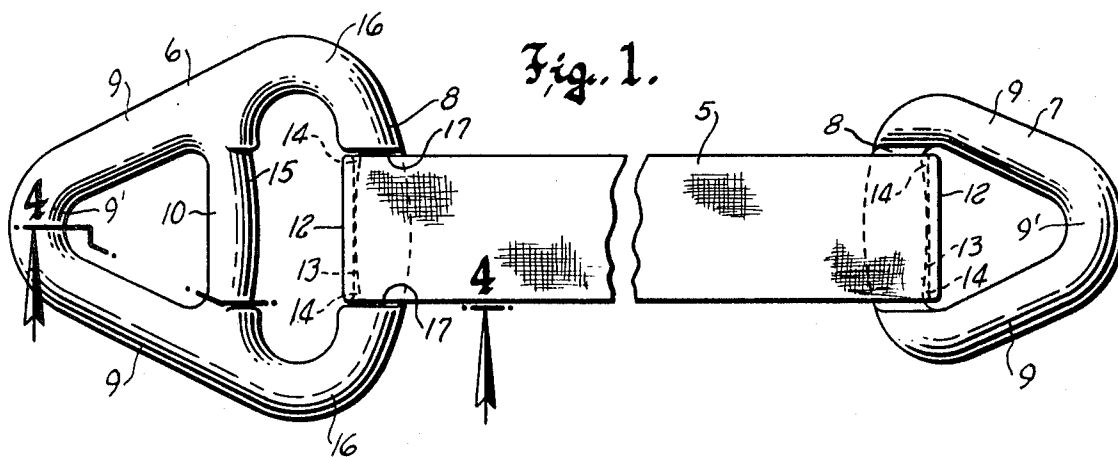
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200, 265 BC, 265 BH, 201.1, 265 CTD; 74/230.5,
229, 241; 294/74—77

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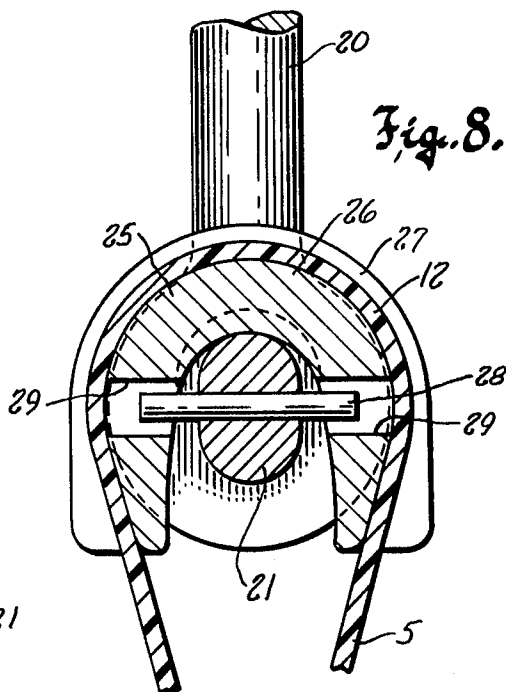
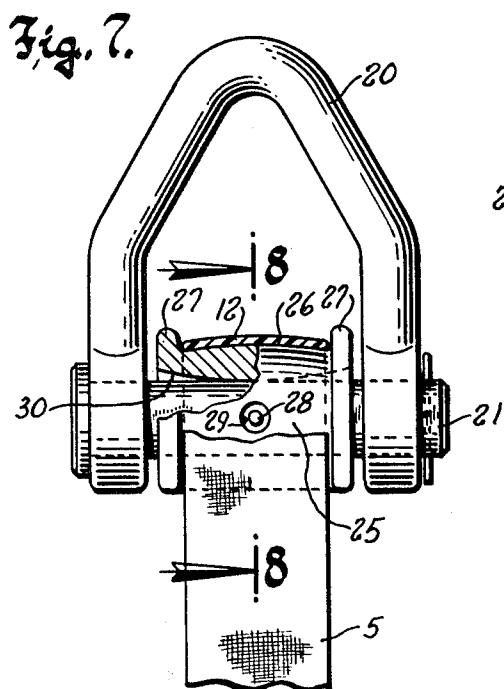
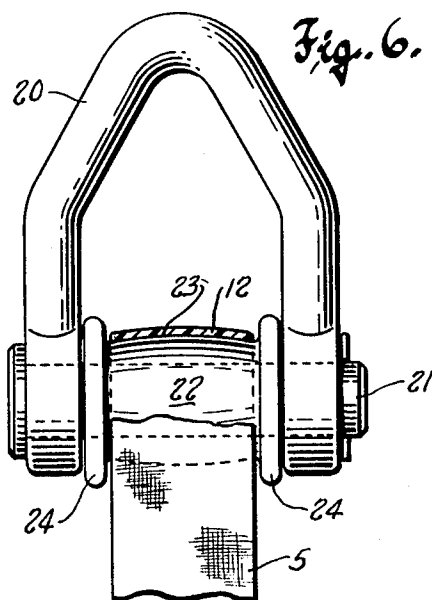
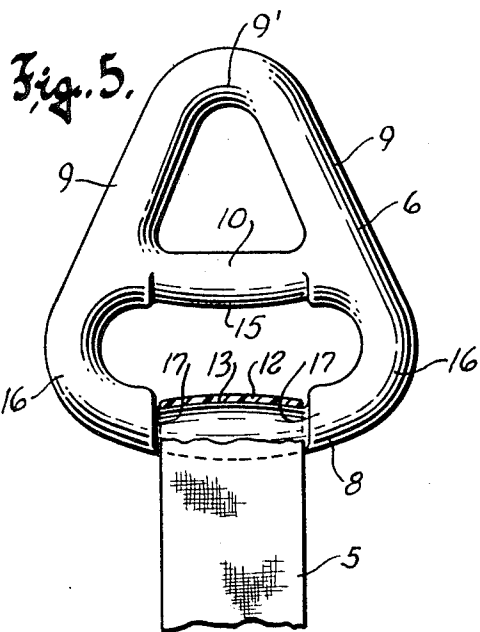
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ABSTRACT: A hoist line sling for lifting heavy loads, consisting of an elongated web (either fabric or metal mesh) has a triangularly shaped metal eye attached to each end thereof in a manner which assures that the stresses which exist in the web as tension loads are applied to the sling through the eyes at the ends thereof, are at all times concentrated in the transversely medial portion of the web containing its longitudinal neutral axis.





