Dec. 28, 1948. F. D. MORAN 2,457,705

WIRE CURLING APPARATUS AND METHOD

Filed July 19, 1944 2 Sheets-Sheet 1

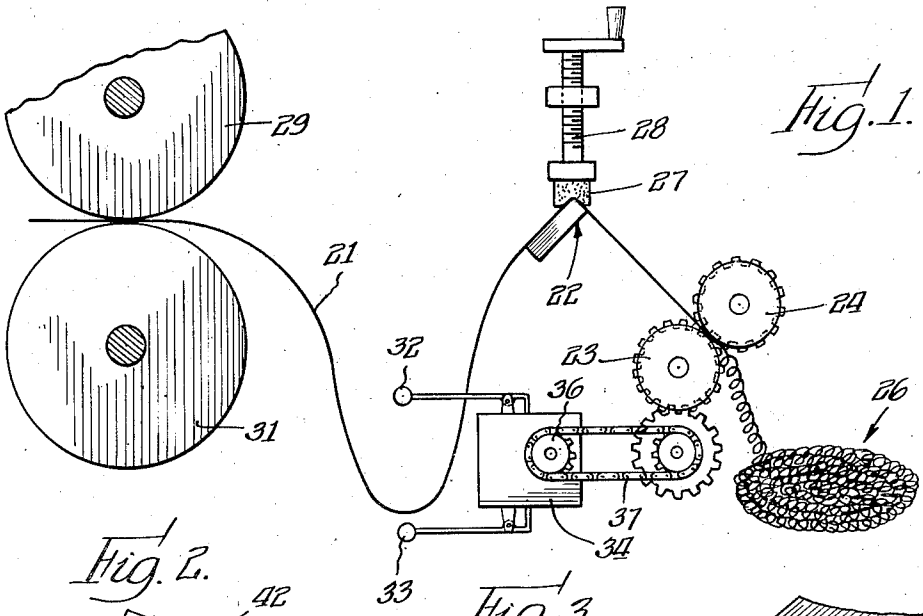


Fig. 1.

Fig. 2.

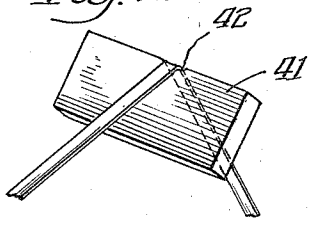


Fig. 3.

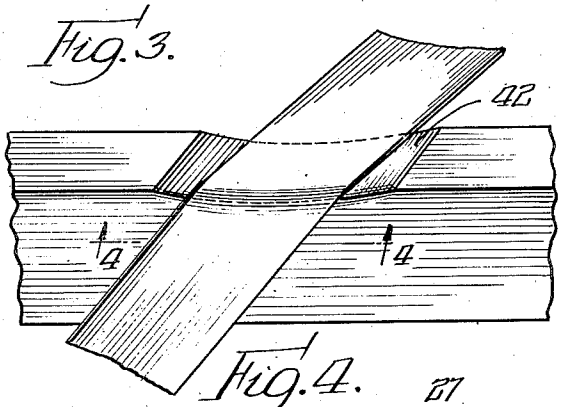


Fig. 4.

Fig. 5.

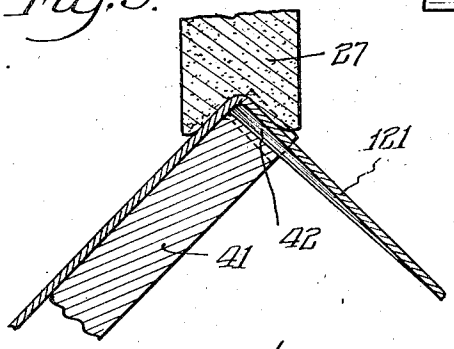
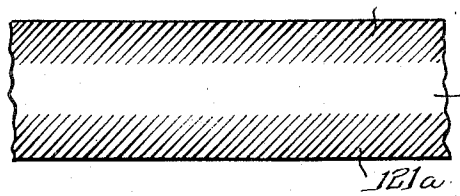
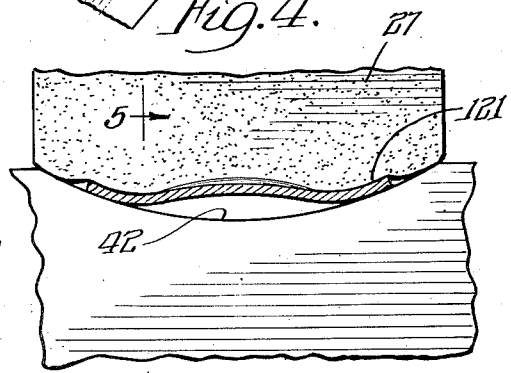


