June 12, 1934. M. W. KELLOGG 1,962,510

METHOD OF AND APPARATUS FOR FORMING TUBULAR BENDS

Filed Sept. 11, 1931

Fig. 1

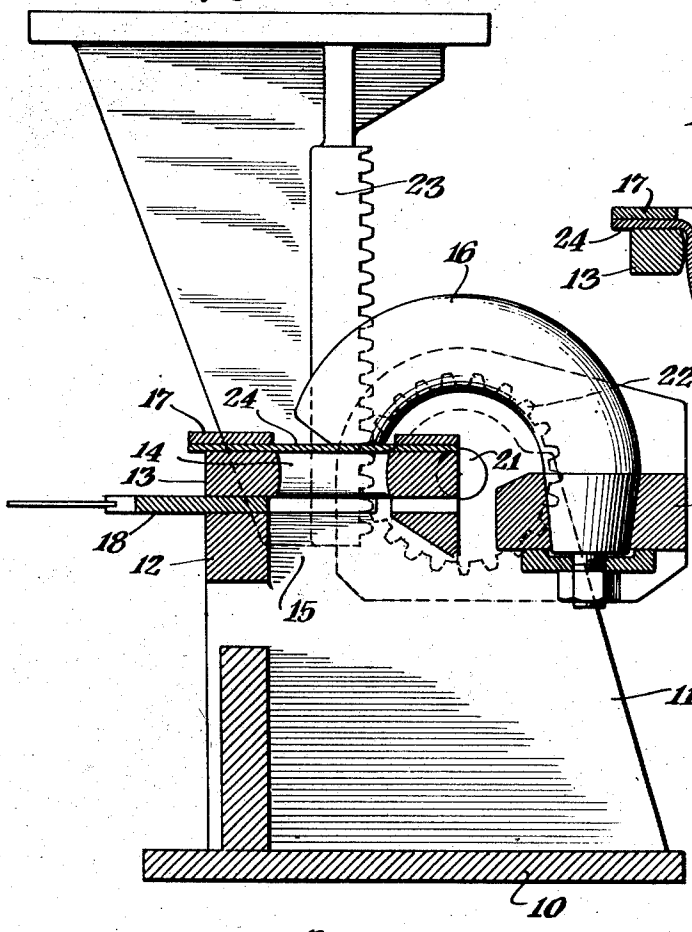


Fig. 2

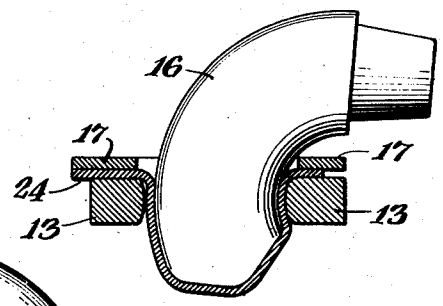


Fig. 3

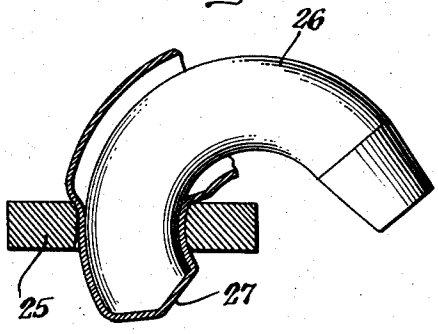
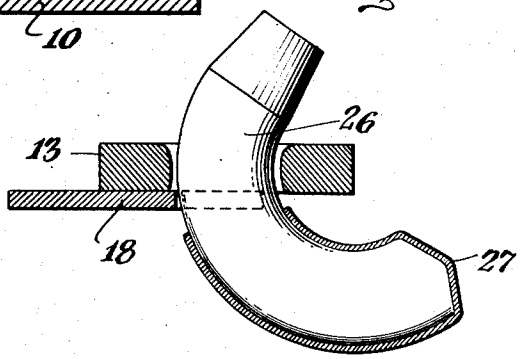


Fig. 4



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Patented June 12, 1934

1,962,510

UNITED STATES PATENT OFFICE

1,962,510

METHOD OF AND APPARATUS FOR FORMING TUBULAR BENDS

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Application September 11, 1931, Serial No. 562,265

22 Claims. (Cl. 113—49)

My invention relates to an improved method and novel apparatus for making metallic tubular bends, particularly short radius tubular bends, such as may be employed as fittings in conduits.