Inventor
Roy Norton
By *William Jones*
Attorney



Inventor
Roy Norton
By *William Jones*
Attorney

Fig. 9.

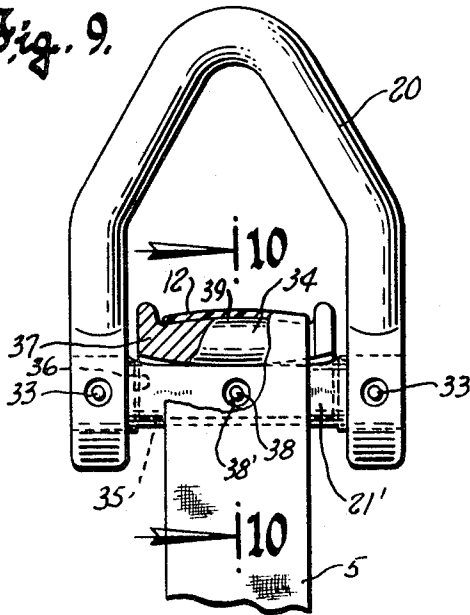
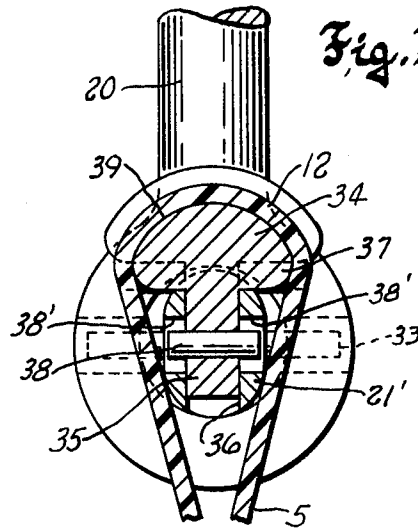
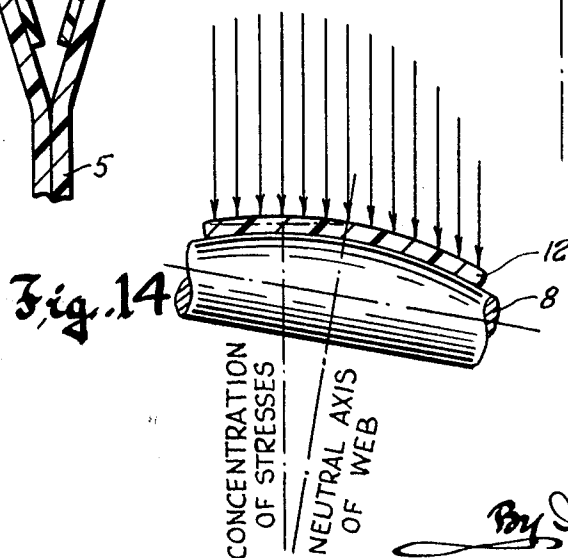
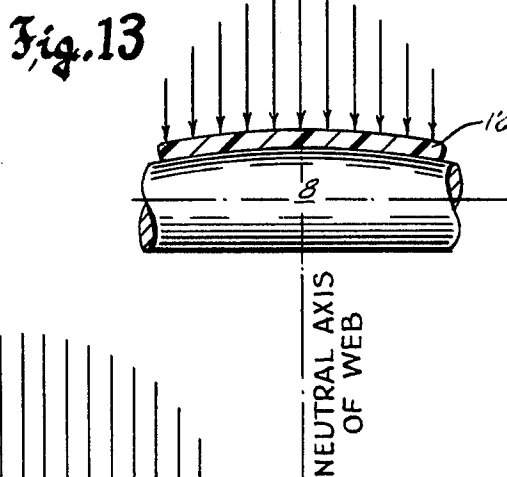
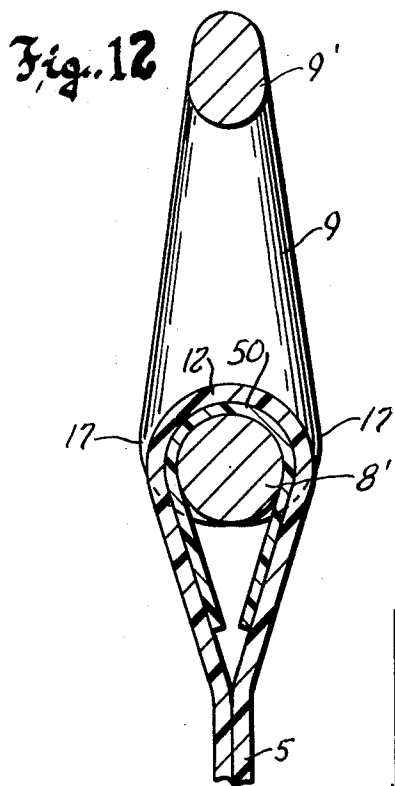
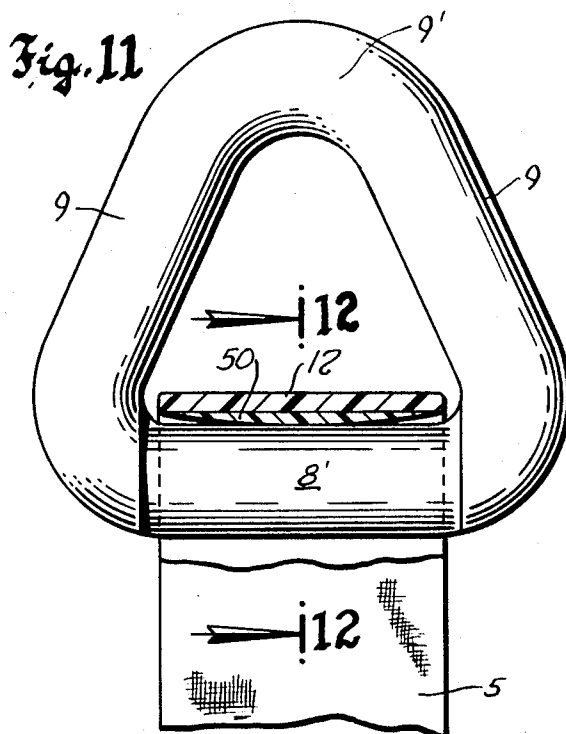