Fig. 6.





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WIRE CURLING APPARATUS AND METHOD

Filed July 19, 1944 2 Sheets-Sheet 2

Fig. 7.

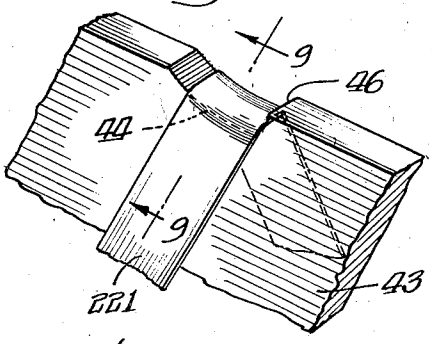


Fig. 8.

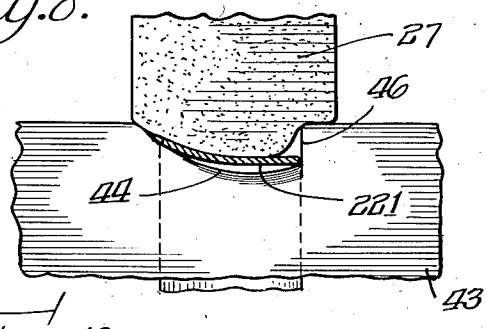


Fig. 9.

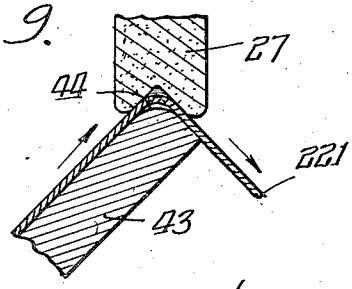


Fig. 10.

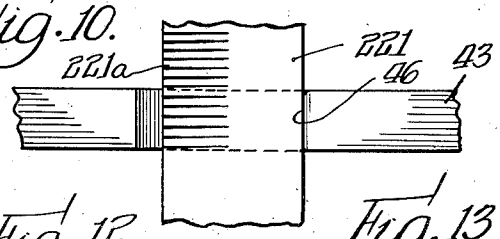


Fig. 11.

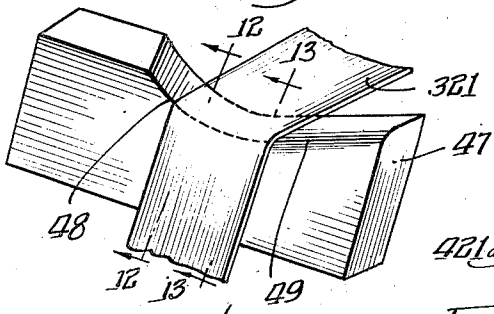


Fig. 12.

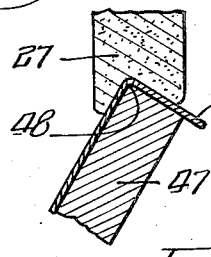


Fig. 13.

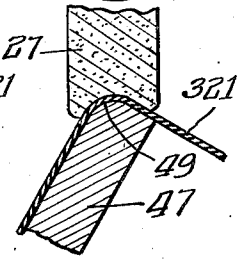


Fig. 14.