One method by which tubular bends have heretofore been formed is to bend a straight metallic tube of the required diameter and length over a form having a contour of the curvature corresponding to that of the bend to be formed.

In carrying out my invention I form a metallic blank, such as a sheet or disc, into a tubular structure and form the tubular structure into a bend of the desired curvature all in a unitary operation. I attain this result by forcing a blank through the aperture of a die by means of a curved plunger having a curvature corresponding to that of the bend which it is desired to form. The metallic blank is thus formed into a curved tubular bend on the plunger and is stripped from the latter by withdrawing the plunger from the die while holding the bend against movement with the plunger.

A feature of my invention resides in a simple machine for economically forming tubular bends.

A second feature resides in forming a blank into a tube and imparting the required curvature to the tube to form a bend of the desired curvature, all in a unitary operation.

In the drawing:

Figure 1 is a sectional side elevation which diagrammatically illustrates the bend forming machine of my invention.

Figure 2 is an enlarged fragmentary detail view showing the manner in which the plunger and die cooperate to form a bend.

Figure 3 is a view similar to Figure 2 but illustrating the manner in which the bend formed in Figure 2 has its diameter decreased and its length and angularity increased.

Figure 4 shows the completion of the bend forming operation with the bend about to be stripped from the plunger.

Referring to the drawing, the numeral 10 designates a base having standards 11 supporting a bed plate 12. Mounted on the bed plate 12 is a die 13 having an aperture 14 aligned with an aperture 15 in the bed plate to permit a curved cylindrical plunger 16 to be moved through the aperture of the die and bed plate. It should be understood that the shape of the die aperture corresponds to the shape of the plunger although of greater diameter and also that instead of being cylindrical the plunger and die aperture may be of any other desired shape, according to the cross-section of the bend to be formed.

Mounted above the die 13 and secured on the bed plate 12 in any desired manner is a plate 17 of annular or other convenient shape. The plate 17 is spaced from the upper surface of die 13 at a distance corresponding substantially to the thickness of the sheets or discs from which the bends are to be formed and is adapted to hold the edges of such sheets or discs against upward movement away from the die during the forming operation without, however, binding the disc or sheet against the die and interfering with the passage of the disc through the die.

A stripper plate 18 is guided in bed plate 12 for movement toward and away from plunger 16. Stripper plate 18 may be bifurcated or otherwise formed to pass around the plunger when the latter extends through the die 13 and is adapted to engage a tubular bend formed by downward movement of plunger 16 to strip the bend from the plunger when the latter is withdrawn through the die 13.

The curved plunger is suitably secured in a yoke 20 fixed to and movable with a shaft 21 journalled, as in the standards 11, in spaced alignment with the die 13. The radius of curvature of the curved plunger 16 corresponds approximately to that of the bend which is to be formed. Of course, the bend when stripped from the plunger will have the same radius of curvature as the plunger, but in finishing the bend this radius may be somewhat altered, if desired. The plunger 16 is secured to the yoke 20 so that its center line is at a distance from the center of shaft 21 corresponding to the radius of curvature of the bend to be formed. Likewise, the die 13 is positioned on bed plate 12 with its center at a similar distance from the center line of shaft 21. Thus, the center lines of die 13 and curved plunger 16 are equidistant from shaft 21 and consequently the center line of plunger 16 is aligned with the center of die 13.