Fig. 10.



Inventor
Roy Norton
By *DeMilton Jones*
Attorney



Inventor
Roy Norton
By [Signature] Jones
Attorney

Fig. 15

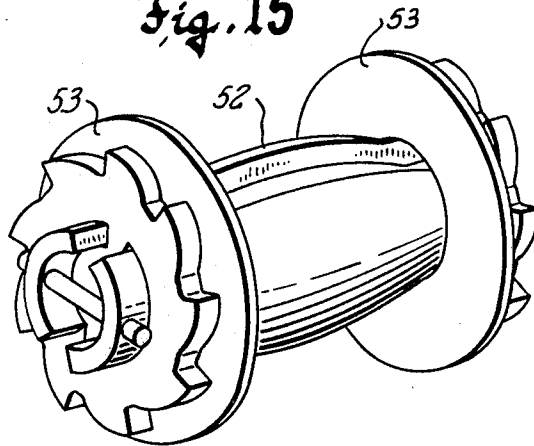


Fig. 17

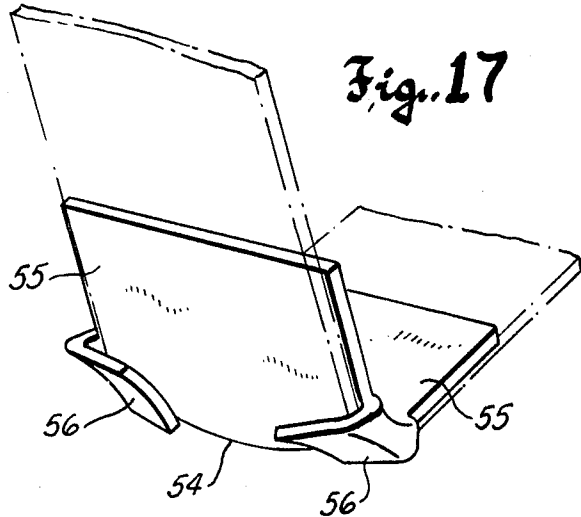
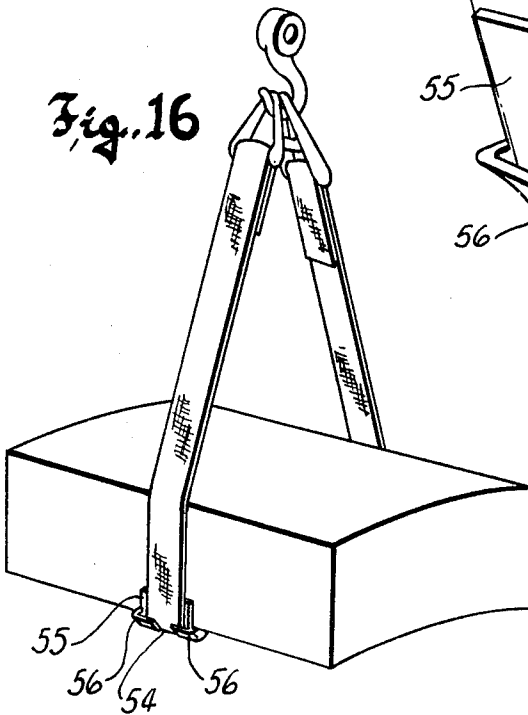


Fig. 16



Inventor
Roy Norton
By *Donald L. Jones*
Attorney

HOIST LINE SLING FOR LIFTING HEAVY LOADS

The invention resides in the discovery that the side edge portions of a web—such as the flexible web of a hoist line lifting sling—will not be stressed to the point of causing premature failure of the web if the stress in the web resulting from heavy tension loads thereon is always concentrated in a zone which contains, or is as close as possible to, the longitudinal neutral axis of the web. This objective is achieved by providing the rigid members to which the web is attached, and through which tension is applied to the web (and/or such other rigid members with which the web may have load bearing engagement) with convexly curved surfaces that extend transversely across the web and provide the load transmitting connections between the web and the rigid members.

Experience has shown that load lifting slings of the type to which this invention pertains, and which are customarily known as hoist line slings, made in accordance with conventional practice and design, always failed or broke first at the side edges of the web, and as soon as a break occurred at one of the side edges, the tear would quickly run across the full width of the web. Heretofore, the only known way of combating such failures of the web was to use what is known as calibrated webbing, or webbing having a higher overall tensile strength rating. Calibrated webbing has increased thickness at the edges with correspondingly higher tensile strength than the transversely medial portion of the webbing along its longitudinal neutral axis. Both of these expedients increase the cost of the sling and reduce its flexibility. Moreover, while slings made with calibrated or higher tensile strength webbing could handle heavier loads without failure, when failure did occur it still always started at one or the other of the side edges of the web.