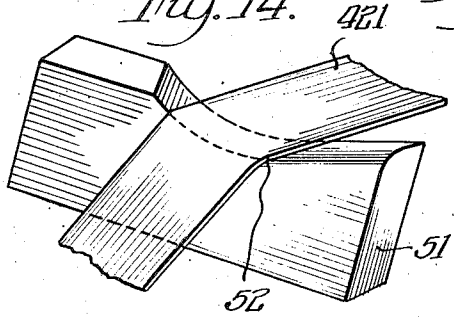


Fig. 15.

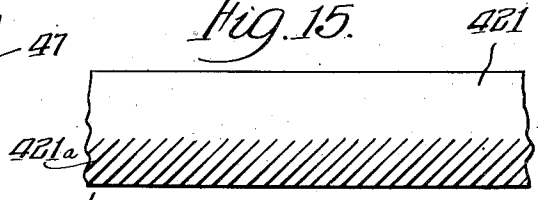
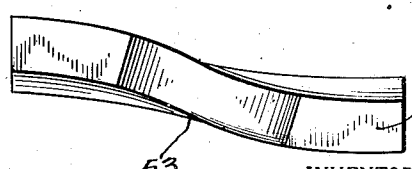


Fig. 16



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UNITED STATES PATENT OFFICE

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WIRE CURLING APPARATUS AND METHOD

Francis D. Moran, Downers Grove, Ill.

Application July 19, 1944, Serial No. 545,556

5 Claims. (Cl. 140—71)

1

My invention relates to an improved method of and apparatus for producing curled wire of the type used for the production of metal cleaning sponges and the like.

In the known art, relatively flat wire has been bent continuously over a curling edge in such a manner as to produce a helix adapted for the production of a cleaning sponge and the like. The curling edge employed has comprised a straight edge formed by the junction of two plane surfaces. The combination of which the straight edge formed a part generally has functioned in one of two ways. In accordance with one method, the wire was maintained in a taut condition on both sides of the straight edge; and in another method, such as illustrated in my Patent No. 2,196,076, the wire was maintained in a taut condition in advance of the straight edge but was drawn over the straight edge by a friction roller which itself was in contact with the straight edge so that the wire, after passing the straight edge, was permitted to curl immediately. The latter method possesses several advantages over the former, particularly in the ability to produce an open curl the openness of which may be readily controlled, and in the ability to operate relatively continuously without breakage of the wire during manufacture. The latter method, however, has the disadvantage that excessive wear of the driving friction roller occurs and both methods have the disadvantage that the wire is relatively brittle after being curled and tends to break up into relatively small pieces during actual use.

The principal object of my invention is to improve the method of and apparatus for producing flat curled wire.

Another object is to produce a curled wire product which is much less brittle than curled wire heretofore produced and which will, therefore, be more resistant to breaking than such previously produced wire.

I have found that by substituting a curling curve for a curling edge, as will be more fully described hereinafter, and employing such curling curve in a combination of the type disclosed, it is possible to continuously produce curled wire without the attendant disadvantages of prior methods and apparatus and also that the curled wire is less brittle and much more resistant to breakage than curled wire heretofore produced. My invention, therefore, has two distinct aspects, namely, the utilization of a curling curve in place of a curling edge, and the combination of such

2

curling curve with other apparatus such as will be described below.

The curling curve has an advantage over the curling edge in that with the latter the flat wire is bent over its entire width and the entire cross section of the wire has been subjected to work of a character to change its metallurgical structure and hence to embrittle it. The curling curve also has the advantage that the wire is easily maintained on it even when it passes over the curling curve at other than a right angle thereto; while the flat wire in process of being curved does not readily maintain its position on a straight edge unless there are channels or guides for the flat wire close to the said curling edge. Because the curve is generally concave, the flat wire engages the curling curve primarily at the edges, the center part of the wire engaging the curling curve only lightly, if at all. Since the center of the wire is less worked by the tool than the edges it is less brittle and the decreased brittleness of a portion of the wire is sufficient to inhibit breakage thereof. The curling curve may be slightly rounded in the direction of movement of the flat wire to prevent tearing the same but it is not sufficiently rounded to minimize the bending action which is required in order to effect the necesary curl. Whatever the specific shape of the curling curve, its concave character is such as to assist in maintaining the wire in contact therewith.

