June 13, 1933. F. M. KEPLER 1,913,490

METHOD OF MAKING ANGULAR TUBING BENDS

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Fig. 1.

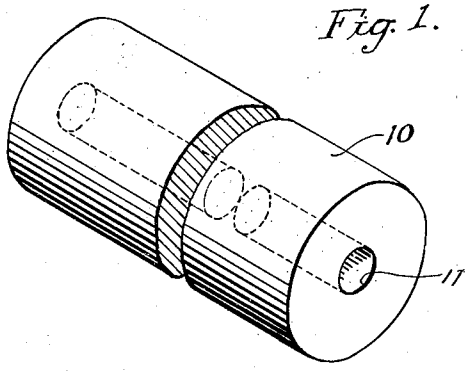


Fig. 2.

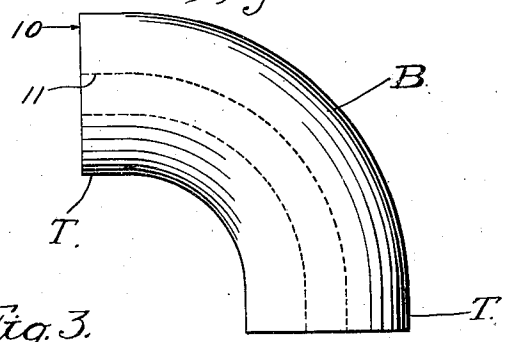


Fig. 3.

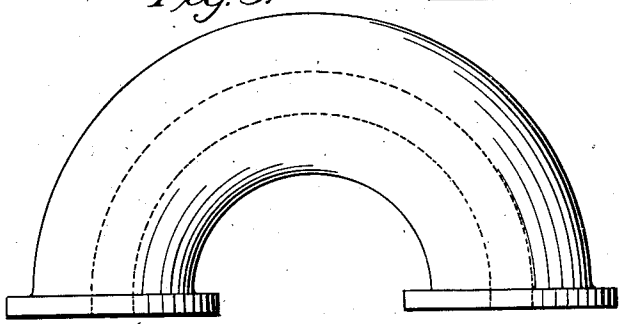
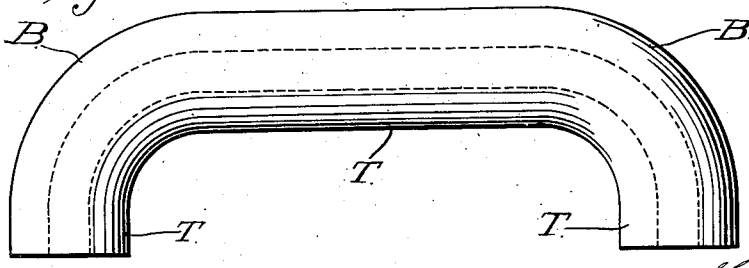


Fig. 4.



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Fig. 5.

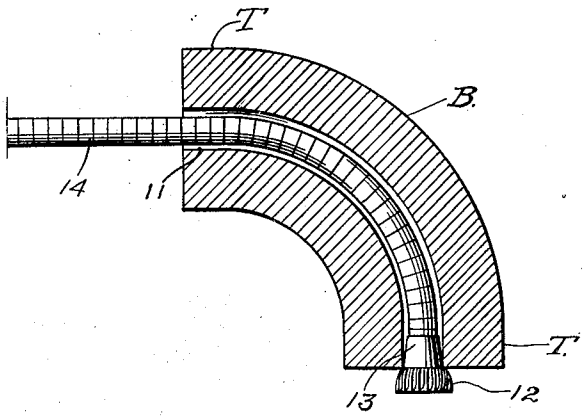


Fig. 6.

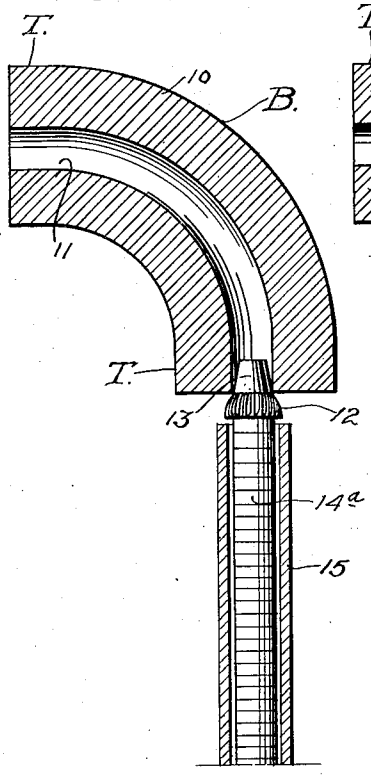


Fig. 7.

