

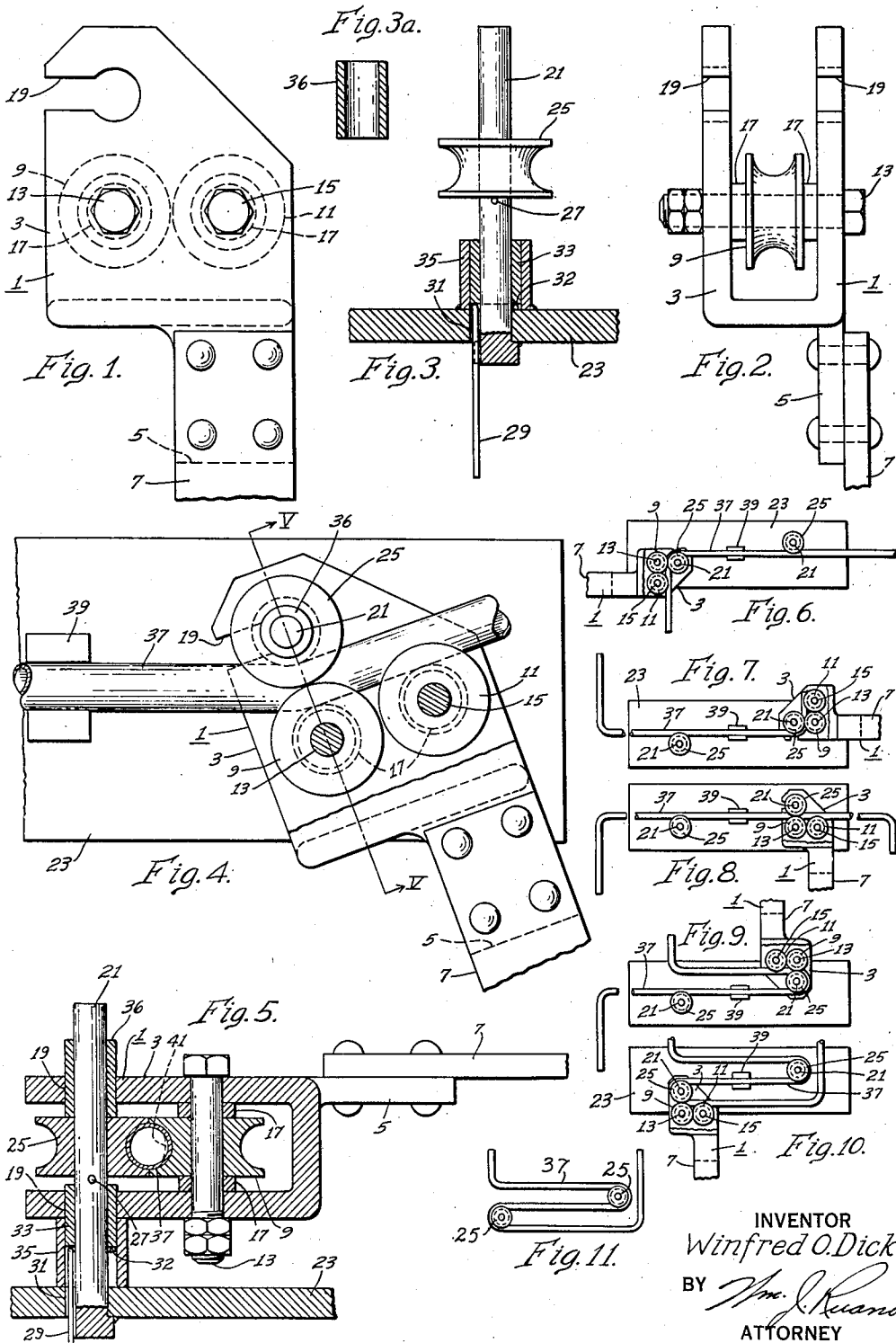
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W. O. DICK

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PIPE BENDING TOOL

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INVENTOR
Winfred O. Dick.
BY *Wm. J. Ruano*
ATTORNEY

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PIPE BENDING TOOL

Winfred O. Dick, Forest Hills, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, East Pittsburgh, Pa., a corporation of
Pennsylvania

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My invention relates to improvements in tube and pipe benders. More specifically, my invention relates to tube and pipe benders adapted for bending tubing and pipe to small radii.

In the past considerable difficulty has been experienced in forming tubing about small radii. A tube formed in the usual manner about rollers or spools usually collapsed in the area of the bend which resulted in a considerable loss in cross-sectional area. In order to avoid this undesirable condition, it has been found necessary to fill the tube with sand or utilize a mandrel during the forming operation. This, of course, entails extra operations with a resulting loss in production time. In addition, forming operations requiring a succession of bends, were in many cases, impossible to make because of interference with the bending tool itself.