The answer to the problem, as indicated in the aforesaid Summary, resided in the discovery that by providing the connection between each end of the web and its respective eye with some means which at all times tends to concentrate the stress to which the web is subjected by tension loads thereon, in a transversely medial portion of the web which contains or is as close as possible to the longitudinal neutral axis of the web, the stresses in the side edge portions of the web are proportionately reduced, and do not reach the disruptive magnitude which gave rise to the problem. Tests have demonstrated that when sling embodying this invention are deliberately subjected to breakage, the initial failure no longer is limited to the side edges of the web as it was in the past. Tests have also shown that without any increase in tensile strength rating of the webbing or any other modification thereof, the slings embodying this invention can handle heavier loads without failure.

Broadly stated, therefore, the purpose and object of the invention is to provide some means (wherever a web—such as that of a load lifting sling—is attached to a rigid connector element or passes over or around a rigid supporting element) by which the stresses in the web incident to its being placed in tension are at all times concentrated in a transversely medial zone or portion of the web which contains, or is as close as possible to, the neutral axis of the web.

More specifically, the purpose and object of this invention is to provide an improved industrial load lifting sling of the type consisting of a flexible web with a metal loop or eye at each end thereof. More particularly, it is the purpose and object of the invention to so construct and design the connection between the ends of the web and the metal eyes that, during use of the sling, no significant difference ever exists in the level of the stresses in the side edge portions of the web from that of the stresses which obtain in the transversely medial portion of the web along its neutral axis. Hence, without resorting to the use of specifically calibrated or higher tensile strength rated webs, the slings can carry heavier loads without failure.

With these observations and objects in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawings. This disclosure is intended merely to exemplify the

invention. The invention is not limited to the particular structure disclosed and changes can be made therein which lie within the scope of the appended claims without departing from the invention.

