June 21, 1938. S. C. HOLLISTER ET AL 2,121,035

METHOD AND MEANS OF JOINING TUBULAR MEMBERS

Filed Aug. 29, 1934

Fig. 2

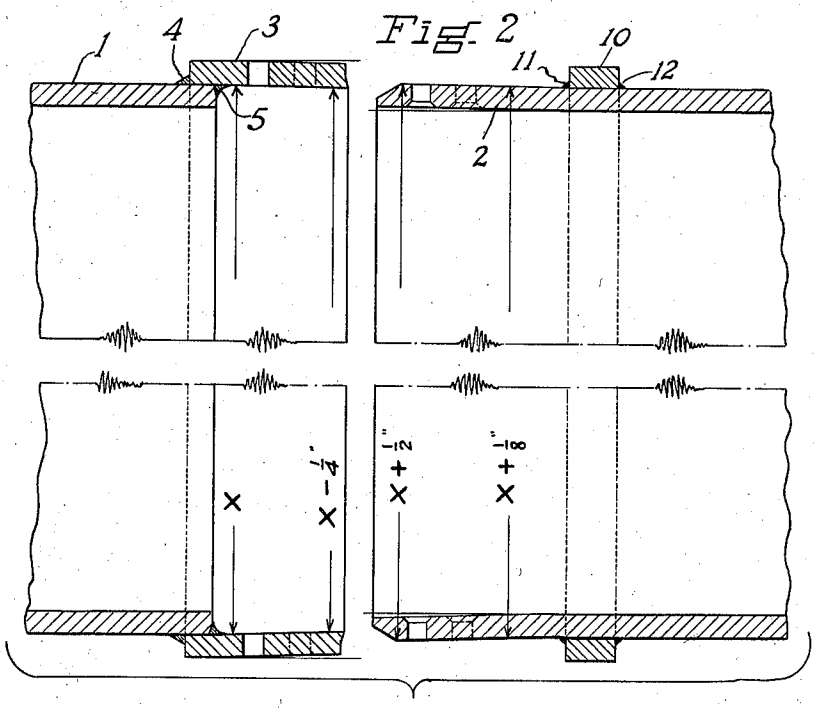


Fig. 3

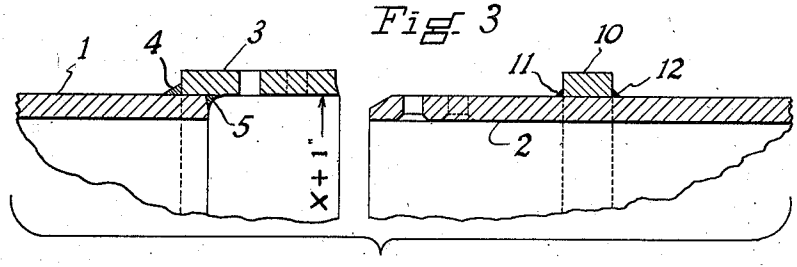


Fig. 1

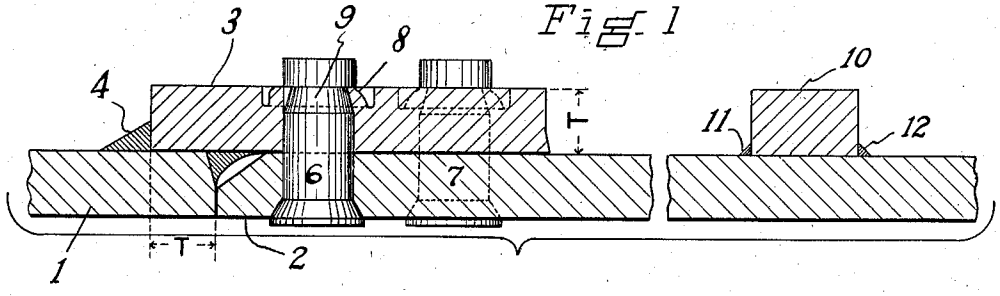
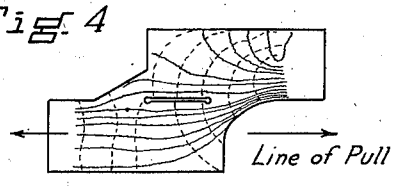


Fig. 4



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METHOD AND MEANS OF JOINING TUBULAR MEMBERS

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5 Claims. (Cl. 113—112)

This invention has reference to jointed tubular members and the method and means by which the combination is made.