The curling curve may be modified in several respects and with some difference in the effect upon the wire but in each instance utilizing the features of the present invention having to do with preventing breakage. The curling curve may be formed by the junction of a plane surface and curved surface or by the junction of two curved surfaces so brought together as to form a junction which is concave and slightly rounded. A practical curling tool of this type may be thought of as a hole drilled at right angles through a flat plate with the edges slightly rounded. Such a curling tool may be modified by drilling the hole at an angle through the flat plate. In order to produce an open curl, the flat wire must be drawn across the curling curve at an angle thereto so as to produce a diagonal bend across the wire instead of a bend straight across the wire. The amount one edge is bent ahead of the other determines the openness of the curl. The curve, which can be thought of as resulting from a hole drilled diagonally in a flat plate, has an advantage over a straight drilled hole in that in the diagonally pro-

duced curve the wire can lie relatively flat in the hole or on a curve comprising a section of such hole.

An open curl can also be produced by bending one edge of the flat wire more than its opposite edge or, indeed, by bending only one edge of the wire. When the wire is curled in this manner, it is not essential that it be bent diagonally, although the wire, if desired, can be bent only along one edge and diagonally at such edge instead of straight. One way of bending the wire only along one edge or to a greater extent only along one edge than the other is to vary the pressure across the width thereof. Still another method is to engage one edge of the wire continuously over a curling curve and the other edge of the wire over a rounded surface formed on a sufficiently large radius so that it has little, if any, bending action on the wire. A curling tool of the latter type may be formed by producing a curling curve and setting it at an angle partially into the outside surface of a cylinder, one edge of the wire engaging the curling curve and the other engaging the said cylinder.

The curling tools and methods of utilizing the same discussed hereinabove are all based on the utilization of a curling curve as contrasted with a curling edge of the type heretofore employed. The curling tool comprising such curling curve is preferably utilized in a combination wherein a resilient pad is employed to hold the wire against the curling tool and the wire is drawn across the curling tool, the wire being taut at that portion thereof between the curling tool and the drawing means employed but definitely slack between the source of supply of the wire and the curling tool.

I have discussed the curling tool generally hereinabove in order that those skilled in the art may understand the general features of the invention fully, it being remembered that the wire which is sought to be curled in accordance with my present invention is only about .001 inch in thickness and approximately .020 inch in width. I do not limit myself to the practice of my invention with wire of this particular dimension but these figures will illustrate the fact that the dimensions of the curling tool are relatively small and that the drawings showing the same are necessarily somewhat schematic and greatly enlarged.

Additional objects and features of the invention will be brought out in the following detailed description taken with the accompanying drawings wherein:

Fig. 1 is an elevational view partly in section showing the apparatus of my present invention;

Fig. 2 is an enlarged perspective view showing the curling tool and the flat wire;

Fig. 3 is a plan view thereof with the resilient pad removed;

Fig. 4 is an elevational view with a portion of the resilient pad in section, the view being taken substantially along the line 4—4 of Fig. 3 looking in the direction of the arrows;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4 looking in the direction of the arrows;

Fig. 6 is an enlarged schematic view indicating the manner in which the wire is affected by the operations shown in Figs. 1 to 5, inclusive;

Fig. 7 is a perspective view showing a modified form of curling tool;

Fig. 8 is a side elevational view of the embodiment of Fig. 7 with the wire in section at the point where it passes over the curling curve;

Fig. 9 is a transverse sectional view taken on the line 9—9 of Fig. 7;

Fig. 10 is an enlarged plan view of the embodiment of Fig. 7 with the resilient pad removed, the flat wire being shaded to indicate the action thereon;

Fig. 11 is a perspective view showing still another modification;

Figs. 12 and 13 are sectional views taken on the lines 12—12 and 13—13, respectively, of Fig. 11;

Fig. 14 is a perspective view showing still another modification;

Fig. 15 is an enlarged schematic view indicating the manner in which the wire is affected by the operation shown in Fig. 14; and

Fig. 16 shows a still further modification of the curling tool.

