Jan. 11, 1938. R. E. FRITSCH 2,105,075

METHOD AND APPARATUS FOR MAKING PIPE BENDS

Filed Oct. 8, 1935

FIG. 1.

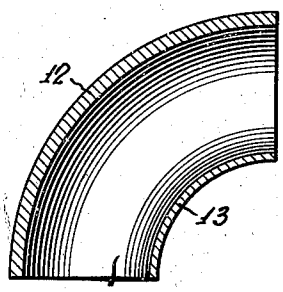


FIG. 2.

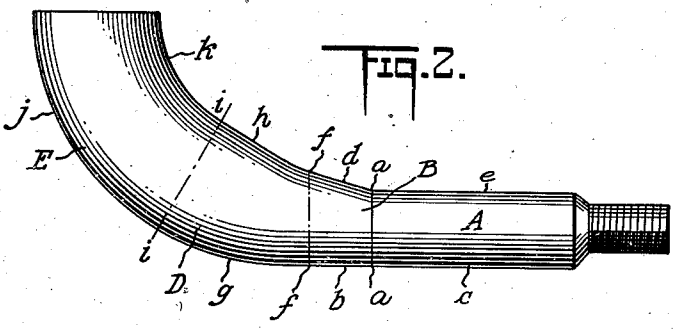


FIG. 3.

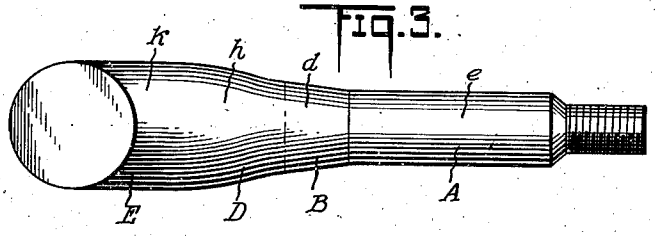


FIG. 4.

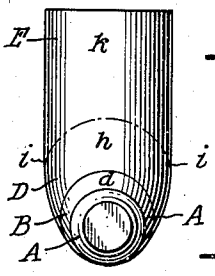


FIG. 6.

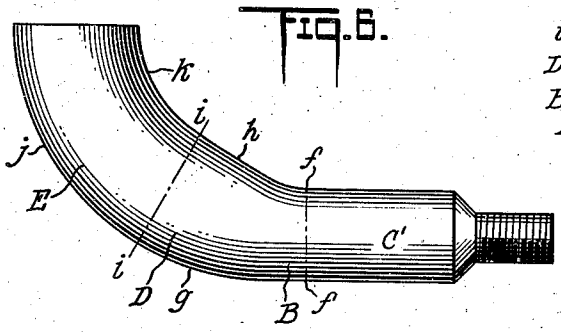


FIG. 5.

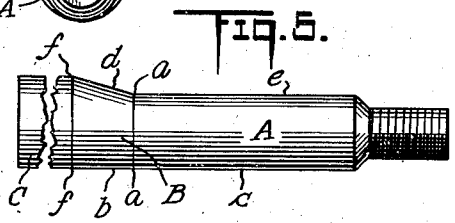


FIG. 7.

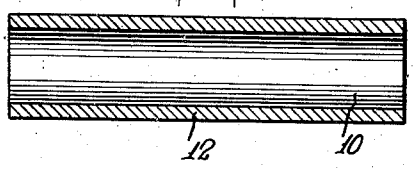
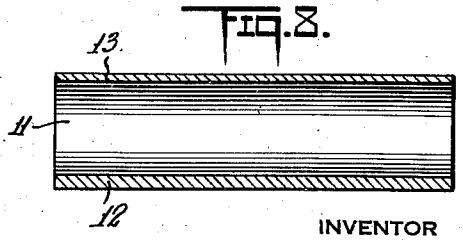


FIG. 8.



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METHOD AND APPARATUS FOR MAKING PIPE BENDS

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4 Claims. (Cl. 153—32)

This invention relates to pipe bends of that type in which the wall along the maximum radius is of substantially greater thickness than the wall along the side of minimum radius, and involves a new method and apparatus for making such a pipe bend. A pipe bend of the character referred to is illustrated in my prior Patent No. 2,066,775, issued January 5, 1937.

The main object of the invention is to easily and effectively make such a pipe bend from a straight pipe section of uniform thickness.

As essential features of my improved method I employ a straight section of tubing preferably seamless and of uniform wall thickness. This pipe section is forced over the mandrel sections which act to first increase the diameter of the pipe without substantial shortening, and by causing the stretching to occur primarily along one side so that the internal and external surfaces are eccentric to each other and the wall along one side is substantially unchanged while the wall along the opposite side is reduced in thickness to an extent dependent upon the extent of expansion or enlargement of the pipe section. This eccentric pipe is then forced over a mandrel section which does not act to materially change the wall thickness at any point, but curves the pipe and expands or enlarges it without substantially shortening the thicker side, but substantially shortening the inner side, that is, the one of smaller radius of curvature.