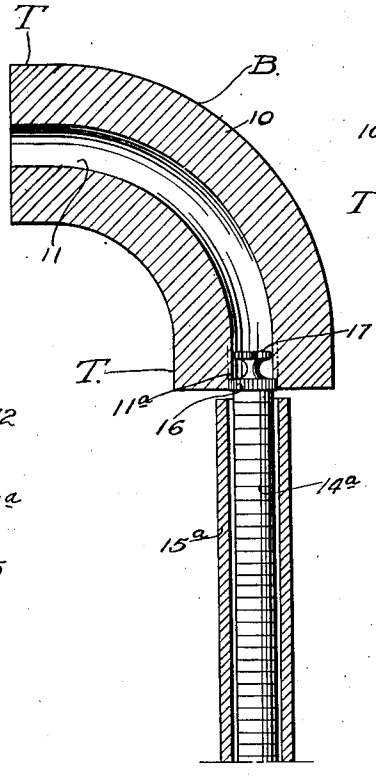
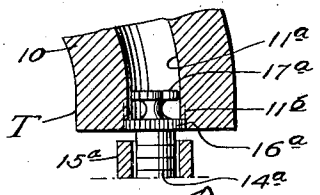


Fig. 8.



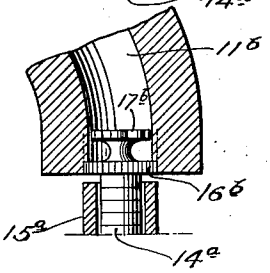


Fig. 9.

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UNITED STATES PATENT OFFICE

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METHOD OF MAKING ANGULAR TUBING BENDS

Application filed October 10, 1930. Serial No. 487,864.

This invention relates to a method of producing angular bends of metallic tubing and more particularly to the production of such bends in a manner providing the bend with a true bore. While many attempts have been made to produce such bends, heretofore they have all depended upon some distortion of the material from which the bend was formed, the common practice being to provide a tube having excess material at the outer side of the bend and then bending the tube. Such a process is relatively expensive and seldom, if ever, produces an opening of uniform diameter. A further method of producing such bends is to force a heated tube longitudinally over an arcuate horn. This method, while it will produce a bend having an opening of uniform diameter, is incapable of producing a bend having tangents at its ends. Obviously, a bend having no tangents is extremely difficult to adapt for connection for it is practically impossible to properly thread such a bend for the reception of a flange or coupling.

My method consists briefly in employing a solid steel or wrought iron bar of the desired dimensions, drilling an axial pilot opening through this bar which is of such small size that it will not be materially distorted when the bar is subsequently formed to the desired bend, then enlarging this opening by passing through the bar a cutter, or a series of cutters, for enlarging the pilot opening to the desired dimensions, the single cutter when employed being guided by a pilot operating in the originally formed opening and the series of cutters being guided in the first instance by the pilot opening and for succeeding cutters by the opening made by the preceding cutter.

The steps employed in producing an angular bend in accordance with my invention are semi-diagrammatically illustrated by the accompanying drawings, in which:

Fig. 1 is a perspective view of the bar before bending and with the pilot opening formed therethrough;

Fig. 2 is a side elevation illustrating one of the several forms in which the bar is bent;

Fig. 3 is a further form in which the bar may be bent;

Fig. 4 is a still further bent form;

Fig. 5 is a sectional view illustrating the enlargement of the opening by use of a rotating reamer pulled through the pilot opening;

Fig. 6 is a similar view illustrating the use of a reamer pushed through the opening;

Fig. 7 is a view illustrating the use of one of a series of broaches to enlarge the opening; and

Figs. 8 and 9 are two others of the series of broaches necessary to enlargement of the pilot opening to its proper size.

In these drawings, for the purpose of illustration of the pilot bore enlargement the bend formed has been illustrated as an L having tangents T. It will be understood that by employing the same procedure a return bend such as illustrated in Fig. 3 or a pair of integrally connected spaced bends the connection between which is straight, as illustrated in Fig. 4, may be readily produced.

Referring now more particularly to these drawings, the bar originally employed is indicated at 10 and the pilot opening drilled therethrough at 11. This opening is of such size that when the bend is produced from the bar it will not be materially distorted; that is to say, it will not be distorted beyond the tolerance limits for a guide such as that hereinafter described.