Before describing the curling tool and the variations thereof, I shall describe the combination of apparatus illustrated in Fig. 1. A flat wire 21 is drawn over a curling tool 22 by a pair of traction rollers 23 and 24 between which the wire is gripped and from which it is discharged in the form of a curled mass 26. A pad 27 holds the wire resiliently against the curling tool and the pressure of the pad against the curling tool is controlled by a screw 28. The pad 27 has the function of bending the wire about the curling tool as will be described and I have found that a resilient pad formed, for example, of rubber, is suitable for the purpose.

One desirable manner of producing a flat wire for fabricating cleaning sponges is to pass a round drawn wire between a pair of flattening rollers 29 and 31. The flattening rollers may be operated at constant speed calculated to be the same as the speed at which the traction rollers 23 and 24 operate so that the flattened wire will be delivered to the tool at the same speed at which it is removed therefrom and adequate slack will be maintained between the flattening rollers and the curling tool in the general manner shown in the drawings. Suitable means is provided, however, to vary the speed of one or the other to maintain the necessary slack. In the drawings I illustrate one simple expedient in which electrical contact bars 32 and 33 are disposed above and below the wire 21, these contact bars being electrically connected to suitable speed change mechanism contained in a housing 34. Within the same housing is a drive mechanism for driving a sprocket gear 36 which in turn drives a chain 37 and gear train, as shown, to drive the two rollers 23 and 24. By means of mechanism known in the art, the speed of the gear 36 is increased slightly when the wire 21 comes in contact with the contact bar 33 and the speed is slightly reduced when the wire 21 comes in contact with the contact bar 32. Thus, slack may be retained in the wire to maintain it at a position intermediate the contact bars 32 and 33.

Quite apart from the matter of the construction of the curling tool, the combination of Fig. 1 possesses certain advantages. Because the resilient pad 27 performs no driving function, it may be lubricated at the place where it contacts the curling tool so that the resistance occasioned by the passage of the wire between the curling tool and the pad is decreased. This reduces wear on the pad and such wear may be distributed by moving the pad transversely of the curling tool to present a fresh area continuously to the surface of the wire by suitable means not shown. Less work is required to curl the wire than is required in other methods and with other apparatus with which I am familiar.

I stated hereinabove that the showing of Fig.

1 is partly schematic, the view being principally illustrative and containing no more structure than is necessary for an understanding of the invention. I wish to point out particularly that the relative sizes of the parts are not accurate, the wire and curling tool, particularly, being relatively out of proportion. It should be borne in mind that while the drawings indicate that the resilient pad 27 is shaped at its lower edge to engage both sides of the curling edge, the fact is that the pad may be perfectly flat across the bottom and it takes its shape by being deformed due to pressure against the curling tool. For best operation of the traction rollers 23 and 24, one is preferably made of hard rubber and the other of semi-soft rubber but any suitable traction means may, of course, be employed. The curling tool 22 may comprise any one of the modifications shown in the remaining figures.

The curling tool indicated in Figs. 2 to 5, inclusive, is of the type referred to hereinabove which can be considered as formed by drilling a small hole diagonally through a flat plate. Since only a portion of the hole is utilized in the actual curling operation, the curling curve portion of the curling tool comprises only a portion of the circumference of the postulated drill hole. The parts are greatly magnified as will be understood from the fact that a drill hole of .125 inch diameter is adequate for the purpose of bending a wire which is .020 inch wide and the curling curve shown in Figs. 2 to 5, inclusive, may be considered as comprising a section of such a hole.