Heretofore, in making lap joints between tubular members, or in making a butt joint with a butt strap over the seam, there has been no endeavor to so proportion the lap with respect to the thickness of the materials and the location of fillet welds as to render both inside and outside circumferential welds of the lapped portions capable of assuming a substantially known proportion of the strain resulting from axially divided stresses in the combination.

The present invention is a combination of tubular members, in overlapping relation, with fillet welds uniting the same exteriorly and interiorly circumferentially with the lap dimension of said members so proportioned with respect to the thickness of the material and the location and shape of the fillet welds as to insure a joint in which strain resulting, as aforesaid, from axially directed stresses in the combination, is somewhat proportionally distributed throughout the joint so that each weld has imposed thereon its respective share of the burden.

In addition, where the combination of the present invention is a buttstrap joint with one side pinned, as by riveting, a feature is the application to the pinned tubular member of a circumscribing tension band augmenting the hoop strength in the reaction zone resulting from longitudinal stresses upon the joint.

Also, the method of forming and assembling the joint is a part of the invention in that, after welding the buttstrap to the one tubular member and applying the circumscribing band to the other tubular member, the relation of male to female end is such that, when assembled, the butt strap is in tension and the male end in compression, thus insuring a tight caulking edge.

The problems which are met and solved in the joint of the present invention may be appreciated when it is considered that a joint is produced with an efficiency of 100% in compression and 62% to 67% in tension on the steel penstock being installed in the Boulder Canyon Project, Bureau of Reclamation, United States Department of the Interior, where a large portion of the penstock is thirty feet in diameter with a plate thickness as great as two and three quarter inches (2¾") under a hydraulic head of over three hundred feet (300'), and from which it will be observed that the static load due to weight of material and of the water filling the penstock is enormous, this being the largest pipe ever constructed of metal.

With the foregoing in mind there will now be described in connection with the accompanying drawing forming a part hereof, a specific embodiment of the present invention.

In the drawing:

Figure 1 is a fragmentary sectional side elevation of the assembled joint.

Figure 2 is a similar view in exaggerated form of the joint just before final assembly.

Figure 3 is a view similar to Figure 2 of the joint ready to be assembled by the hot method.

Figure 4 is a diagrammatic sectional side elevation in the same plane as Figure 1 showing the stress distribution for one joint as determined by the photo-elastic analysis.

In detail:

Each of the figures of the drawing discloses the adjacent tubular members (1) and (2) which have already been assembled in butted relation in Figure 1, and are to be so assembled in Figures 2 and 3 by the methods hereinafter to be described.

The tubular member (1) has circumferentially welded thereto the circumscribing buttstrap (3) which is of the same plate section thickness as the plate of the tubular member (1), and is set back or lapped upon the said tubular member (1) the distance (T) which, in this instance, is equivalent to the thickness dimension of the plate.

The buttstrap (3) is joined to the tubular member (1) exteriorly by a 30°–60° fillet weld (4), as shown, and interiorly the end of the tubular member (1) is faced off at a slight angle so as to be joined with the buttstrap by a curved fillet weld (5), thus securing a distribution of stress lines such as is shown in Figure 4 when the joint is tensioned longitudinally, with no excessive concentration at any one location and with each weld doing its respective share, a condition which is unattainable with the usual degree of lap in a joint of this character.

The adjacent tubular member (2) is faced off on its end at the angle shown in order to permit its entrance into the buttstrap (3) when cold, and also to be free of the curved fillet weld (5) when the members (1) and (2) are joined as shown in Figure 1.

The buttstrap (3) and tubular member (2) are drilled, as indicated, in staggered relation for the two rows of pins or rivets which are of the countersunk type on the inside and are dimensioned and ground with respect to the holes which receive them so that they are a force fit. Each pin hole in the buttstrap (3) on the outer surface is trepanned to groove form so as to leave a ring of metal (8). The pins (6) and (7) are each undercut, as at (9), to leave a cylindrical head beneath which the ring of metal (8), for each, is compressed or swaged into place after the pin is first forced home, and thus each pin is not only set in its final position but is actually placed under a tension.

The free end of buttstrap (3) is shaped as shown to provide a caulking edge.

Spaced back from the end of the tubular member (2) and in the kick up zone which will result from longitudinal strain upon the joint is a shrink ring (10) circumscribing the tubular member and augmenting its hoop strength, and preferably being of a width greater than and of a thickness at least equal to that of the plate from which tubular member (2) is formed. This ring is welded to the said tubular member as shown at (11) and (12).

