March 20, 1934. A. J. LOEPSINGER 1,951,802

METHOD OF MAKING PIPE BENDS

Filed Oct. 3, 1931 2 Sheets-Sheet 1

Fig. 1

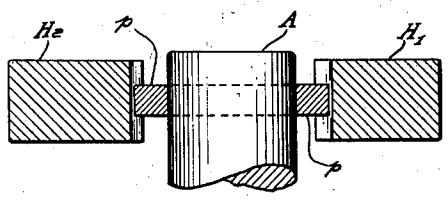


Fig. 3

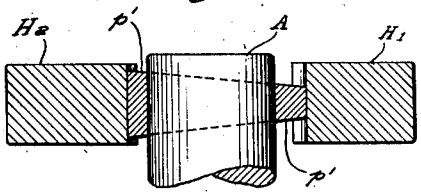


Fig. 2

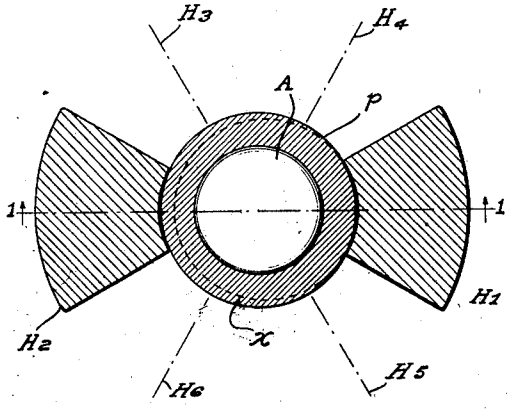


Fig. 4

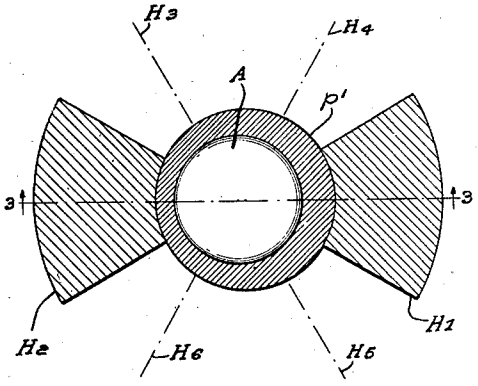
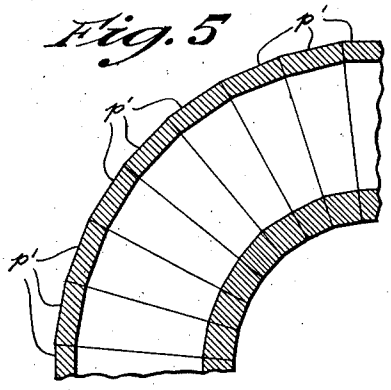


Fig. 5



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METHOD OF MAKING PIPE BENDS

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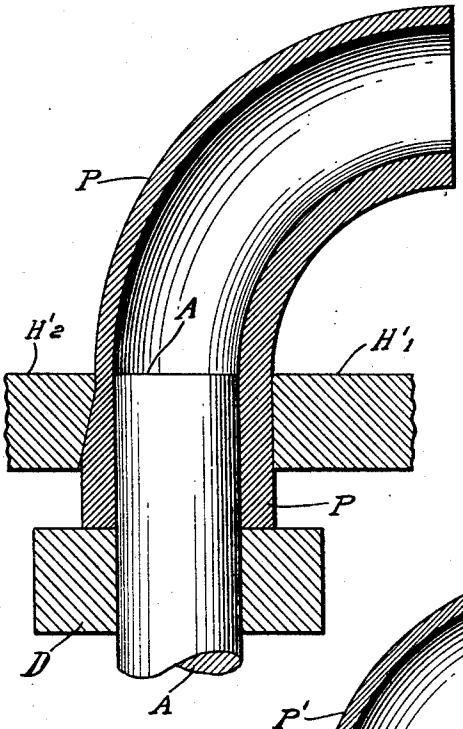


