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METHOD AND APPARATUS FOR FORMING SHEET METAL

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This invention relates to metal forming, and particularly to a new method and apparatus for bending sheet metal.

It is often necessary to bend a sheet of metal into a curve of special form without destroying the resiliency of the metal which defies the use of conventional rolling machines. For example, when an attempt is made to put a permanent slight bend in a rolled sheet of metal which is elastic by the use of conventional rolling machines or press procedures, the metal will snap back to its original shape just as soon as the deforming pressure is removed therefrom. The only way in which such a sheet of metal can be made to retain such a bend is to destroy to some extent its elasticity by the application of heat or other means. This technique is not suitable where the original physical characteristic of the metal sheet, i.e., resiliency, is desired in its bent form.

The primary object of the present invention is to provide a method for forming sheet metal by means of which slight and/or unusual curves can be made in the sheet without destroying inherent physical characteristics of the original sheet or unduly damaging the appearance of the surfaces thereof.

Another object is to provide a method of forming thin metal sheets which involves expanding or elongating the skin of metal on one surface of the sheet in a designated area to cause the sheet to bend in the vicinity of said designated area in such manner that the treated side of the sheet is on the convex side of the bend.

Another object of the present invention is to provide a method of forming metal sheets which consists in blasting the area of the sheet which is to constitute the convex side of the curve to be formed therein with a jet of fluid under pressure containing a fine abrasive to set up compressive stresses in the surface which exceed the yield point of the material causing the material to elongate on the treated surface.

A further object is to provide a masking fixture for controlling the shape and degree of bend made in a metal sheet by this technique.

The novel features that we consider characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIGS. 1 and 2 are perspective and end views, respectively, showing a particular form of sheet metal part which the present invention is capable of readily forming whereas the use of conventional rolling machines is not suitable for the forming of this part;

FIGS. 3 and 4 are perspective and end views of a fixture which was designed to form the part shown in FIGS. 1 and 2; and

FIG. 5 is an end view showing how the present technique of forming sheet metal might be used to straighten sheets having a bend set therein as the result of being coiled up in rolls or having a set bend for any other reason.

In FIGS. 1 and 2 there is shown a sheet metal part 10 which the present technique of forming metal was devised to form when it was found that conventional sheet metal-forming techniques, including rolling machines, were not suitable for the job. This part 10 is used to form the support for a soft rubber pad which is used as a platen on a contact photographic printer to hold the light-sensitive paper in firm, flat contact with the material to be copied during the printing operation. This curved metal sheet 10 must be resilient so that when the platen is in its raised position, the part assumes the curved form shown, but when the platen is in its holding position, the part 10 must flatten out to hold the paper flat. It is also pointed out that the curved portion 11 of part 10 must blend into a straight portion 12 on either side, another condition which defies the use of conventional rolling machines which are adapted for forming complete and uniform curves in a sheet of metal.

The fact that part 10 must be resilient or elastic enough to flex between its normally curved form and a flat condition means that the flat sheet of metal from which the part is to be formed must be resilient or elastic. It will be appreciated that to form a slight bend in a sheet of resilient metal by conventional rolling techniques without in some way impairing the resilient characteristics of the metal would be impossible because the sheet would merely snap back to its original flat form when the deforming pressure was removed.

In accordance with the present invention, the part 10 is formed from a flat sheet of metal by "sand blasting" that area of the surface of the sheet in which the curve is to be formed and which blasted surface ultimately forms the convex side of the final curve. The principle involved seems to be that the "sand blasting" elongates the metal on the blasted surface of the sheet. As the sheet is blasted, compressive stresses are set up in the surface which eventually exceed the yield point of the material causing the material on the surface to elongate. This elongation will bend the sheet in such a manner that the blasted side is on the convex side of the curve. This explanation holds true providing the penetration is relatively shallow and the neutral axis of the section is not disturbed. This technique is not limited to the use of sand as the abrasive in the blast so that the term "sand blast" is used in a generic sense to mean any suitable abrasive which may be blasted against the surface with a jet of air, or other fluid, under pressure.

We have found that the shape and degree of curvature placed in a sheet of metal by this technique can be readily controlled by the use of a masking fixture which masks the area of the surface to be blasted and prescribes the degree of curvature imparted to the sheet. In forming a part 10 of the type shown in FIGS. 1 and 2, fixture 15 of the form shown in FIGS. 3 and 4 has been found useful. This fixture merely consists of a wooden frame having a bottom 16, side walls 17 and two top walls 18 separated at the center of the fixture to provide a space 19 defining the area through which the sand blast can pass to the surface of the metal sheet. One end 20 of the frame is open to permit insertion of a flat sheet of metal 21 endwise into the same, as shown in FIG. 3, and the other end of the frame may be provided with a stop pin or an end wall 22 to limit the insertion of the sheet into the frame. After the flat sheet of metal 21 is placed in the fixture, the surface area of the sheet exposed by the space 19 is uniformly subjected to a sand blast 23 from a conventional source 24 until the desired curve is formed in the sheet. To this end, a blast of limited area may be moved back and forth over the fixture, or if the blast is in a fixed position, the fixture may be moved back and forth under it, or if a blast of sufficient area to cover the exposed surface is used, then both the blast and the fixture may be stationary relative to each other.