The curling tool comprises a flat section 41 of steel or the like along the top face of which is a diagonally disposed shallow slot 42 of arcuate shape. The flat section 41 is placed at an angle with respect to the flat wire 121 so that it engages only one edge of the shallow slot 42, that is to say, the edge or curve formed by the juncture of the shallow arcuate slot 42 and the forward face or surface of the section 41. This juncture which I have heretofore called the curling curve is rounded only enough to avoid tearing of the wire so that in effect a sharp bend is imparted to the wire as it passes over the curling curve as indicated in Fig. 5. Fig. 4 shows, however, that only the edges of the wire engage the curling curve, the result being that the center portion of the wire is not appreciably changed in metallurgical structure while along the sides bands 121—*a* of deformed metal are produced which cause the wire to curl in the desired manner. Since any method of producing the wire results in longitudinal orientation of crystals, the effect of the sharp bending along the sides is to break up such crystals and produce a structure which, while producing the curl, nevertheless, still produces a brittle area. The center portion of the wire, however, is not embrittled so that the wire as a whole will not readily break. Since the wire passes the curling curve diagonally, the sharp bending and resulting crystal deformation is at an angle as indicated by the shaded lines in Fig. 6. This causes the wire to curl openly, that is, in the form of a helix and the angle of the shade lines in Fig. 6 representing the angle at which the flat wire passed over the curling curve will determine the openness of the curl.

It will be recalled that the open curl or the helix form of curl may be produced by bending the wire more along one edge than at the opposite edge and that this can be brought about either by exerting greater pressure against the wire on one edge than at the other or by shaping the curling curve to cause a differential bending. Figs. 7 to 13, inclusive, disclose this feature and reference will be made first to Figs. 7 to 10, inclusive, in which the differential bending of the wire is caused by applying greater pressure to one side of the wire than the other. The curling tool utilized in Figs. 7 to 10, inclusive, comprises a flat section 43 of metal or the like at the edge of which a generally arcuate slot 44 is interrupted by a shoulder 46 defining a straight edge against which one edge of the flat wire 221 is adapted to engage. The section 43 is carried in the same manner as the section 41 (see also the generally indicated tool 22), so that the wire 221 engages only one edge of the slot 44 in the manner indicated in Fig. 9. The resilient pad 27 engages directly downwardly to hold the wire frictionally against the curling curve but, as shown clearly in Fig. 8, the shoulder 46 defining the straight edge prevents the resilient pad from applying any appreciable pressure to that edge of the wire which is in contact with the said shoulder, while the pad freely and firmly engages the opposite edge of the wire to produce a sharply bent portion along the edge thereof as indicated by the shaded section 221—*a* of Fig. 10. Pressure against one side only of the flat wire 221 would normally tend to cause the wire to shift sideways in the arcuate slot defining the curling curve, but the shoulder interposed at one side of the curling curve prevents the wire from shifting sideways in the manner suggested.

In Figs. 11 to 13, inclusive, I show a modified form of the invention wherein the shape of the curling tool causes the wire to be bent more sharply along one edge than the other. In this form of the invention, a flat section 47 has its top surface finished to form a curling curve 48 interrupted at approximately the normal center line thereof by a rounded portion 49. The portion 49 may be considered as a portion of a cylinder into which the curling curve 48 is partially set so that one side edge of the flat wire engages over the curling curve in the manner illustrated in Fig. 12 while the other side of the wire engages the fractional portion of cylinder 49, as indicated in Fig. 13. As in the remaining figures, the center of the wire is substantially unaffected by the bending action and the bent area will approximate that indicated by the shaded portion 221—*a* of Fig. 10. In Figs. 11 to 13, inclusive, the numeral 321 is applied to the wire to indicate the third modification. I wish to point out, however, that in many respects the form of curling tool disclosed in Figs. 11 to 13, inclusive, is the preferred form of invention so far as actual construction of the curling tool itself is concerned.