Fig. 6

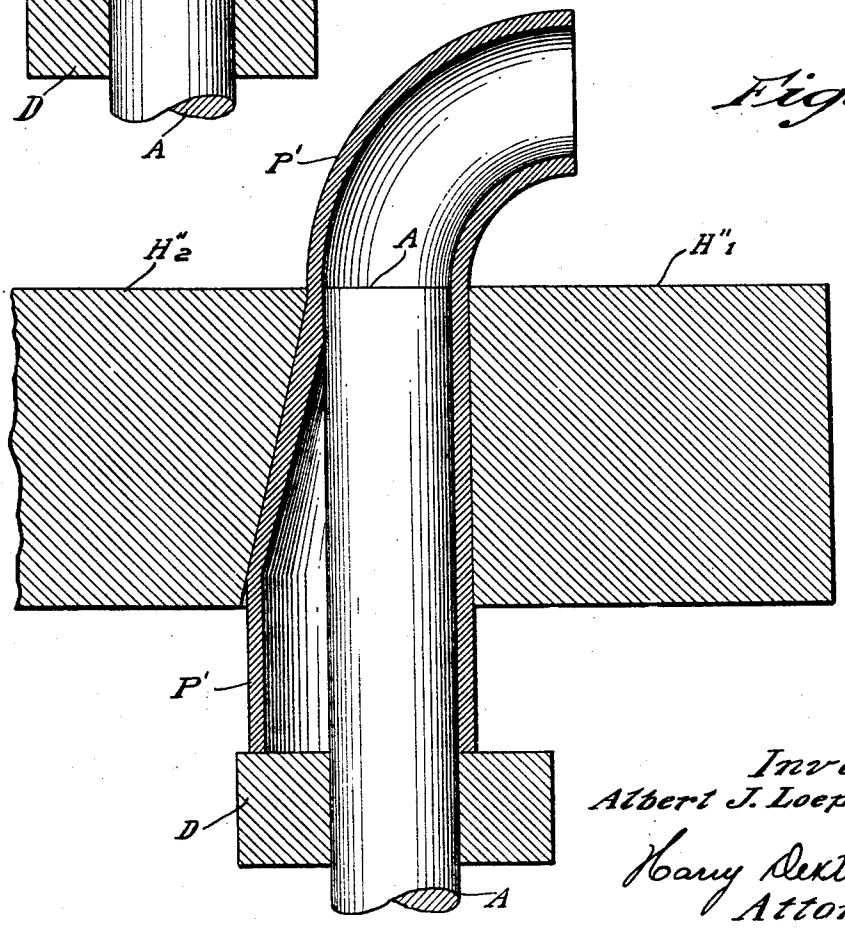


Fig. 7

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METHOD OF MAKING PIPE BENDS

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Application October 3, 1931, Serial No. 566,651

7 Claims. (Cl. 29—157)

This invention relates to an improved method and means for making bends. More especially the principles of the invention are herein disclosed in their application to the production of pipe bends and particularly such bends having even thick walls.

The usual method of producing bends is to apply a direct external bending force to the material. In the particular case of pipes the customary practice heretofore has been to securely anchor one end of the section to be bent and then exert a force against the free end in direction to cause the pipe to bend around a fixed former or die. Provision is usually made for changing the direction of the bending force so that as the bend forms this force is continued normal to the neutral axis.

As in all cases of bending in this manner the material on the outside of the neutral axis is stretched and thinned, that on the inner side is compressed and thickened, while the material which is at the same distance from the axis of curvature as is the neutral axis is neither stretched nor compressed. Thus in the case of pipes, where the neutral axis is also the geometrical axis, the outer wall of the bend is thinned, the inner wall thickened and only the side walls remain substantially unchanged in thickness. Accordingly the making of pipe bends in this manner has been limited to bends of large curvature with uneven wall thickness. By this method it has not been possible to make bends having even thick walls nor even acceptable bends of sharp curvature with uneven thick walls because when pipes are sharply bent by this method the tension in the outer wall has resulted in its collapse and the compression in the inner wall has caused it to buckle. Since bends having even thick walls and a short radius of curvature are now commercially in greatest demand, the present invention is primarily directed to the production of such bends, but it is to be understood that the principles involved may be applied in the making of tubular bends with uneven walls and also bends from solid material.

In its broadest aspect the invention has to do with effecting bending by transformation of dimension. In the particular application herein described curvilinear elongation is accomplished by transformation of thickness into length. In connection with pipe bends, the improved method consists in applying force to the outside of the pipe, in direction toward its normal axis, in such manner as to cause the axial elements of the wall to elongate. By varying the extent of elongation of these elements, a bend of any desired degree of curvature can be produced.

It is a feature of the invention that the curving or bending of the material is not dependent upon the action or influence of any external bending force, but is effected solely by a transformation of dimension. No curved former, dies, or mandrel heretofore deemed necessary to bend the material is required for the practice of this invention. The only elements of structure needed to carry out the improved method in the case of pipe bends is a fixed cylindrical anvil, a series of hammers or force exerting members surrounding it, and some suitable means for moving the pipe along the anvil.

The accompanying drawings illustrate, somewhat diagrammatically, the principles of the method and means for practicing it, and the claims are intended to cover, by suitable expression, whatever features of patentable novelty exist in the invention disclosed.