The drawings illustrate several complete examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a plan view of the opposite end portions of a sling of the type to which this invention pertains, showing the same in its relaxed condition;

FIG. 2 illustrates one manner of using the sling, which is generally referred to in the trade as a "basket hitch";

FIG. 3 illustrates another way of lifting a load with the sling of this invention, known as a "choker hitch";

FIG. 4 is a cross-sectional view through FIG. 1 on the plane of the line 4-4;

FIG. 5 is a plan view, similar to FIG. 1, but showing only one end of the sling and under load, part of the loop at the end of the web being broken away and in section;

FIGS. 6 and 7 are views similar to FIG. 5, but illustrating two modified embodiments of the invention;

FIG. 8 is a cross-sectional view through FIG. 7 on the plane of the line 8-8;

FIG. 9 is another view similar to FIG. 5, illustrating still another modified embodiment of the invention;

FIG. 10 is a cross-sectional view through FIG. 9 on the plane of the line 10-10;

FIG. 11 is a view similar to FIG. 5, illustrating what might be considered a reversal in the arrangement of the parts forming the connection between the web and the eyes at the ends thereof, from that employed in the other embodiments of the invention.

FIG. 12 is a cross-sectional view through FIG. 11 on the plane of the line 12-12;

FIGS. 13 and 14 are diagrammatic views to better illustrate how the load concentrating means incorporated in the connection between the ends of the web and the eyes distributes the stresses across the width of the web, and keeps the side edge portions of the web from being over stressed;

FIG. 15 is a perspective view of the spool of a ratchet-type web tensioner embodying this invention;

FIG. 16 is a perspective view illustrating a sling equipped with corner guards to protect the web of the sling against being cut by sharp edges on the load being lifted, and which corner guards embody this invention; and

FIG. 17 is a perspective view of one of the corner guards of the sling shown in FIG. 16, at an enlarged scale to better illustrate the adaptation of this invention thereto.

Referring now more particularly to the accompanying drawings in which like numerals indicate like parts, and especially to FIGS. 1 to 5, inclusive, the numeral 5 denotes the fabric web of a load lifting sling especially adapted for industrial use. The ends of the web have attaching eyes 6 and 7 connected thereto. Each eye has a rigid crossbar 8 to which the web is connected and the eye 6 has a second crossbar 10 joining its side legs 9 at a distance from and parallel to the crossbar 8. The space between the crossbars 8 and 10 and the portions of the side legs spanning the same is large enough to have the eye 7 at the other end of the web passed therethrough to enable the sling to be used as a choker hitch, (shown in FIG. 3) as well as a vertical hitch (shown in FIG. 2). Each end of the web has a loop 12 formed thereon, in which the rigid crossbar 8 of its respective eye is received. The loops 12 are produced in the conventional manner by passing the end portion of the web around the crossbar and then sewing, or otherwise bonding, the same solidly to the underlying portion of the web.

Heretofore, the crossbars of the eyes embraced by the loops 12—or at least the transversely curved surfaces thereof that are engaged by the loops when the sling is under load—were longitudinally straight from end to end. Theoretically, with that straight line relationship, the stresses in the web as a load

was lifted should have been substantially uniform across the full width of the web, but they were not at all uniform. That ideal condition could only exist if the lines of force during use of the sling always remained exactly normal to the straight line engagement between the web loops and the crossbars of the eyes.

In practice, however, the angle between the lines of force and the straight line engagement of the web loops with the crossbars of the eyes, was different from job to job, and even during lifting of a load it was apt to change. As a result, the side edge portions of the web were constantly and alternately subjected to higher stresses than the transversely medial portion of the web. This caused the side edge portions of the web to be strained to the point of breakage and resulted in failure of the web at loads considerably less (up to 20 percent less) than would have been the case if the stresses were uniformly distributed across the width of the web.

The consequences of alternately concentrating the lifting stresses in the side edge portions of the web are graphically illustrated by the condition of an old fashioned pair of suspenders that has been subjected to prolonged and perhaps severe use—both side edges are ruffled and anything but straight as they were when the suspenders were new. In the case of the suspenders, the consequences of overstressing the side edge portions seldom did more than detract from the sartorial appearance of the wearer, but in the load lifting slings heretofore available it resulted in premature failure of the sling.

By virtue of this invention, a relatively slight structural change in the connection between the ends of the web and the adjacent eyes relieves the side edge portions of the web of the disruptive stresses to which they would be subjected without the benefit of this invention. In the embodiment of the invention illustrated in FIGS. 1—5, inclusive, this change consists in so shaping the rigid crossbars 8 that the surfaces thereof engaged by the loops 12 when the sling is under load are crowned or convexly curved from end to end, as indicated at 13 in FIG. 5. In cross section, the crossbars 8 may be round or oval-shaped, as shown, in which event the major axis lies in the medial plane of the eye.