Referring back to the previous embodiments, I have shown that an open curl may be imparted to the wire by engaging both edges of the flat wire against the curling curve while passing such wire over the curling curve diagonally; or alternatively by passing the wire over the curling curve at right angles to the surface of the curling tool, the curling curve being shaped in such a manner, however, as to bend the wire more along one edge than the other. Figs. 6 and 10 indicate the results of these two methods. I find, however, that it is also possible to combine these two features to treat a wire 421 in such a manner as to produce a bending action such as indicated by the shaded area 421—*a* of

Fig. 15. It will be noted that the shaded lines indicating the angle of bending are diagonal, but that they extend only to an area along one edge of the wire. In this form of the invention, the section 51 is provided with an edge slot 52 running across the top edge of the section 51, substantially identical with that shown in Fig. 11, but the wire is drawn over the curling curve diagonally instead of straight as in the previously described embodiment.

Fig. 16 shows a curling tool only, the wire being left out of the figure to facilitate the showing of the curling curve. The curling curve 53 formed in the body of the tool 54 can be thought of as being generally similar to that disclosed in Fig. 11 but comprising part of an edge slot running diagonally to the surface of the section in which it is placed but wherein the section in which the clot comprising the curve is formed itself has a curved surface rather than a plane surface. The structure can be thought of as formed by producing an arcuate slot in a flat section of metal, and then twisting the section to curve its previously flat sides to define a compoundly curved surface. Such a curling curve comprises, in effect, a curve formed by the juncture of a cylinder and curve in which the latter is of constantly changing radius. This curve is of such a nature that a plane surface will not bisect it but it may be bisected by a curved surface, preferably one of constantly shifting arc of curvature but suitably comprising also a section of an arc.

The curve shown in Fig. 16 may be employed to produce a structure like that shown in Fig. 15.

I have described my invention in detail to permit those skilled in the art to practice the same, but my invention is limited only by the scope of the claims defining the same.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. Apparatus for curling flat wire comprising a curling curve over which the wire is adapted to be bent, stationary resilient pressure means for holding the wire bent across the curling curve to bend the same, means for delivering the wire in a slack condition to the curling curve, and means for continuously drawing the wire across the curling curve and from between the curling curve and pressure means, whereby to continuously impart a bend along the length of the wire and curl the same.

2. Apparatus for curling flat wire comprising a curling tool having a curved edge slot, a resilient pad holding said wire against a margin of said slot and means for drawing the wire across said curling tool while so held by the pad to curl the same, the said curved edge slot, resilient pad and drawing means being so constructed and arranged as to bend said wire more along part of its cross section than another, whereby to curl the wire while leaving a non-brittle area therein.

3. Apparatus for curling flat wire comprising means for delivering the flat wire to be curled to a curling tool while maintaining said wire in a slack condition, a curling tool over which the wire is adapted to be bent, stationary resilient pressure means for holding the wire bent across said curling tool to bend said wire, and means, spaced from said stationary resilient pressure means, for continuously drawing the wire across said curling tool and between said curling tool and said stationary resilient pressure means, whereby said wire is maintained in a substantially taut condition between said stationary resilient pressure means and said means for drawing the wire across the curling tool, whereby, after passing said last-mentioned means, curling of the wire takes place.

4. Apparatus for curling flat wire comprising means for delivering the flat wire to be curled to a curling curve while maintaining said wire in a slack condition, a curling curve over which the wire is adapted to be bent, stationary resilient pressure means for holding the wire against said curling curve to bend said wire, the curling curve being shaped so that the flat wire, as it is drawn thereover, is subjected to a pressure greater against at least one edge than at the center thereof whereby to impart to the wire a tendency to curl, and means, spaced from said stationary resilient pressure means, for continuously drawing the wire across said curling curve and between said curling curve and said stationary resilient pressure means, whereby said wire is maintained in a substantially taut condition between said stationary resilient pressure means and said means for drawing the wire across the curling curve, whereby, after passing said last-mentioned means, curling of the wire takes place.

5. The method of curling relatively flat wire which comprises feeding said wire continuously between and in contact with a curling curve and a stationary resilient pad whereby said wire is caused to bend sharply against said curling curve, said wire engaging said curling curve at at least one edge of said wire but not across the entire area thereof whereby to embrittle only edge portions of the cross section of the wire, and continuously drawing the wire across said curling curve.

FRANCIS D. MORAN.

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