The mechanics of the method are shown in Figures 1 to 5 inclusive. Figure 1 is an elevation in section as on line 1—1 of Figure 2, and Figure 2 is a plan, showing a section of a pipe in position to be operated upon; Figures 3 and 4 are similar views showing the result of an assumed operation; and Figure 5 is an elevation in medial section of an imaginary bend.

Figure 6 is an elevation in medial section showing a pipe bend with an unevenly-thick wall formed according to the present invention; and Figure 7 is a similar view showing a bend with an even-thick wall.

Referring to the drawings, and particularly to Figures 1 to 5 inclusive, A is a fixed cylindrical anvil, and p is a ring-like section of a pipe. The cross section of the wall of this ring is represented as a square or, in other words, as having the same dimensions axially (length) and radially (thickness). H1 and H2 represent force exerting members here shown as radial hammers adapted to be moved toward the anvil A. Other such hammers, represented by the dot and dash lines H3 to H6 inclusive, of Figures 2 and 4, would be distributed around the anvil and movable toward its axis. Their individual movements would be different in extent progressively around the anvil, the end of movement of all the hammer faces being represented by the dotted line x in Figure 2. In Figures 1 and 2 hammers H1 and H2 are shown in contact with the outside wall of the pipe section p with the operating face of each hammer equidistant from the anvil.

Assume that the several hammers are now

moved towards the anvil to the limit of their movement. Hammers H1 and H2 will occupy the respective positions shown in Figure 4, hammer H1 being moved only a slight amount while hammer H2 is moved sufficiently to decrease the thickness of the pipe section, which is opposite the median line of this hammer, to one-half its original thickness. Where this occurs, the material of the pipe section is caused to elongate so that its length is twice its original length. Since the change in thickness from the left side of the pipe section, as seen in Figure 3, is progressively less toward the right side the change in length or elongation is likewise less and so the pipe section p assumes substantially the form p' seen in Figures 3 and 4. Thus by the active operation of the hammers and the passive resistance of the anvil there has been a transformation of dimension, to wit, of thickness into length.

If a number of such sections p' are produced and placed one upon another, as shown in Figure 5, a bend will result whose radius of curvature is dependent solely upon the transformation of dimension in each section. If instead of a limited number of sections p' in the bend of Figure 5 an indefinite number were to be substituted, the tangential edges would become exceedingly short and form a smooth curve. Thus, in theory, a built-up bend is produced from pipe sections whose axial elements have been elongated in straight lines.

If now instead of transforming separate pipe sections of finite length between the hammers and the anvil, a pipe as a whole is pushed along the anvil and the hammers given a vibratory motion of proper magnitude, the consequent transformation of dimension will effect elongation only in the direction of motion, the heretofore assumed pipe sections remaining joined together, becoming infinitesimal in length, and forming a smooth bend. Because of the variation in elongation of the axial elements, the elongation as a whole will be curvilinear in character as illustrated in Figure 6 where the pusher D causes the pipe P to move upward as the hammers H'1, H'3 etc. operate upon it. This is the procedure contemplated in the practical embodiment of my invention. The pipe P shown in Figure 6 is even walled to start with and just fits about the anvil A. In consequence, the bend formed from such pipe will have uneven wall thickness being thinnest at the outside of the bend and thickest at the inside.

To make bends of even wall thickness it is only necessary to start with pipe having sufficient material in its wall to enable the desired curvilineal elongation to be made. This requirement can be met by starting with pipe having a graduated wall thickness, the side of the pipe destined to form the outer curve of the bend being thickest, since that side is to be most elongated, while the side of the pipe which is to become the inner wall of the bend should be thinnest, since it is elongated the least.

Another way in which the requirement can be met—and probably the preferred way in practice since pipes of any desired size and even wall thickness are readily obtainable commercially—is to start with a pipe whose internal diameter is greater than that of the desired bend, but whose wall thickness is equal to that of the desired wall. With such pipe the portion of its wall whose axial elements are to have the least degree of curvature would conveniently remain undisturbd in length and it would be necessary simply to prethicken the other portions of the pipe to such an extent that when the final transformation of dimension occurs the resulting thickness and curvilinear elongation will be as desired.

This pre-thickening is easily accomplished in my method of bending, by merely providing deeper hammers H''1, H''3, etc. as shown in Figure 7 with the undercut operating faces extending downward far enough to engage the pipe as initially presented to them. As shown in this figure the hammer H''3 (as would also the other hammers of the series) gradually reduces the diameter of the pipe P' and in so doing unevenly thickens the wall in precisely the manner necessary to produce an even wall bend when the subsequent thinning and resulting elongation occurs.