By virtue of the endwise extending convex curvature of the crossbars 8, when the sling is relaxed—as shown in FIG. 1—the side edge portions of its loops 12 are spaced from the crossbar, as indicated at 14 in FIG. 1. Accordingly, when a load is applied to the sling—and assuming that the resulting lines of force are normal to the axis of the crossbar 8 and hence normal to a line extending transversely across the web at right angles to its side edges—as in FIG. 13—that load is initially applied upon the transversely medial portion of the web along its neutral axis, since the crossbars 8 are rigid and retain their shape even when the sling is lifting a heavy load. Only after the medial portion of the web has been stressed, are stresses manifested in the side edge portions of the web. The arrows in FIG. 13 depict both the direction of the lines of force and the relative magnitude of the stresses across the width of the web. In this case—which is by no means the usual situation during use of the sling—the stresses in the web are concentrated in the transversely medial portion of the web along its neutral axis and are progressively less in the portions of the web at opposite sides of the neutral axis.

FIG. 14 illustrates how during use of the sling, the angle between the lines of force and the axis of the cross bar 8 deviates from the ideal condition, and how this invention precludes overloading stresses in the side edge portions of the web and consequent premature failure of the web and, on the contrary, reduces the differential between the stresses in the loaded side edge portion and in the medial portion of the web. Since the direction in which the crossbar 8 inclines will alternate during use of the sling between that shown in FIG. 14 and the opposite thereof, it follows that this reduction in differential obtains at both sides of the neutral axis, with the result that the stresses in the web are more uniformly distributed across the width thereof.

When the sling is used as a choker hitch, as shown in FIG. 3, a medial portion of the web engages the second crossbar 10 which, like the crossbars 8, is rigid and has the surface 15 thereof—which is engaged by the web—longitudinally convex, as clearly shown in FIG. 1. As a result of the convex curvature of the surface 15, the side edge portions of the web bearing thereagainst are not as stressed as they would be in the absence of such convex curvature.

Preferably the divergent end portions 16 of the side legs 9 are larger in cross section than the adjacent end portions of the crossbars 8, which results in the provision of shoulders 17 to hold the loops of the web properly positioned on the crossbars 8 and, as best seen in FIG. 4, the shoulders 17 also provide ribs or runners to protect the loops from contact with surfaces that would otherwise cause abrasion, as when one end of the sling is slipped across the floor under a load preparatory to lifting the same.

It is also preferable to have the thickness of the eye convergently tapered from its crossbar 8 to its crane hook engaging apex 9'.

The invention is, of course, not limited to adaptation in the manner illustrated in FIGS. 1—5, inclusive, wherein the eyes are permanently attached to the ends of the fabric web. Thus, for instance, each eye can be replaced by a clevis 20 with a removable crosspin 21, as shown in FIG. 6. In this case, a crowned spool 22 mounted on the crosspin between the legs of the clevis provides the convexly curved surface 23 by which the application of overloading stresses upon the side edge portions are prevented.

FIGS. 7 and 8 illustrate an embodiment of the invention which—like that of FIG. 6—employs a clevis 20 and a removable crosspin 21—but in this case the spool is supplanted by a saddle 25. The top of the saddle 26 is round in cross section, as shown in FIG. 8, and also crowned or endwise convex as seen in FIG. 7. Flanges 27 hold the loop of the fabric web in position and protect the same against abrasion; and to hold the saddle assembled with the crosspin 21, a small pin 28 having a drive fit in a crossbore through the pin 21, has its end portions loosely received in holes 29 in the sides of the saddle. By virtue of the size of the holes 29 in comparison to that of the end portions of the pin 28, and the fact that the space between the side portions of the saddle is larger than the transverse width of the pin 21, it follows that the saddle is free to rock from side to side during use of the sling. This allows the sling to accommodate itself to the load without sliding on the saddle.

The embodiment of the invention illustrated in FIGS. 7 and 8 has an additional feature not possessed by the slings of FIGS. 1—6, inclusive. This feature, which may be regarded as edgewise accommodation of the web in its connection to the eye or clevis, is obtained by having the undersurface 30 of the saddle convexly curved from end to end, as shown in FIG. 7. As will be apparent, it is therefore possible for the saddle to rock lengthwise thereof on its supporting pin 21 and thereby accommodate any tendency of the load to shift the web edgewise in one direction or the other.

The embodiment of the invention illustrated in FIGS. 9 and 10 possesses all of the features found in the saddle version of the connection shown in FIGS. 7 and 8, with the exception of the ready removability of the pin 21'. In this case, the crosspin 21' has cylindrical end portions that are received in appropriate holes in the legs of the clevis 20 and held against disassembly therefrom by pins 33 driven into the end portions of the crosspin 21' and loosely received in holes in the hubs of the clevis.