If, as in the making of part 10, the desired curve calls for a rise of .375 inch between the edges of the finished part and the point where the curve meets the straight portions of the part, then the dimension A of the fixture would be .375 inch. Then if the loaded fixture is left in the sand blast until the formed sheet touches the bottom of the masking edges of the top walls 18, as shown in full lines in FIG. 4, then the operator can stop the blasting operation knowing that the desired curve has been formed in the sheet. This condition can be sensed audibly, as well as visually, because as the sheet starts to curve, it will fit loosely in the fixture and vibrate to a certain extent until such time as it bends sufficiently to contact the masking edges of the fixture. Accordingly, when the vibration of the sheet ceases, the operator knows that the desired forming of the sheet has been completed. It will be seen that the fixture 15 not only controls the form of the curve to be made in the metal sheet but also constitutes a gauge for testing said final curve.

It will be noted that the width of the open space 19 in the fixture will determine the chord of the curve to be formed in the metal sheet. In the making of part 10, as shown in FIGS. 1 and 2, the space 19 is 3.5 inches wide while the top walls 18 are 3.468 inches wide to correspond with the dimensions of the curved and straight portions in the formed part. The amount of bending produced by this technique will increase proportionally with the duration of the blast, the grit size of the abrasive used and the pressure used to blast the surface. We have been able to form the part 10 shown in FIGS. 1 and 2 from a flat rolled aluminum sheet .040 inch thick in 30 seconds using a #120 grit crushed steel shot at 80 p.s.i. This forming technique is not limited to the forming of rolled aluminum sheet but could be used to form sheet steel or any material that will take a permanent set regardless of shape or method of fabrication, providing the possible limit is not exceeded. This includes both thermosetting plastics and thermoplastic materials as well as metals, also moldings, castings and tubing as well as rolled sheet. The arcuate extent or chordal width of the curve desired will, of course, be dependent upon the width of the area of the sheet which is exposed to the sand blasting. This technique provides a desired bend in a sheet of metal without destroying any physical characteristics of the original sheet and without defacing the surface of the sheet to an extent that it cannot be readily covered over with a fine coat of paint or lacquer.

This technique of forming metal sheets is not limited to the idea of putting bends in flat sheets but can also be used for straightening or flattening sheets which have taken a set for one reason or another, i.e., having been cut from a long strip which has been rolled up for an extended time. To flatten such a curved sheet, the concave side of the sheet is sand blasted to elongate the same. This can be readily done by placing the curved sheet 29 in a fixture 30 of the type shown in FIG. 5 with the concave side of the curve facing the opening 31 in the top of the fixture. Then the concave surface of the sheet is sand blasted through the opening in the fixture until the sheet flattens onto the bottom wall of the fixture, see dotted line position of sheet 29. The extent of the sand blasted area, or the width of the opening in the fixture, will vary with the degree of curvature in the sheet which is to be taken out. One way of readily indicating to the

operator when the curved sheet is flattened within tolerable limits is to make the depth of the fixture slightly greater than the thickness of the sheet. While this will mean that the operator might have to deform the sheet in order to initially insert it into the fixture, after he has blasted it sufficiently for it to rattle or vibrate in the fixture, he will be sure that it is flattened to the desired extent.

Although we have shown and described certain specific embodiments of our invention, we are fully aware that other modifications thereof are possible. Our invention, therefore, is not to be limited to the specific details shown and described but is intended to cover all modifications coming within the scope of the appended claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. The method of forming a bend of prescribed curvature in a portion of a flat sheet of metal comprising the steps of uniformly sand blasting the surface which is to form the convex side of the curve in the area to be bent while masking off the remainder of the surface, confining the sheet during sand blasting so that when it is flat, it will be free to vibrate, but when it has become bent to the prescribed amount, it will be held against vibration, and stopping said sand blasting when the sheet is held against vibration.

2. In the method of flattening a curved sheet of metal consisting of sand blasting the concave surface of said sheet until the sheet bends to a flattened condition, the step of confining said sheet prior to and during sand blasting in such a way that it will be held against vibration due to its curvature but will be free to vibrate when it becomes flattened within desired tolerance whereby vibration of the sheet serves as a signal when to stop sand blasting the surface.