After drilling of the opening, the bar is bent, this bending being accomplished in any suitable machine or fixture, following which the pilot opening is enlarged to the desired size. This is accomplished by any of the several mechanisms illustrated in the drawings. In the form shown in Fig. 5 the numeral 12 designates a rotary reamer or cutter of a construction such that it will increase the size of the pilot opening from its normal size to the desired internal diameter for the bend. The forward end of this reamer has an axial, forwardly tapering projection 13 functioning as a pilot and having its greater diameter very slightly less than the diameter of the pilot opening 10. Connected with this

organization is a means for rotating the cutter and for causing it to move longitudinally of the bend guided by the pilot 13 in engagement in the pilot opening. This means in Fig. 5 constitutes a flexible shaft 14 of a size to pass through the pilot opening and by means of which the pilot and cutter organization may be rotated and caused to move longitudinally.

In Fig. 6 this means constitutes a flexible shaft 14*a* for rotating the organization and forcing the cutter through the bend guided by the engagement of the pilot in the pilot opening. As a means preventing flexing of the flexible shaft 14*a* as regards those portions thereof external to the bore which is being formed, a standard guiding sleeve 15 is provided to surround such portions of the flexible shaft.

In Fig. 7 I have illustrated a means for enlarging the opening by a broaching operation. Where broaching is resorted to, due to the small size of the pilot opening as originally formed, use of a series of broaches is necessary. The first broach is indicated at 16, this broach having a pilot 17 to engage in the pilot opening 11 and be guided thereby, this broach enlarging the opening to an extent indicated at 11*a*. A second broach 16*a* shown in Fig. 8 has a pilot 17*a* to fit the enlarged opening 11*a* formed by the broach 16, the pilot fitting the bore 11*a* while the third broach shown in Fig. 9 at 16*b* has a pilot 17*b* to fit the enlarged opening 11*b* produced by the broach 16*a*. The series of broaches may contain any desired number, depending upon the character of the material acted upon and the differences in diameter between the pilot bore and the bore which is to be finally produced. Such broaches may be either pulled or pushed through the openings, the latter method of operation being herein illustrated.

In this construction as in the construction employing the cutters, a flexible movable member 14*b* must be employed for moving the broaches through the bar. This flexible member when pushed must, obviously, be guided by a sleeve 15*a* similar to the sleeve 15 to prevent deflection of those portions of the flexible member which are exterior to the opening being formed. It will be obvious that by following the method hereinbefore set forth it is possible to produce angular bends B of any desired character and having tangents of desired length, and provide such bends with bores of uniform diameter and curvature. Obviously, by these processes either flanged or unflanged bends may be produced.

As both the method and apparatus employed are capable of considerable modification, I do not wish to be understood as limiting myself to the specific examples herein given except as hereinafter claimed.

I claim:

1. The method of producing tubular angle bends consisting in employing a normally straight bar, forming an axial pilot opening of a diameter relatively small as regards the desired diameter of the final opening in the finished bend, shaping the bar to produce the desired bend and passing a cutting means through the bar to increase the diameter of the opening.

2. The method of producing tubular angle bends consisting in employing a normally straight bar, forming an axial pilot opening of a diameter relatively small as regards the desired diameter of the final opening in the finished bend, shaping the bar to produce the desired bend and passing a cutter through the bar to increase the size of the opening while employing the pilot opening as a guide for such cutting means.

3. The method of producing tubular angle bends consisting in employing a normally straight bar, forming a longitudinal pilot opening therein of a diameter relatively small as regards the desired diameter of the final opening in the finished bend, shaping the bar to produce a bend including alternate arcuate and tangent portions and enlarging the opening by passing a cutter therethrough.

4. The method of producing angular bends of metallic tubing consisting in forming the bend with an opening having alternate arcuate and tangent portions and of considerably less diameter than the diameter of the opening of the completed bend and then passing a cutter through the opening to enlarge said opening to a desired and uniform diameter while guiding the cutter by the opening.

5. The method of producing angular bends of metallic tubing consisting in forming the bend with an opening comprising terminal arcuate portions and an intermediate tangent straight portion, the opening being of considerably less diameter than the diameter of the opening of the completed bend and then passing a cutter through the opening to enlarge said opening to a desired and uniform diameter while guiding the cutter by the opening.

6. The method of producing angular bends of metallic tubing consisting in forming the bend with an opening comprising a central arcuate portion and terminal tangent portions, the opening being of considerably less diameter than the diameter of the opening of the completed bend and then passing a cutter through the opening to enlarge said opening to the desired and uniform diameter while guiding the cutter by the opening.

FRANCIS M. KEPLER.