The primary distinction between the embodiment of the invention shown in FIGS. 9 and 10 and that of FIGS. 7 and 8, however, resides in the fact that instead of a saddle loosely seated on the crosspin, a T-bar 34 has its stem portion 35 received in a slot 36 in the crosspin 21' with the head 37 of the T-bar resting on the crosspin. A pin 38 fixed in the stem portion of the T-bar with its ends projecting therefrom and loosely received in holes 38' in the crosspin, holds the parts assembled without, however, interfering with longitudinal rocking of

the T-bar on the crosspin 21'. Such longitudinal rocking is possible by virtue of the fact that the underside of the head 37 is convexly curved from end to end; and to gain the desired concentration of load, the upper surface 39 of the head is convexly curved from end to end.

In the embodiments of the invention thus far described, the means for concentrating the load upon the transversely medial portion of the web along its neutral axis has been on that part of the connection (between the web and eye) which is on the eye. The reverse relationship can be employed, however, as illustrated in FIGS. 11 and 12. In this case, the crossbar 8' of the eye is axially straight—at least as to the surface thereof which is engaged by the loop of the web, and the underside of the loop has a pad 50 formed thereon, the underside of which is convexly curved transversely of the web and lengthwise of the crossbar 8'. Accordingly, when the sling is relaxed, contact between the underside of the loop of the web and the crossbar 8' is confined to a small area substantially equispaced from the opposite edges of the web, to thereby concentrate the load on the transversely medial portion of the web along its neutral axis during use of the sling.

The pad 50 may be made of any suitable material having the required flexibility and compressive strength, and—as shown in FIG. 12—the pad 50 preferably extends a substantial distance along the opposite stretches of the loop.

The invention is also advantageously applicable to ratchet-type webbing tensioners in which one end of a length of webbing is attached to the frame structure of a ratchet mechanism and the other end portion of the webbing is wound up on a spool that is rotated and held by the ratchet device. FIG. 15 illustrates the spool 52 of such a ratchet device, which in accordance with this invention has a convex curvature from end to end between the flanges 53 of the spool. Hence, as a webbing is wound upon the spool and tensioned, the resulting stresses are concentrated in the transversely medial portion of the webbing along its neutral axis.

Still another area in which this invention can be advantageously applied is in connection with corner guards used with lifting slings to protect the same against being cut by sharp edges on the load to be lifted. FIG. 16 illustrates how such corner guards are used. Generally the corner guard is a metal stamping or casting of right angular cross section to embrace a sharp edge of a piece to be lifted, and for convenience it usually has some means of keeping the guard assembled with the web of the sling.

As shown in FIG. 17, adaptation of the invention to the corner guard involved forcing the bend or junction 54 which connects the two flanges 55 of the guard with a convexly curved outer surface. The curvature is most pronounced on the plane which bisects the angle between the flanges 55 and then merges gently into the planes of the flanges.

Inwardly directed fingers 56 at the opposite ends of the guard overlie the side edge portions of the web to hold the guard assembled with the sling, and preferably these fingers have their undersides convexly curved to avoid sharp edged contact with the web.

From the foregoing description taken in connection with the accompanying drawings, it will be apparent to those skilled in this art that the present invention materially reduces the hazard of premature failure of flexible webs such as those of industrial load lifting slings, which in use are subjected to tension loads along lines of force that are not at all times exactly normal to a line extending transversely across the web at right angles to its side edges, and in so doing significantly improves web-type load lifting slings.

What I claim as my invention is:

1. In a hoist line sling designed to lift and handle heavy industrial loads, and which sling comprises an elongated flexible web of substantially uniform width and thickness throughout its length, and attaching members connected with the web and by which the web may be operatively connected with a load and with a lifting hook, the improvement by which the side edge portions of the web carry no more than does the medial

portion thereof of the stresses in the web that result from tension loads on the web during use of the sling, and which improvement resides in the connection between the web and each of said attaching members, said connection comprising:

- 5 A. a rigid crossbar having an axis and being of a length slightly greater than the width of the web, said crossbar extending transversely of the web and having both ends thereof equally supportingly connected with the attaching member;
- 10 B. parts on said crossbar and on said web in load bearing engagement;
- 15 C. load concentrating means on one of said parts by which said stresses in the web during use of the sling are concentrated in the medial portion of the web as distinguished from its side portions, said load concentrating means comprising an elongated load bearing surface on said one part extending transversely across the full width of the web and being convexly curved along the length thereof, said convex curvature being substantially symmetrical to the axis of said crossbar; and
- 20 D. said one part and the crossbar being sufficiently rigid to preclude deformation thereof by loads encountered during use of the sling.

2. In a hoist line sling, the structure of claim 1, wherein at least one of the attaching members is an eye at one end of the web, and wherein said rigid crossbar is an integral part of said eye, and said part that is on the web and has load bearing engagement with the crossbar is a loop formed in the web.

3. In a hoist line sling, the structure of claim 1, wherein said one part of the connection which has the convexly curved surface is on the web.

4. In a hoist line sling, the structure of claim 3, wherein the part of the connection which is on the web is a loop formed by a portion of the web and embracing the rigid crossbar, and wherein said one part which has the convexly curved surface is a pad on the inner surface of said loop and in load bearing engagement with the rigid crossbar.