The shorter the bend desired, the greater the volume of material must be in a unit length of the initial pipe. If the latter has the same wall thickness as the finished bend, the size of pipe needed to produce a desired bend can be easily computed. As the material at the innermost portion of the bend is neither stretched nor compressed in my method, the axial length of the innermost element remains unchanged. This, then determines the length of a pipe section needed to form the bend, and with its length and wall thickness thus known, it only remains to compute the diameter so that the volume of material in the pipe section will equal that of the bend to be made from it.

As a general requirement it may be stated that the volume of material in a section of pipe whose length is equal to that of the neutral axis of the desired bend must be as great as the volume of material in the finished bend. When the initial pipe has the same wall thickness as the finished bend, the neutral axis of the bend will be its innermost element or axial element of least radius of curvature. If the inner wall of the bend is to be thinner than the original wall of the pipe then the neutral axis will be an imaginary axial element of unchanged length lying between the innermost element of the bend and the center of curvature.

While I have described in detail the production of even walled bends, since as before stated such bends are in greatest demand, it is to be understood that my method of bending by elongation may be employed to make bends having any distribution of material desired, that is, in the case of pipe bends, the wall having the greater radius, ordinarily the thinner, may be made the thicker and the wall having the lesser radius, ordinarily the thicker, may be made the reverse. Also by varying the elongation of the axial elements of the side walls helical bends or coils may be produced. The variation in wall thickness in the finished bends is accomplished by controlling the extent to which the several hammers shall move toward the anvil, and having thus predetermined the final thickness of wall, the desired degree of curvature of the bend is attained by supplying the proper amount of material in the pipe to be bent.

I claim:

1. The method of making a pipe bend or the like from pipe of uniform external diameter which consists in applying force to the outer wall of a pipe in directions perpendicular to its longitudinal axis to reduce the dimension of the pipe in direction transverse to its longitudinal axis and thereby increasing the longitudinal dimension thereof; the said transformation of dimensions occurring in such relation as to effect bending of the pipe.

2. The method of making a pipe bend or the like which consists in applying force to a pipe having initially a wall of uniform thickness and a uniform external diameter in directions perpendicular to the longitudinal axis of the pipe and in graduated intensity circumferentially of the pipe thereby to reduce the thickness of the wall from one side of the pipe to the other side and simultaneously effect curvilinear elongation of the pipe.

3. The method of making a pipe bend or the like which consists in applying force to a pipe having a uniformly thick wall and larger internal diameter than the desired bend in such manner as to reduce the internal diameter of the pipe throughout its length to the internal diameter of the desired bend and thereby thicken the wall unevenly, and then applying force to the thickened portion of the wall in directions perpendicular to the axis of the pipe and in graduated intensity circumferentially of the pipe to reduce the thickness of said thickened portion and thereby effect curvilinear elongation of the pipe.

4. The method of making a pipe bend or the like from pipe of uniform external diameter which consists in applying force to the outside of the pipe, in direction perpendicular to its normal axis, in such manner as to cause the axial elements of the wall to elongate; the said force being applied with varying intensity circumferentially of the pipe whereby the extent of elongation of the axial elements is progressively varied and bending of the pipe thereby effected.

5. The method of making a pipe bend or the like which consists in moving a pipe whose bore is greater than that of the desired bend along an anvil whose discharge end is of the same diameter as the internal diameter of the desired bend; applying force to the pipe before it reaches said end to reduce its internal diameter to that of the said end and simultaneously thicken the pipe wall unevenly and applying force to the said thickened wall opposite the said anvil end to reduce the thickness of said thickened wall and effect curvilinear elongation of the pipe as it leaves said anvil end.

6. The method of making a pipe bend from pipe of uniform external diameter which comprises imparting longitudinal movement to the pipe and simultaneously applying force to the outer surface thereof in directions perpendicular to the longitudinal axis of the pipe to reduce the internal diameter of the pipe throughout its length and simultaneously increase the wall thickness of the material that is to form the arc of relatively large radius in the bend, followed by applying force to the outer surface of the deformed pipe in direction perpendicular to the longitudinal axis to effect the thinning of the thickened material and thereby simultaneously effect curvilinear elongation of the pipe.

7. The method of making a pipe bend or the like with a wall of uniform thickness which consists in applying force externally to a pipe having a wall of the thickness desired and a bore greater than that desired in the finished bend, while maintaining one portion of the pipe wall at its initial thickness and permitting the remainder of the pipe wall to become progressively thicker until said applied force contracts the pipe to the bore of the desired bend; and then applying force to the thus thickened portion of the pipe wall to reduce said portion to the thickness of the initial pipe; the pipe being free to bend as the thinning of said thickened portion occurs.

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