3. A method for forming a bend of prescribed curvature in a central region only of a substantially flat sheet of metal comprising the steps of confining said sheet between two walls, one of said walls having inner edges defining an opening therein which edges are spaced at a prescribed transverse distance from the other of said walls, with the central portion only of one face of said sheet exposed through said opening, and sand blasting the exposed central portion only of said face through the said opening until by bending at said central portion the sheet simultaneously contacts the one wall at said inner edges and the other wall.

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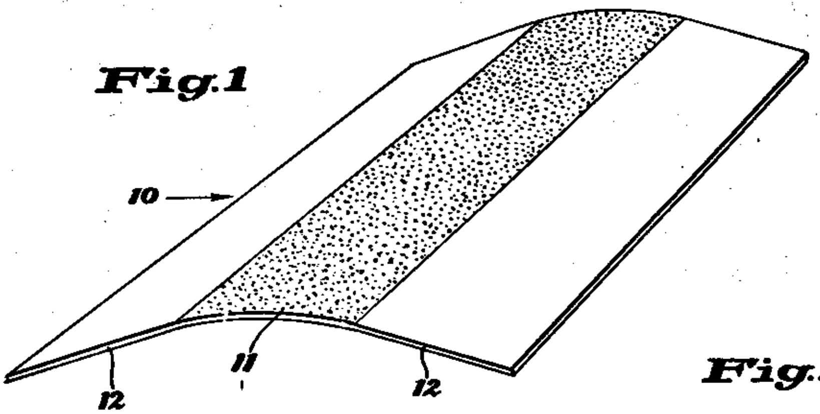

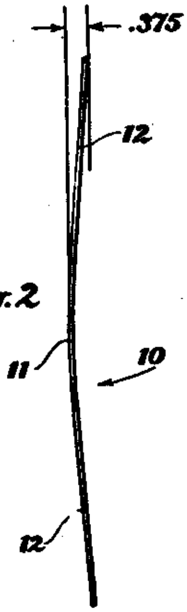

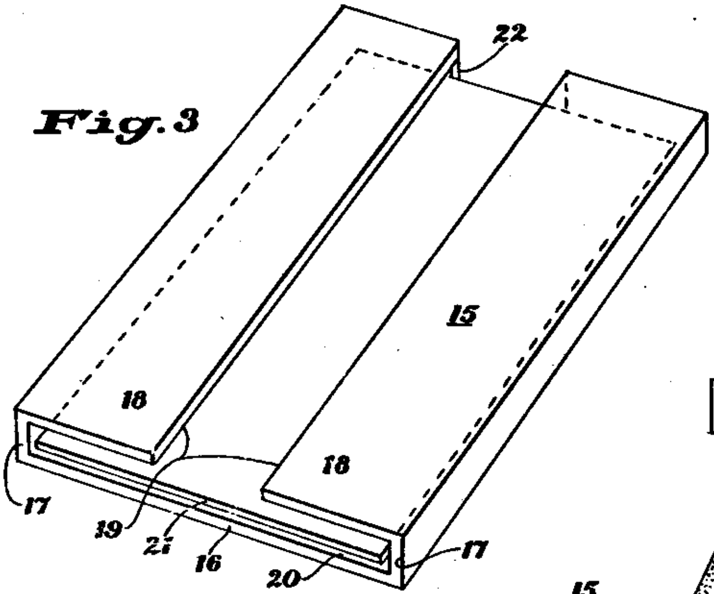

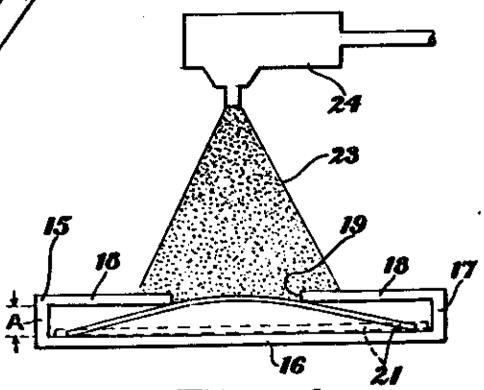

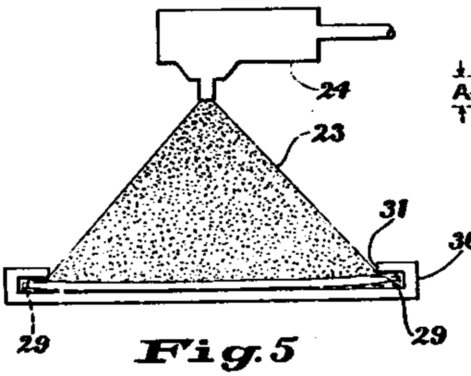

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