It is, therefore, a principal object of my invention to provide a tube or pipe bending tool which will bend a tubular member to small radii with but a negligible area loss and which in addition is adaptable to make a succession of bends without interference of the tool with the tubular member being bent.

Another object of my invention is to provide a tool for bending tubing or pipe to small radii that will support the walls thereof in such a manner that their collapse is substantially prevented during the bending operation.

A more specific object of my invention is to provide a tool for bending tubular members comprising a pair of rollers in peripheral engagement having semicircular peripheral grooves of a diameter equivalent to that of the tubular member for completely surrounding and supporting the wall thereof during the bending operation.

Other objects and advantages will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawing, in which:

Figure 1 is a side elevational view of the bending arm;

Fig. 2 is an end elevational view of the bending arm;

Fig. 3 is a sectional view taken through the base or support at the vertically arranged post about which the forming wheel is slidably mounted;

Fig. 3a is a sectional view of a detail of the pipe bender;

Fig. 4 is an assembly view of the tube or pipe bender in operation;

Fig. 5 is a sectional view taken on the line V—V of Fig. 4; and

Figs. 6–11 illustrate the steps and procedure in forming a cooling coil requiring a succession of bends with my novel form of pipe bender.

Referring now to the drawing, there is shown in Figs. 1, 2, 3 and 3a details of the various parts

comprising my tube or pipe bender. Numeral 1 generally denotes the bending arm comprising a forked support 3 having an offset extension 5 to which is riveted or otherwise secured a handle or bar 7 of any suitable length. Within the forked support is a pair of rollers 9 and 11, each of which has a semicircular peripheral groove. They are rotatably positioned in substantially peripheral contacting relation near the root of the forked support by bolts 13 and 15 extending therethrough and centrally spaced between the sides of the fork by spacers 17. As may be seen from Fig. 1, a center-line intersecting the axes of the two rollers 9 and 11 extends substantially parallel to the base or root of the fork. Slots 19 have been provided in the extremities of the forked support 3 and are of sufficient width to clear the vertically arranged post 21 shown in Fig. 3. The centerlines of the slots 19 extend substantially parallel to the previously mentioned centerline intersecting the axes of the rollers 9 and 11 and the slots terminate in circular openings vertically disposed with respect to roller 9 so that a centerline of said circular opening intersecting the axis of roller 9 will have an angular displacement of 90° from said centerline intersecting the axes of the rollers 9 and 11. The handle 7 is offset as shown in Fig. 2 to avoid interference thereof with a tubular member being bent in the device. Normally during bending operations, this interference does not occur since the machine is so designed that it clears the bend being made. However, when a succession of reverse bends are made, a portion of the tubular member may project past the point where a new bend is to be made. It is then the expedient of offsetting the handle is necessary.

Fig. 3 illustrates the base or supporting structure of my tube or pipe bender. The vertically arranged post 21 extends upwardly through a hole in the base 23 and is rigidly secured therein in any suitable manner. A roller 25 is slidably positioned about said post, its position thereon being determined by the pin 27. A thrust wire 29 extending downwardly through a hole or slot 31 adjacent the post 21 is formed into an offset loop 32 on the upperside of the base which loosely encircles the post and has seated thereon a sleeve 33 positioned about the post, such that movement of said thrust wire upwardly will correspondingly move the sleeve up the post. A sleeve 35 secured to the base 23 completely surrounding this assembly is of such length that upon positioning the bending arm 1 about the post with the circular openings in the slot extremities and the post in concentric relation, the roller 9 is in the plane of the roller 25 and the rollers are in peripheral engagement. It is then only necessary to push the thrust wire upwardly to insert the sleeve 33 actuated thereby into the adjacent circular opening

in the fork and a further sleeve 36 (Fig. 3a), slidable on the post, into the upper circular opening of the fork, to concentrically lock the bending arm with respect to the post 21 and allow freedom of angular movement thereabout with the rollers 9 and 25 in continuous peripheral engagement, throughout this angular movement. This assembly is clearly illustrated in Fig. 5 and the advantages resulting therefrom will be hereinafter noted in detail. The base may be clamped to a bench or gripped in a vise or otherwise secured upon any horizontal surface. It should here be mentioned, however, that the roller 25 need not be mounted to a fixed base member as shown, since it will function equally well if positioned within a forked member similar to that of the bending arm, which forked extremities will project within the extremities of fork 3 and be suitably secured therein by sleeves inserted in the circular openings over extensions to the roller shaft.

I have found that by providing an easily detachable bending arm and assembling, in effect, a jig of forming rollers 25, as illustrated in Figs. 6-10, inclusive, that by moving the bending arm from one vertically arranged post to another to perform the bending operations, the difficulties encountered in bending tubular members through a succession of bends were eliminated.