5. In a hoist line sling, the structure of claim 1, wherein said one part of the connection which has the convexly curved surface is on the rigid crossbar.

6. The hoist line sling of claim 5, wherein said eye has divergent side members joined to the ends of the crossbar with the side members and crossbar lying in a common plane,

and wherein the portions of said side members that are contiguous to the ends of the crossbar project transversely to said common plane beyond the surfaces of the crossbar to provide shoulders at the ends of the crossbar which hold the loop of the web properly positioned on the crossbar and provide ribs to protect the web from contact with possibly abrasive surfaces.

7. In a hoist line sling, the structure of claim 5, wherein said one part of the connection which has the convexly curved surface is a member separate from but embracing the rigid crossbar.

8. In a hoist line sling, the structure of claim 7, wherein the rigid crossbar is round in cross section, and wherein said member which has the convexly curved surface is a flanged and crowned spool freely rotatably mounted on the crossbar.

9. In a hoist line sling, the structure of claim 7, wherein said member which has the convexly curved surface is a saddle of substantially U-shaped cross section, straddling the rigid crossbar, the top surface of the saddle being longitudinally crowned to provide the convexly curved surface.

10. In a hoist line sling, the structure of claim 9, further characterized by pins projecting from the sides of the crossbar and loosely received in holes in the adjacent portions of the saddle to keep the saddle on the crossbar without restraining limited movement of the saddle with respect to the crossbar.

11. In a hoist line sling, the structure of claim 10, wherein the underside of the saddle is longitudinally convexly curved so that the saddle can rock on the crossbar.

12. In a hoist line sling, the structure of claim 11, wherein the crossbar is narrower than the space between the sides of the saddle, so that the saddle has some freedom to rock from side to side as well as longitudinally of the crossbar.

13. In a hoist line sling designed to lift heavy industrial loads, and which sling comprises an elongated flexible web of substantially uniform width and thickness throughout its length, and a rigid metal eye connected to each end of the web and by which the web may be operatively connected with a load and a lifting hook, the eye having spaced side arms, the improvement by which the side edge portions of the web carry no more than does the medial portion thereof of the stresses in the web that result from tension loads on the web during use of the sling, and which improvement resides in the connections between the web and the eyes, each of said connections comprising:

A. a rigid crossbar which forms an integral part of the eye and has both ends thereof equally supportingly connected to the spaced arms of the eye, said crossbar having an axis;

B. a loop on the web embracing the crossbar and having load bearing engagement therewith;

C. load concentrating means by which said stresses in the web during use of the sling are concentrated in the medial portion of the web as distinguished from its side edge portions,

said load concentrating means comprising an elongated load bearing surface on the rigid crossbar extending transversely across the full width of the web and with which the loop on the web has said load bearing engagement,

said load bearing surface being convexly curved along the length thereof with the curvature substantially symmetrical to the axis of the crossbar; and

D. said crossbar being sufficiently rigid to preclude deformation thereof by loads encountered during use of the sling.

14. In a hoist line sling, the structure of claim 13, wherein said crossbar has a flat-sided slot therethrough, the flat sides of which are parallel to the general plane of the eye, and wherein

said elongated load bearing surface is the top of the head of a T-shaped member having its stem received in said slot with the underside of the head of the T bearing upon the crossbar at opposite sides of the slot.

15. In a hoist line sling, the structure of claim 14, wherein the underside of the head of the T-shaped member is convexly curved longitudinally thereof so that the T-shaped member may rock lengthwise of the crossbar.

16. In a hoist line sling, the structure of claim 14, wherein the top surface of the head of the T-shaped member is transversely rounded.

17. A hoist line sling for lifting heavy industrial loads, which comprises a flexible web having parallel side edges, connected at each end to a rigid eye, characterized in that:

A. each eye is substantially triangular in shape, with three connected legs, one of which forms a crossbar extending between the free ends of the other two legs;

B. loops on the ends of the web embracing the crossbars of the eyes to have force transmitting engagement with the inner surfaces of the crossbars during use of the sling, said crossbars being rigid and undeformable by loads lifted with the sling, and the inner surfaces of the crossbars being convexly curved lengthwise thereof so that during use of the sling and application of tension upon the web through an eye, the portion of the web medially of its side edges is stressed before any load is placed upon the side edge portions of the web;

C. a second rigid crossbar connected to and bridging said other two legs of one of the eyes in parallel spaced relation to its first mentioned crossbar,

the space between the first and second crossbars and the legs to which they are connected being large enough to permit the eye at the other end of the web to be passed therethrough to enable the sling to be formed into a loop around a load to be lifted by a pull on the eye at said other end of the web,

and the surface of the second crossbar which faces the first crossbar being convexly curved lengthwise thereof and transversely rounded.

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