Nov. 24, 1931. F. A. HAUGHTON 1,833,747

METHOD OF MAKING ANNULAR MEMBERS

Filed Oct. 31, 1928

Fig. 1.

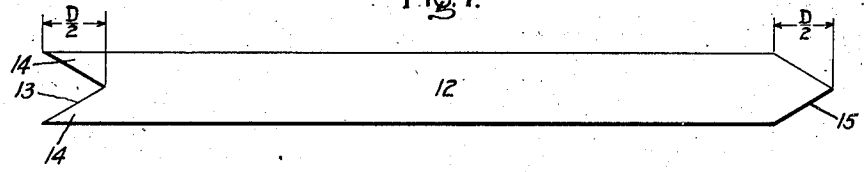


Fig. 2.

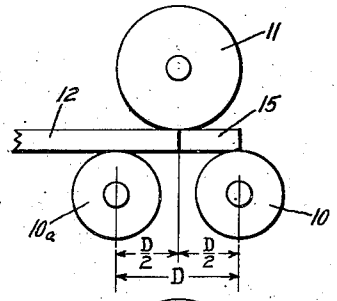


Fig. 3.

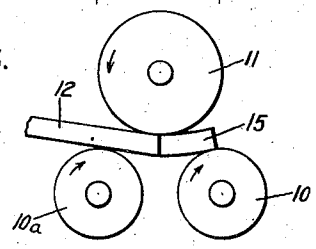


Fig. 4.

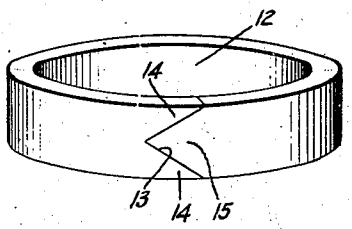
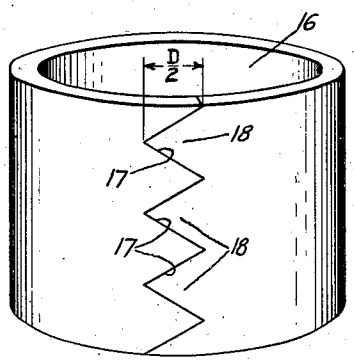


Fig. 5.



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING ANNULAR MEMBERS

Application filed October 31, 1928. Serial No. 316,230.

My invention relates to a method of making annular members by rolling slabs or plates of material into annular form, which are of general utility, but are particularly useful in making dynamo-electric machine frames and cylindrical pressure vessels.

It has been the practice heretofore in making annular members out of slabs or plates of steel to form them in bending rolls. These rolls consist of two stationary rolls arranged side by side and spaced apart and a vertically adjustable roll usually arranged directly above the space between the stationary rolls.

Ordinarily the slab or plate of material has been first formed, adjacent the ends, of the curvature required in the completed annular member because these portions could not be formed with this curvature by means of the rolls. This is due to the fact that in rolling the slab the maximum bending stress therein is approximately midway between the stationary rolls and decreases in direct proportion to the distance toward the end thereof, so that when the portion adjacent the end of the slab is just entering or just leaving the rolls, bending therein takes place almost entirely at a point spaced from the end thereof a distance approximately equal to half of the spacing of the stationary rolls, and practically not at all between this point and the end of the slab. In the case of thick slabs or plates the portions adjacent the ends have, therefore, been formed in a suitable press, and if they were being worked hot it was necessary to reheat them after the forming operation before they could be rolled into annular form. In the case of thin slabs or plates it has been the practice to form the portions adjacent the ends of the desired curvature by placing the slabs or plates in the rolls with the end portion projecting a small amount beyond one of the lower rolls and bend the same downwardly as desired by means of a sledge hammer. This necessitated removing the slab or plate from the bending rolls and turning the same over, as the rolls bend the ends of the slab or plate upwardly during the rolling operation.

The object of my invention is to carry out a method of making an annular member such that the slab or plate can be rolled into annular form entirely by the use of the rolls and without any interruption in the process of manufacture. This is particularly important when hot slabs are being roled into annular form as the interruption caused by the independent preliminary operation of forming the ends, necessitates reheating of the slab or plate, in many cases, before the rolling operation can be continued. I carry out this method by forming the portions adjacent the ends of the slab or plate of varying cross-section such that they can be given uniform curvature in the bending rolls, and then roll the slab or plate into annular form with the ends engaging each other.

My invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawings Fig. 1 is a plan view of a slab having the ends formed in accordance with my invention; Fig. 2 is a diagrammatic view of the bending rolls showing the end of the slab arranged therein; Fig. 3 is a view similar to Fig. 2 showing the rolls adjusted to bend the slab; Fig. 4 is a perspective view of the completed annular member, and Fig. 5 is a perspective view of a plate rolled into annular form in accordance with my invention, such as would be useful in making a container or pressure vessel.

Referring to the drawings, the rolls which I employ in forming slabs or plates into annular members are commonly known as pyramid rolls and comprise two rolls 10 and 10*a* which are arranged side by side and supported in fixed relation to each other, and a vertically adjustable roll 11 which is arranged directly above the space between the stationary rolls. In carrying out my method of making an annular member, I first form the ends of the slab 12 so that they can be bent with uniform curvature in the bending rolls without twisting the ends of the slab. I obtain uniform curvature of the portion adjacent the ends of the slab by forming

them of a cross-sectional area which varies from the ends to a point spaced from the ends thereof a distance approximately

$$\frac{D}{2},$$

which distance is half the distance D between the rolls 10 as shown in Fig. 2. By this construction when the slab is placed in the rolls with one extremity 15 above the center of the bottom roll 10 as in Fig. 2 and the upper roll is adjusted as shown in Fig. 3 to bend the slab 12, the maximum bending moment exerted upon the slab will be directly under the axis of the upper roll 11 and decrease in proportion in both directions along the slab as the points of contact with the two lower rolls is approached. Owing, however, to the width of the slab being reduced in proportion as the end is approached commencing from the point of maximum bending moment, any cross section of the slab throughout this portion is equally stressed by downward adjustment of the upper roll 11 and consequently will bend equally throughout this portion. Coincident with the downward adjustment of the upper roll 11 practically no bending will take place between the said point of maximum bending moment and the point of contact with the lower roll 10*a* for the reason that the slab is of constant width throughout this portion and consequently the stress in any cross section of this portion becomes less in proportion as the point of contact with roll 10*a* is approached.

In order to prevent twisting of slab 12, when the portion adjacent the end thereof passes into and out of the rolls, I vary the cross-sectional area in such manner that the ends thereof are symmetrical with respect to the longitudinal axis of the slab. As shown in Fig. 1, I do this by forming a V-shaped notch 13 in one end so as to provide projections 14 on both sides of the slab, approximately

$$\frac{D}{2}$$

in length, and by forming the other end thereof with a corresponding V-shaped portion 15,

$$\frac{D}{2}$$

in length, which is adapted to fit into the notch. In bending portions 14 in the rolls it will be observed that the resultant of the forces acting on each of the portions is the same distance from the axis of the slab, so that they they will balance each other and there will be no tendency to twist these portions when they pass into and out of the rolls. Moreover, there is no tendency for the V-shaped portion 15 of the slab to twist when it passes into and out of the rolls, as the resultant of the forces exerted thereon by the rolls is on the longitudinal axis of the slab.

After forming the ends of the slab 12 in this manner, I place one end thereof between the rolls 10, 10*a* and 11, as shown in Fig. 2, and lower roll 11 to bend the slab as shown in Fig. 3. I then cause the rolls to be rotated in the direction indicated by the arrows in Fig. 3 and bend the slab throughout its length to the curvature corresponding to the amount of adjustment of the upper roll 11. When the other end of the slab, by reason of rotating the rolls, has reached the point of contact with roll 10*a* I make a further downward adjustment of the upper roll 11 causing the portion of the slab from the point of maximum bending moment to this end to bend uniformly throughout due to its uniformly decreasing effective width at the portions 14, Figs. 1 and 4. I then rotate the rolls in the opposite direction and impart a further degree of curvature to the slab. I repeat this cycle as often as necessary until the slab is formed into a complete circle and the end 15 conforms to the notch 13, and I then revolve the annular member in the rolls several times with only a very slight downward adjustment of the roll 11 thereby obtaining a high degree of accuracy in true circular form and causing the portion 15 to be firmly seated in the notch 13. I can do this without interruption on account of the overlapping ends which avoids an abrupt open gap at the ends into which each of the rolls would jolt in passing. I then remove the annular member from the rolls, which is now in the form shown in Fig. 4 and weld the portion 15 to the portions 14.