The shaft 21 carries a gear 22 meshing with the teeth of a rack 23 for turning shaft 21 to operate plunger 16. The rack 23 is suitably guided for reciprocating movement perpendicularly to the bed plate 12 and die 13 thereon. Rack 23 may be operated in any desired manner, as for example, by connection to the plunger of a hydraulic press or by means of hydraulic or other suitable operating mechanism of its own. Thus, the forming machine of my invention may be employed with a hydraulic press as an adjunct

for forming bends or may be constructed as a complete forming machine per se.

The operation is as follows: A metallic blank 24, which may be either a sheet or disc of the required size, is placed upon the die 13. The blank 24 may, if desired, be heated before being placed upon die 13. The retaining annulus 17 is secured in place to hold the blank 24 at its edges. Shaft 21 is then rotated counter-clockwise by depression of rack 23. On rotation of shaft 21 the yoke 20 is carried therewith and moves the end of plunger 16 against the blank 24, forcing the blank through the aperture 14 in die 13, as shown in Figure 2. During this operation the annulus 17 prevents the edges of blank 24 from being forced upwardly away from the die, without, however, binding the blank against the die. The rotation of shaft 21 is continued until all of the blank 24 has been forced through die 13 forming a tubular bend on the plunger 16 as shown in Figure 4. The curvature of the bend formed on the plunger 16 corresponds to the curvature of the plunger and its inner and outer diameters correspond, respectively, to the diameters of the plunger and the aperture of the die.

Stripper plate 18 is then moved inwardly, either manually or automatically, so that it extends around plunger 16 and is adapted to engage the bend thereon. The rack 16 is then raised, turning shaft 21 in the opposite direction and effecting withdrawal of plunger 16 through the aperture of die 13. In this movement of plunger 16 the bend formed thereon is moved into engagement with stripper plate 18 and being thus held from further movement with plunger 16 is stripped from the plunger.

If it is desired to form the bend into one of smaller diameter with a greater angularity and length, the bend formed as described above is placed upon a die 25 having a smaller diameter and forced through die 25 by a plunger 26, also of smaller diameter, as shown in Figure 3. It is to be understood that in such case the die 25 and plunger 26 are positioned at the same distances from the center line of shaft 21 as die 13 and plunger 16, inasmuch as the radius of curvature remains the same, although it is desired to decrease the diameter of the bend and to increase its angularity and length. This operation may be repeated with increasingly smaller dies and plungers until the bend is of the required diameter and angularity.

When the bend is stripped from the plunger after given the desired dimensions in one or more forming operations, it is cropped at its ends to smooth the same and to remove the material at 27 which closes one end of the bend.

It should be understood that in many cases a bend of the desired diameter and angularity may be formed directly from a blank in a single operation, and further operations, except cropping the ends of the bend, are unnecessary. However, in some cases, the bend may be formed from the blanks in a series of operations which progressively decrease the diameter of the bend and increase its length and angularity, as described above. The latter method may be found desirable in certain cases, as, for example, when the diameter, thickness and radius of curvature necessitate a series of operations.

I may form bends having various radii of curvature by employing curved plungers of the corresponding radii with the plungers and cooperating dies positioned relatively to the axis of rotation of the plunger as described above. My invention is particularly adapted to the formation of bends having short radii of curvature but is also suited to the production of tubular bends of relatively large radii of curvature.

In practicing my invention I may form bends having various degrees of angularity. My method and apparatus are particularly suitable for forming bends of about 90° angularity but it is also possible to form bends up to an angularity of about 180°. It should also be understood that the angularity of a completed bend may be determined by the size of the blank utilized and the degree of movement of the plunger in a single or successive forming operations. It will also be apparent that I may form bends subtending certain angles by first forming a bend of greater angularity and then cutting it into sections having the desired angularity. For example, I may first form a bend subtending an angle of 90° and then cut this bend into two bends each subtending a 45° angle.

It should be noted my apparatus for forming tubular bends is simple in construction and operation and makes it possible to make tubular bends in a simple and economical manner.

I claim:

1. A machine for forming curved tubular bends comprising an apertured die having a surface for supporting a blank, a curved plunger, means for operating said plunger to force said blank through said die to form a curved tubular bend on said plunger, and means for stripping said bend from said plunger.