The two steps may be separately performed on separate mandrels, but preferably are progressively performed in succession as the pipe is forced over a single mandrel having sections of the desired shape and size.

In the accompanying drawing:

Fig. 1 is a central longitudinal section through a pipe bend which may be made by means of my improved method and apparatus,

Fig. 2 is a side elevation of a mandrel embodying my invention and which may be employed for carrying out my improved method and for making the product shown in Fig. 1,

Fig. 3 is a top plan view of the mandrel,

Fig. 4 is an end view of the mandrel,

Figs. 5 and 6 are side elevations of separate mandrels which may be employed for separately performing the steps which may be performed as a single operation on the mandrel shown in Fig. 2,

Fig. 7 is a longitudinal section of a pipe section which may be employed, and

Fig. 8 is a longitudinal section of a pipe section as it might appear after performing the first step, but before performing the second step in the operation.

The pipe section 10 which may be employed as stock for the pipe bend and which may be of any desired length depending upon whether the pipe bend is to extend through 90°, 180° or other arcuate length including a plurality of turns as a spiral, is shown in Fig. 7. This may be made from a sheet welded in a seam along one side, but is preferably a section of standard seamless tubing of uniform wall thickness.

As a result of the first step of the process this pipe section 10 is expanded eccentrically to form the pipe section 11 shown in Fig. 8. As a result of this operation the wall 12 along one side is not substantially changed in thickness, whereas the wall 13 along the diametrically opposite side is reduced to an extent dependent upon the amount of increase in diameter. There is no substantial change in the length of the pipe section. As a result of the second step in the operation the eccentric pipe 11 is bent to form the pipe bend 14 shown in Fig. 1. In this operation the thicker wall 12 which forms the side of the tube bend of maximum radius is not substantially changed in either length or thickness, but the thinner wall 13 which is the one of the minimum radius is substantially shortened, but without substantial change in its wall thickness. The internal diameter of the pipe bend is substantially greater than the internal diameter of the eccentric pipe section shown in Fig. 7.

In carrying out my improved method the pipe section forming the stock and shown in Fig. 7 may be progressively changed to the pipe bend shown in Fig. 1 without passing through the intermediate stage illustrated as a straight pipe section in Fig. 7.

If the two operations are to be performed separately and on separate mandrels I employ as the mandrel for performing the first step that shown in Fig. 5. This includes a cylindrical section A which serves primarily as a guide over which the stock is advanced. The external diameter of the section A may be substantially the same as the internal diameter of the pipe section 10, although it may be slightly larger to give a very slight expansion intended primarily to correct any slight irregularity in the stock. The section B of the mandrel is in the form of the frustum of a cone eccentrically disposed in respect to the guide section A. The smaller end of this section B abuts and registers with the end of the guide section in a plane *a—a* and the side *b* forms a straight line extension of the side *c* of the guide section. The

diametrically opposite side *d* of the section B is shown as being at an angle of about 16° to the side *e* of the guide section.

The pipe 10 is delivered along the guide section A and forced over the section B and as a result the pipe is expanded in diameter, but the expansion is eccentric in that the wall is materially reduced in thickness due to the stretching action in passing up the inclined surface *d*, whereas the opposite wall in passing along the surface *b* is not changed to any substantial extent. It will be understood that the pipe section is preliminarily heated before being forced over this mandrel, and heating means may be employed for maintaining the temperature during the expanding action. Ordinarily a greater amount of heat will be applied to the upper side where the main expansion takes place than is applied to the lower side.

The section B serves as an eccentrically expanding mandrel, but does not impart to the pipe any change in curvature lengthwise of the pipe. Beyond the eccentric expanding section B there may be a cylindrical guiding section C registering with and abutting the larger end of the section B in a plane *f—f* over which the pipe in the form shown in Fig. 8 will be delivered.

Merely as an example of the mandrel and relative dimensions which may be employed, the guide section A may be of a diameter of 3.6 inches, the guide section C of a diameter of 4.4 inches, and the eccentric expanding section B may be 2.85 inches long and the surface *d* at an angle of 16° to the axes of the sections A and C. The angle of the surface *d* to the surface *e* should be a comparatively small one so that the main component of the pressure exerted on the interior of the pipe blank will be a radial one tending to expand the pipe, and there will be a comparatively small component axially of the pipe blank and retarding the endwise movement of the blank along the inclined surface *d*.

The eccentric straight pipe section shown in Fig. 8 and made by the mandrel shown in Fig. 5 is forced over a second mandrel to change it to the form shown in Fig. 1. The second mandrel is illustrated in Fig. 6.

The mandrel shown in Fig. 6 includes a guide section C′ which is cylindrical in form and of a diameter substantially the same as the diameter of the section C shown in Fig. 5. In fact these two sections C and C′ may be one and the same, or as shown in Figs. 2, 3 and 4 may be entirely omitted. Beyond the guide section C′ is a curved tapered section D having its smaller end abutting and registering with the section C′. The outer side *g*, that is, the one of maximum radius, is tangential to and forms an extension of the lower side of the guide section C′ and determines the curvature which is to be imparted in making the bend shown in Fig. 1. The opposite side *h*, that it, the one nearer to the radius of curvature, may be substantially straight or curved, but diverges from the surface *g* so that the end of the curved tapered section D in the plane *i—i* is larger than the end of the guide section C′ and is of the diameter desired for the internal diameter of the final product. As shown, the surface *h* is at an angle of about 30° to the surface *e* and the axis of the section A.