In order to obtain accurate bends, however, the bending arm 1 must be accurately positioned with respect to the forming roller 25 throughout the bending operation. Since the bending arm is to be moved from one vertically arranged post to another some means must be provided to permit accurate and expeditious repositioning of the bending arm on each of the several posts.

The slidably mounted sleeves 33 and 36 satisfy this condition since they position and lock the bending arm 1 with respect to the vertically arranged post 21 so that the forming and supporting rollers 25 and 9 respectively are disposed in accurate relationship and maintained in such relationship throughout the bending operation. Thus the operator need but supply the necessary force to move the bending arm through the required number of degrees to produce the desired bend without regard to the alignment of parts and upon completion of the bending operation it is only necessary to slide the sleeves from their fork engaging position to remove the bending arm from the post. This operation is easily repeated at all of the vertically arranged posts carrying the forming rollers and comprising the jig about which the tubular member is formed.

Figs. 4 and 5 clearly illustrate the assembly and operation of the device. A tubular member 37 having a diameter equivalent to that of the circular peripheral grooves of the rollers is securely clamped by clamping means secured to the base, schematically shown at 39, in such position that it extends tangential to the roller 25 about which the tubular member is to be formed. This roller is termed the forming roller. The forked member is then positioned and concentrically locked with respect to the post 21 by means of the sleeves 33 and 36 as hereinbefore described. It may now be seen that with the forming roller 25 and roller 9 in peripheral engagement, the tubular member is completely encircled and is tangentially positioned to said rollers at the point of their peripheral engagement. Since the roller 9 completes the encirclement of the tubular member, thereby providing support of the tube on all sides, it is termed the supporting roller. Roller 11 is tangentially engaged by the portion of the tubular

member extending beyond the forming and supporting rollers and supplies the force necessary to bend the tubular member about the forming roller when a force is applied to the bending arm. Hence, it is termed the bending roller.

As sufficient force is applied to the handle 7 of the bending arm 1 to provide angular movement thereof, the bending roller will begin to form the tubular member about the forming roller. At the same time, the supporting roller is moved in the same angular degree in continuous peripheral engagement with the forming roller, thereby following the tangent of the end of the arm being formed in the tubing. It is readily seen that it is in this region that the maximum deformation of the tubular member is taking place and that by supporting the tubular member on all sides in this region, collapse of the wall thereof is substantially prevented, making it possible to bend the tubular member to a very small radius without an appreciable loss in cross-sectional area. By encircling the tubular member at the tangent of the end of the arc and thereby supporting the wall thereof where the deformation is greatest, the tubular member is prevented from spreading. In addition, the extremely high pressure developed when the tubular member is being bent around the forming roller is uniformly distributed about its wall portion engaging the roller to eliminate a concentration of forces at any point which would cause a collapse of the wall.

While the forming roller adequately supports the tubular member to prevent collapse of its wall as a result of high bending pressures, it would be insufficient in itself to prevent extreme area loss. On short radius bends in the absence of the supporting roller, the flattening of the wall above the support of the forming roller would be considerable, causing the tubular member to spread and spill over the edges of the semi-circular groove. Increasing the depth of the groove while limiting the spreading movement merely deflects such deformation upwardly which, in combination with the flattening of the outer surface, produces a squared-off effect which results in considerable loss in cross-sectional area.

When a tubular member is bent according to the principles of my invention, such area loss as previously mentioned is avoided. While I do not claim to entirely eliminate cross-sectional area loss, I have reduced the same to a practically negligible amount. In fact the wall collapse is confined to a very slight flattening of the wall structure on the outer radius of the bend as shown by the dotted lines and indicated by numeral 41 in Fig. 5. This, of course, is due to the high tensile stress developed in this area during the course of the bending operation. It may also be noted upon a further inspection of Fig. 5 that the supporting roller prevents spreading of the tubular member, thereby preventing a further flattening or collapse of the wall. It is, of course, evident that such collapse as occurs even with the bending tool which I have provided can only be eliminated by internal support of the wall. Area tests made on a $\frac{3}{8}$ inch diameter tubular member of the type suitable for cooling coils indicates but a 7%-8% cross-sectional area loss in the bent portion. This tubing was bent to a radius of $\frac{1}{2}$ inch in my device.