2. A machine for forming curved tubular bends comprising an apertured die having a surface for supporting a blank, a curved plunger, and means for operating said plunger in one direction for forcing said blank through said die to form a curved tubular bend on said plunger and for operating said plunger in the opposite direction to withdraw it from the aperture of said die.

3. A machine for forming curved tubular bends comprising an apertured die having a surface for supporting a blank, a curved plunger, means for operating said plunger in one direction for forcing said blank through said die to form a curved tubular bend on said plunger and for operating said plunger in the opposite direction to withdraw it from the aperture of said die, and means for engaging said bend to strip the latter from said plunger during said withdrawal thereof.

4. A machine for forming curved tubular bends comprising a die having an aperture and a surface for supporting a blank, a rotatably mounted plunger, and means for turning said plunger to force said blank through the aperture of said die to form a curved tubular bend on said plunger.

5. A machine for forming curved tubular bends comprising a die having an aperture and a surface for supporting a blank, a rotatably mounted plunger, means for turning said plunger in one direction to force said blank through the aperture of said die to form a curved tubular bend on said plunger and for turning said plunger in the opposite direction for withdrawing it from the aperture of said die, and means to hold said tubular bend against movement with said plunger as the latter is withdrawn for stripping said bend from said plunger.

6. A machine for making curved tubular bends comprising, an apertured die having a surface for supporting a metallic blank, a curved plunger positioned with its center line in alignment with the center of the aperture of said die, and means

for operating said plunger to force said blank through the die to form a curved tubular bend on said plunger.

7. A machine for making curved tubular bends comprising, an apertured die having a surface for supporting a metallic blank, a curved plunger positioned with its center line in alignment with the center of the aperture of said die, means for operating said plunger in one direction to force said blank through said die to form a curved tubular bend on said die and for operating said plunger in the opposite direction to withdraw it from the aperture in said die, and means operative to strip said tubular bend from said plunger during said withdrawal thereof.

8. A machine for making curved tubular bends comprising, an apertured die having a surface for supporting a metallic blank, a curved plunger, a shaft mounted in spaced alignment with said die, means secured to said shaft for supporting said plunger with the center line thereof in alignment with the center of the aperture of said die, and means for operating said shaft to cause said plunger to force said blank through said die to form a tubular bend on said plunger.

9. A machine for making curved tubular bends comprising, an apertured die having a surface for supporting a metallic blank, a curved plunger, a shaft mounted in spaced alignment with said die, means secured to said shaft for supporting said plunger with the center line thereof in alignment with the center of the aperture of said die, means for operating said shaft in one direction to cause said plunger to force said blank through said die to form a tubular bend on said plunger and for operating said shaft in the opposite direction to withdraw said plunger from the aperture of said die, and means for holding said bend against movement with said plunger on said withdrawal thereof to effect stripping of said bend from said plunger.

10. The method of making a tubular bend which comprises forming a seamless tubular bend from a flat metallic blank by forcing the blank through an aperture die by means of a curved plunger, and thereby drawing the blank over and around the plunger and shaping it to conform to the latter.

11. The method of making a tubular bend from a metallic blank which comprises, forcing the blank through an apertured die by means of a curved plunger to form on the plunger a tubular bend having a radius of curvature corresponding to that of the plunger, and stripping the bend from the plunger.

12. The method of making a tubular bend from a metallic blank which comprises, forcing the blank through an apertured die by means of a curved plunger to form on the plunger a tubular structure closed at one end and having a radius of curvature corresponding to that of the plunger, stripping said tubular structure from the plunger, and cropping the ends of said tubular structure to open the closed end thereof and to form an open tubular bend of uniform cross-section.

13. The method of making a tubular bend which comprises, placing a metallic blank upon an apertured die, moving a curved plunger in one direction to force the blank through the die and form on the plunger a tubular structure having a radius of curvature corresponding to that of the plunger, moving the plunger in the opposite direction, and holding the tubular structure against movement with said plunger in said opposite direction for stripping the tubular structure from the plunger.