Beyond the curved tapered section D is a final guide section E which corresponds to the curvature and internal diameter of the final product, and has its outer surface *j* and its inner surface *k* curved about the same radius and parallel. The surface *j* is an extension of and preferably lies in the arc of the same circle as does the surface *g*.

As the eccentric pipe is forced over the section D the thicker side following the surface *g* is curved, but is not substantially changed in thickness. Due to the fact that the surface *h* is shorter than the surface *g* and is at a much steeper angle to the axis of the section A than is the surface *d* and therefore offers a substantially greater resistance to the endwise movement of the metal than does the surface *d*, the metal is redistributed and the increase in diameter accompanied by the curvature does not substantially change the thickness of the thinner wall 13.

The two expanding sections B and D thus operate in a different manner. The section B expands the pipe and reduces the thickness on one side without changing the length, while the section D curves the pipe, increases its diameter and shortens the inner side due to the retardation of the metal engaging the surface *h* whereby the metal is distributed laterally, but without substantial change in thickness.

In practice the mandrels shown in Figs. 5 and 6 are preferably combined in a single mandrel, that is, the section D directly abuts and registers with the section B without the intermediate guide section C or C′. Such a preferred form of mandrel is shown in Figs. 2, 3 and 4, and the parts corresponding to the parts of the two separate mandrels have been indicated by the same reference characters. As previously noted, in such a combined mandrel the pipe section does not at any time take the form shown in Fig. 8, but the straight pipe of uniform wall thickness shown in Fig. 7 is progressively changed to the curved section with greater thickness at the outside than at the inside as shown in Fig. 1.

It will be understood that the mandrel may be held stationary and a series of pipe sections forced in succession over the mandrel, or that the pipe sections may be held against endwise movement and the mandrel pulled through.

The final guide section E may be omitted or varied in length, but it is desirable in that it holds the pipe bend to a true radius and with the curved axis in the same plane as it is delivered and after the forming of the successive portions is completed.

The words "upper" and "lower" have no significance as applied to commercial practice as the expansion and curvature may be in any plane. They apply only to the positions in which the parts are shown.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of making a pipe bend having the wall along the side of maximum radius thicker than the wall along the side of minimum radius, which includes the steps of expanding a straight pipe section eccentrically to increase the diameter without substantially changing the length, reducing the thickness along one side without substantially changing the thickness along the other side, and then curving and further expanding the expanded pipe section to shorten the thinner side without substantially shortening the thicker side and without substantially changing the thickness of either side.

2. The method of making a pipe bend having the wall along the side of maximum radius thicker than the wall along the side of minimum

radius, which method includes the steps of forcing a section of straight pipe having a wall of uniform thickness over a mandrel section having a straight side and an oppositely disposed inclined surface at a comparatively low angle to said straight side, whereby the pipe section is eccentrically expanded to thereby reduce the thickness of the wall engaging said inclined side with but slight if any retardation of said wall during the axial movement, and then over a curved mandrel section having one side tangent to the straight side of the first mandrel section, and the opposite side at an angle to said inclined side and diverging from said curved side, whereby the pipe section is curved and expanded with such retardation and lateral flowing of the material in the wall at the side of minimum radius as will prevent any substantial change in the reduced thickness of said wall.

3. A mandrel for making a pipe bend having the wall along the side of maximum radius thicker than the wall along the side of minimum radius, said mandrel including a cylindrical guiding section, a frusto-conical section with its smaller end abutting and registering with the end of the guiding section, the axis of said frustum being at an angle to the axis of the guiding section, one side of the frustum forming a straight line of one side of the guiding section, and the other side of the frustum being at a comparatively low angle to the other side of the guiding section, and a curved section of progressively increasing diameter, the smaller end abutting and registering with the larger end of the frustum, the side of larger radius being tangent to said first mentioned side of the frustum, and the side of smaller radius being at an angle to said second mentioned side of the frustum.

4. A mandrel for making a pipe bend having the wall along the side of maximum radius thicker than the wall along the side of minimum radius, said mandrel including a cylindrical guiding section, a frusto-conical section with its smaller end abutting and registering with the end of the guiding section, the axis of said frustum being at an angle to the axis of the guiding section, one side of the frustum forming a straight line of one side of the guiding section and the other side of the frustum being at a comparatively low angle to the other side of the guiding section, a curved section of progressively increasing diameter, the smaller end abutting and registering with the larger end of the frustum, the side of larger radius being tangent to said first mentioned side of the frustum, and the side of smaller radius being at an angle to said second mentioned side of the frustum, and a curved section of uniform diameter throughout and having one end registering with the larger end of said first mentioned curved section.

RUDOLPH E. FRITSCH.