The manner of attaching the buttstrap (3) to the tubular member (1), and the shrink ring (10) to the tubular member (2) results in a peculiar set of conditions with respect to the assembling of the joint, in that the buttstrap (3) by reason of the proper dimensioning of the parts and overlap, and the welds (4) and (5), contracts so that if its diameter adjacent the fillet weld (5) is X'', then its diameter at the free end, before assembly, will be, for instance, X''−¼''; also shrinking and welding the ring (1) on the tubular member (2) opens up the end of the section (2) so that its outside diameter may be, for instance, X''+½'' while back at the depth to which it is to be inserted in the buttstrap (3) to meet the tubular member (1), its diameter may be, for instance, X''+⅛''.

Two methods may be used for assembly, as previously mentioned; first, the tubular member (2), by reason of its bevelled end to accommodate the fillet weld (5), may be aligned and inserted in buttstrap (3) in contiguous relation with the tubular member (1) and then forced home to abutting relation of the members (1) and (2) by powerful jacks, the buttstrap (3) thus becoming tensioned and the tubular member (2) being placed under compression thereby after which the holes for pins (6) and (7) are reamed to final size, the pins forced home and the metal rings (8) swaged to position.

The hot method is similar except that the buttstrap (3) is heated with the result that its former dimension of X''−¼'' may now expand to, for instance, X''+1'' in which the male tubular member (2) may then be easily inserted into position with the ends of members (1) and (2) abutting and the holes for pins (6) and (7) aligned whereupon the abutting ends of tubular members (1) and (2) are then tack welded and the buttstrap (3) shrinks to its final tensioned size placing the tubular member (2) under compression; the holes for pins (6) and (7) are then reamed to final size, the pins driven home, and the metal rings (8) swaged.

In either the cold or hot method the shaped caulking edge of the buttstrap (3) upon the tubular member (2) is a close fit for producing a proper caulked joint.

While, in the foregoing, there is described a specific embodiment of the invention for the purpose of complying with the patent statutes it is nevertheless to be understood that the invention is not to be unduly limited thereby and that its intended scope is the broadest which may be attributed to the appended claims defining the invention in view of the prior art.

We claim:

1. In combination, tubular members in substantially abutting relation, a buttstrap overlying the seam and lapping each tubular member, means uniting each of the tubular members with said buttstrap, at least one of said means comprising pins headed upon each end and forced through holes in the respective member and buttstrap, and including a ring of metal swaged from the buttstrap to beneath the head of each pin on the buttstrap end for locking and tensioning the pins.

2. The method of assembling tubular members in butt joint relation, which comprises the steps of welding a butt-strap in overlapping relation with the end of one of said members in a manner which produces a female member of lesser diameter free opening than the exterior of the tubular member to be joined thereto, axially forcing the male tubular member into the buttstrap, and then finally locking the buttstrap and male tubular member together.

3. The method of assembling tubular members in butt-joint relation, which comprises the steps of welding a buttstrap in overlapping relation with the end of one of said members in a manner which produces a female member of lesser diameter free opening than the exterior of the end of the tubular member to be joined thereto, drilling the buttstrap and male tubular member for force fit uniting pins, applying to the male member, in the zone of kick up from axial stress in the completed joint, a circumscribing reenforcing shrink band, entering the said male member into the buttstrap and forcing the same into final position, and then pinning the joint with pins under tension.

4. The method of assembling tubular members in butt-joint relation, which comprises the steps of welding a buttstrap in overlapping relation with the end of one of said members in a manner which produces a female member of lesser diameter than the exterior end of the male tubular member to be joined thereto, drilling the buttstrap and male tubular member for force fit uniting pins, applying to the male member in the zone of kick up from axial stress in the completed joint a circumscribing shrink band whereby the end of the said male member is belled to a larger outside diameter than the normal inside diameter of the free end of the buttstrap, then heating the buttstrap until it is expanded to receive the belled end of the male member and inserting the same into the buttstrap to a position with the tubular members abutting and the pin holes registering, driving and locking the pins when the buttstrap has cooled, and then caulking the juncture between the buttstrap and male member.

5. A joint construction comprising aligned tubular members, a buttstrap band overlapped upon and circumferentially welded interiorly and exteriorly to one of said members with the welds and the overlap arranged with respect to each other to provide a substantially predeterminable stress flow pattern throughout the juncture of the band and member, said band extending beyond its member and over the aligned member, pins entering the last mentioned member through said buttstrap, and a circumscribed tension band on the pinned tubular member reinforcing the hoop strength in the reaction zone resulting from longitudinal stress upon the joint.

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