14. The method of forming a tubular bend of desired internal and external diameters and having a desired radius of curvature which comprises forcing a metallic blank through a die aperture, the diameter of which corresponds to the external diameter of the bend to be formed, by means of a curved plunger having a diameter corresponding to the internal diameter of the bend to be formed and a radius of curvature approximating that of the bend to be formed.

15. The method of making a short radius tubular bend which comprises placing a metallic sheet or disc upon an apertured die, holding the edges of said sheet or disc in place, forcing said sheet or disc through said die by means of a curved plunger to form on said plunger a tubular bend having a curvature corresponding to the curvature of said plunger, stripping said bend from said plunger by holding said bend against movement and withdrawing said plunger from said die.

16. The method of forming a tubular bend of desired internal and external diameters which comprises forcing a blank through an apertured die by means of a curved plunger to form on said plunger a curved tubular structure having a radius of curvature corresponding to that of the plunger, stripping said tubular structure from said plunger, and reducing the internal and external diameters of said tubular structure by forcing the latter through one or more dies having apertures of increasingly smaller diameter by means of curved plungers of correspondingly diminished diameters.

17. The method of forming a tubular bend of desired internal and external diameters which comprises forcing a tubular blank through an apertured die by means of a curved plunger to form on said plunger a curved tubular structure having a radius of curvature corresponding to that of the plunger, stripping said tubular structure from said plunger, and reducing the internal and external diameters of said tubular structure by forcing the latter through one or more dies having apertures of increasingly smaller diameter by means of curved plungers of correspondingly diminished diameters.

18. The method of forming a tubular bend of desired internal and external diameters and having a desired radius of curvature, which comprises forcing a tubular blank through an apertured die by means of a curved plunger having a radius of curvature approximating that of the bend to be formed to form on said plunger a curved tubular structure having a radius of curvature corresponding to that of the plunger, stripping said tubular structure from said plunger, and reducing the internal and external diameters of said tubular structure by forcing the latter through dies having apertures of successively decreased diameters by means of curved plungers of correspondingly decreased diameters and having radii of curvature approximating that of the bend to be formed, the diameters of the last of said dies and plungers corresponding respectively to the external and internal diameters of the bend to be formed.

19. The method of forming a tubular bend of desired internal and external diameters and having a desired radius of curvature, which comprises forcing a tubular blank through an apertured die by means of a curved plunger having a radius of curvature approximating that of the

bend to be formed to form on said plunger a curved tubular structure having a radius of curvature corresponding to that of the plunger, stripping said tubular structure from said plunger, reducing the internal and external diameters of said tubular structure by forcing the latter through dies having apertures of successively decreased diameters by means of curved plungers of correspondingly decreased diameters and having radii of curvature approximating that of the bend to be formed, the diameters of the last of said dies and plungers corresponding respectively to the external and internal diameters of the bend to be formed, and conforming the bend thus formed to the desired radius of curvature.

20. The method of making pipe bends, which comprises forcing a blank into a closed exterior circular die in contact with the blank for the full circumference of the die opening by subjecting the blank to pressure by an interior curved horn die with its end contacting the blank, and then inserting the interior die through the exterior die by relative arcuate movement between the two dies and thereby drawing and shaping the blank over the horn die to conform to the latter while confined radially and for its full circumference by the circular die.

21. The method of making pipe bends, which comprises forcing a blank through a circular outer die by means of an inner curved die and while confined radially and for its full circumference between the two dies, thereby drawing the blank over the inner die and shaping it to conform to the latter.

22. A machine for forming curved tubular bends, comprising an apertured circular die, a rigid plunger having an operating portion of substantially uniform circular cross-section and curved on a radius, and means for causing relative arcuate movement between said plunger and said die to force a blank through the latter and thereby draw the blank over the plunger and shape it to conform thereto, the aperture of the die being substantially concentric with said operating portion of the plunger in the passage of the latter through the die.

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