In making cylindrical containers or pressure vessels one of the objections to the use of longitudinally extending welded joint has been the frequent localization of stresses at the joint when the cylindrical vessel was subjected to pressure. This has been due to the fact that the side walls of the vessels have not been of true circular form, so that when pressure has been applied thereto the side walls tended to assume true circular form which subjected the joints to a combined bending and tension stress, and often caused them to fail. In accordance with my method this objection to a welded joint in a vessel of this kind has been overcome by making the joint of such form that localization of stresses can occur only over a small portion of the joint, and rolling a plate constituting the cylindrical wall of the vessel into true circular form so that the wall is subjected only to tension stress. I do this by rolling a plate into true circular form in bending rolls of the arrangement diagrammatically shown in Fig. 2, and forming the joint of interfitting portions so that the welded portion of a longitudinal section of the joint includes a small proportion

thereof. Forming the joint of interfitting portions also enables me to roll the plate into annular form with uniform curvature throughout its length entirely by the use of bending rolls, as the portions adjacent the ends are formed of varying cross-section such that the rolls give them the same curvature as the main portion of the plate. This method is carried out in the present instance by first forming one end of a plate 16 with a plurality of notches of a depth approximately

$$\frac{D}{2}$$

which is half the distance between the relatively fixed rolls as indicated at 17, and the other end with a plurality of projections 18,

$$\frac{D}{2}$$

in length, and adapted to conform to the notches in the completed annular member. In this way the portions adjacent the ends of the plate vary in cross-section so that they can be given the curvature desired in the bending rolls without removing the plate from the rolls during the process of manufacture, and without twisting the ends of the plate. By forming the projections 18 and notches 17 in the ends of the plate in this way, it will be seen that I obtain greater strength of the joint connecting them together, which is welded in the completed annular member, than in a construction in which two straight abutting edges are welded together in accordance with the usual practice, because of the greater length of the weld and the small proportion of the weld in any longitudinal section of the joint. After forming the notches, and projections in the ends of the plate I roll the same into annular form shown in Fig. 5, in the same manner that the slab 12 is rolled in annular form as above described, and the ends thereof are welded together.

Modifications of the particular method which I have disclosed will occur to those skilled in the art, so that I do not desire my invention to be limited to the method set forth, except as defined in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of making an annular member comprising forming a portion adjacent each of the ends of a slab of material of uniformly varying cross-section throughout their length so that they can be given uniform curvature in bending rolls, and rolling the slab in a direction from one of the formed ends thereof toward the other into annular form with the ends engaging each other.

2. The method of making an annular member comprising making a portion adjacent one end of a slab of material of uniformly varying cross-section throughout their length by forming a V-shaped notch which is substantially symmetrical with respect to the longitudinal axis of the slab and the other end with a V-shaped portion uniformly varying in cross-section throughout its length and substantially symmetrical with respect to the longitudinal axis of the slab which is adapted to conform to the notch, and rolling the slab in a direction from one of the formed ends thereof toward the other into annular form with the portion conforming to the notch.

3. The method of making an annular member comprising making a portion adjacent one end of a slab of material of uniformly varying cross-section throughout its length by forming a notch which is substantially symmetrical with respect to the longitudinal axis of the slab and the other end with a portion of uniformly varying cross-section throughout its length and substantially symmetrical with respect to the longitudinal axis of the slab which is adapted to conform to the notch, rolling the slab in a direction from one of the formed ends thereof toward the other into annular form with the portion conforming to the notch, and securing the ends of the slab together.

4. The method of making an annular member comprising making a portion adjacent one end of a slab of material of uniformly varying cross-section throughout its length by forming a V-shaped notch which is substantially symmetrical with respect to the longitudinal axis of the slab and the other end with a V-shaped portion of uniformly varying cross-section throughout its length and substantially symmetrical with respect to the longitudinal axis of the slab which is adapted to conform to the notch, rolling the slab in a direction from one of the formed ends thereof toward the other into annular form with the portion conforming to the notch, and securing the ends of the slab together.

5. The method of making an annular member comprising making a portion adjacent one end of a slab of material of uniformly varying cross-section throughout its length by forming a V-shaped notch which is substantially symmetrical with respect to the longitudinal axis of the slab and the other end with a V-shaped portion of uniformly varying cross-section throughout its length substantially symmetrical with respect to the longitudinal axis of the slab which is adapted to conform to the notch, rolling the slab in a direction from one of the formed ends thereof toward the other into annular form with the portion conforming to the notch, and welding the ends of the slab together.

6. The method of making an annular member which comprises forming one end of a slab of material with a V-shaped notch of a depth equal to half the distance between the axes of relatively fixed bending rolls and

substantially symmetrical with respect to the longitudinal axis of the slab, forming the other end of the slab with a V-shaped portion of a length equal to half the distance between the relatively fixed rolls and substantially symmetrical with respect to the longitudinal axis of the slab which is adapted to conform to the notch, and rolling the slab into annular form with the portion conforming to the notch.

In witness whereof, I have hereunto set my hand this 30th day of October, 1928.

FRANK A. HAUGHTON.