The bending roller also provides several desirable advantages. Its position is, of course, very important. It must be so spaced from the point of tangency of the tubular member with the forming roller that it will uniformly bend the same about the forming roller. If its moment

arm with respect to said point of tangency is too large, that portion of the tubular member beyond the end of the arc of the bend will not be perfectly straight, but will leave said arc in a curve of gradually increasing radius, terminating at the point of the applied force. If the bending roller for example, were of smaller diameter, such that when in peripheral contact with the supporting roller its point of applied force would have a relatively small moment arm with respect to said aforementioned point of tangency, it may readily be seen that the applied force to the tubular member necessary for bending would be considerably increased and would reach such a value that even such wall support as provided by the semi-circular peripheral groove in the bending roller would be insufficient to prevent damage of the wall by crushing. By providing three rollers of substantially equal size as shown, and positioning the bending roller in substantial peripheral engagement with the supporting roller, I have found that the moment arm so formed for bending the tubular member satisfactorily serves to keep the bending pressure within practical limits, and at the same time, prevents the tubular member from arcing or curving beyond the portion being bent.

The bending roller by being freely rotatable does not increase the tensile stress in the tubular member during bending. For example, in bending operations involving a succession of bends, the plan of such configuration is dimensioned to the centerlines of the curves. It is, therefore, desirable in order to conveniently obtain an accurate, finished product, to be able to lay out such dimensions along the length of the tubular member and position such marks tangential to the forming roller that upon completion of the bend, the distances between said centerlines is accurately maintained. In order to accomplish this, it is necessary to prevent axial travel of the tubular member during bending. This is accomplished by means of the clamp 39 which supports the tubular member in its proper position and also prevents axial travel thereof. If now some other means, as for example, a shoe having an arcuate groove in its surface, were to be substituted for the bending roller, it may be seen that sliding friction forces developed as a result of the pressure of engagement of said shoe with the tubular member during bending would be considerable and the shoe during its course of travel along said member, would exert a considerable pull thereon, thereby increasing the tensile stress therein to cause a further collapse of its wall. The provision of a rotatable bending roller eliminates this difficulty.

A further advantage residing in a tube or pipe bender of the type I provide is its convenience of operation on tubular configurations involving a succession of bends. Figs. 6-11 inclusive, clearly illustrate the steps and procedure in bending a cooling coil. In this application, the base member 23 supports two forming rollers 25 and has the clamping means 39 secured thereto intermediate said rollers. The illustrations as shown are believed to be self-explanatory and a detailed description of each is, therefore, unnecessary. For other tubular shapes, the forming rollers may be repositioned or more of them may be utilized. In some instances, as for example, Figs. 7 and 8, it is necessary to rotate the tubular member 180° in the clamp in order to make the bend in the desired direction or slide it axially

to properly position the bend. In any case, however, it is not necessary to remove the tubing and it is only necessary to re-position the bending arm from one forming roller to another to make the desired bend. Upon completing the final bending operation as shown in Fig. 10, the forming rollers are easily removable by lifting the tubular form and the forming rollers from the vertical posts, as shown in Fig. 11, after which the rollers are removed from the tubular form and replaced on the vertical posts 21.

It is evident from the foregoing description that I have provided a tube or pipe bender which measurably facilitates the bending of tubular members to small radii by eliminating the necessity of sand packing the tube or utilizing a mandrel during the bending operation, and which produces a bend which is highly satisfactory for most purposes, since the cross-sectional area loss is reduced to a minimum. I have further provided a bending tool which, in addition to the above-named advantages, also facilitates the forming of tubular coils or the like involving numerous bends, with a minimum of effort and time.

I am, of course, aware that others, particularly after having had the benefit of the teachings of my invention, may devise other devices embodying my invention, and I, therefore, do not wish to be limited by the specific showing made in the drawing or the descriptive disclosure hereinbefore made, but wish to be limited only by the scope of the appended claims.

I claim as my invention:

1. A tool for bending tubular members comprising, in combination, a base, a vertically arranged post secured to said base, a forming roller rotatably and slidably mounted about said vertically arranged post, clamping means secured to said base for positioning a tubular member tangential to said forming roller, a bending arm having a forked extremity, a supporting roller and a bending roller rotatably mounted within the fork, a slot in each of the extremities of the fork and means engageable within the slots and with said post for locking said bending arm to said post for angular movement thereabout and operatively positioning said supporting and bending rollers with respect to said forming roller, whereby said rollers are disposed to bend a tubular member about said forming roller upon angular movement of the bending arm.

2. A tool for bending tubular members comprising, in combination, a base, a vertically arranged post secured to said base, a forming roller rotatably and slidably mounted about said vertically arranged post, clamping means secured to said base for positioning a tubular member tangential to said forming roller, a bending arm having a forked extremity, a supporting roller and a bending roller rotatably mounted within the fork, slots in the extremities of said fork, each of said slots terminating in a concentric circular opening of a diameter larger than the width of the slot, sleeve members slidably mounted about said vertically arranged post adapted to be removably positioned within said concentric circular openings for locking said bending arm to said post for angular movement thereabout and engaging said supporting and bending rollers with said tubular member whereby said rollers are disposed to bend the tubular member about said forming roller upon angular movement of the bending arm.

WINFRED O. DICK,