Aug. 26, 1947. W. E. COURTNEY 2,426,260

METHOD OF DEFORMING SHEET MATERIAL ON PREDETERMINED SPACED LINES

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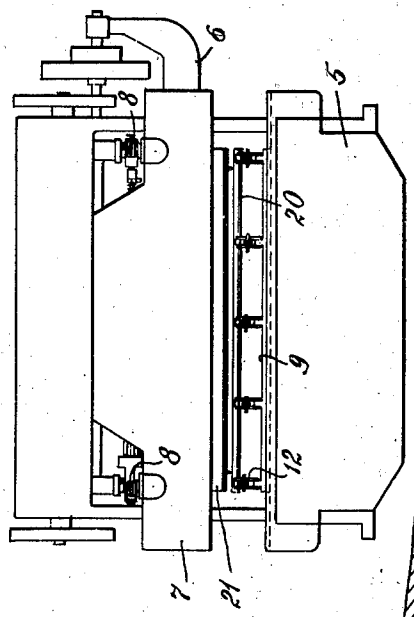


Fig. 1.

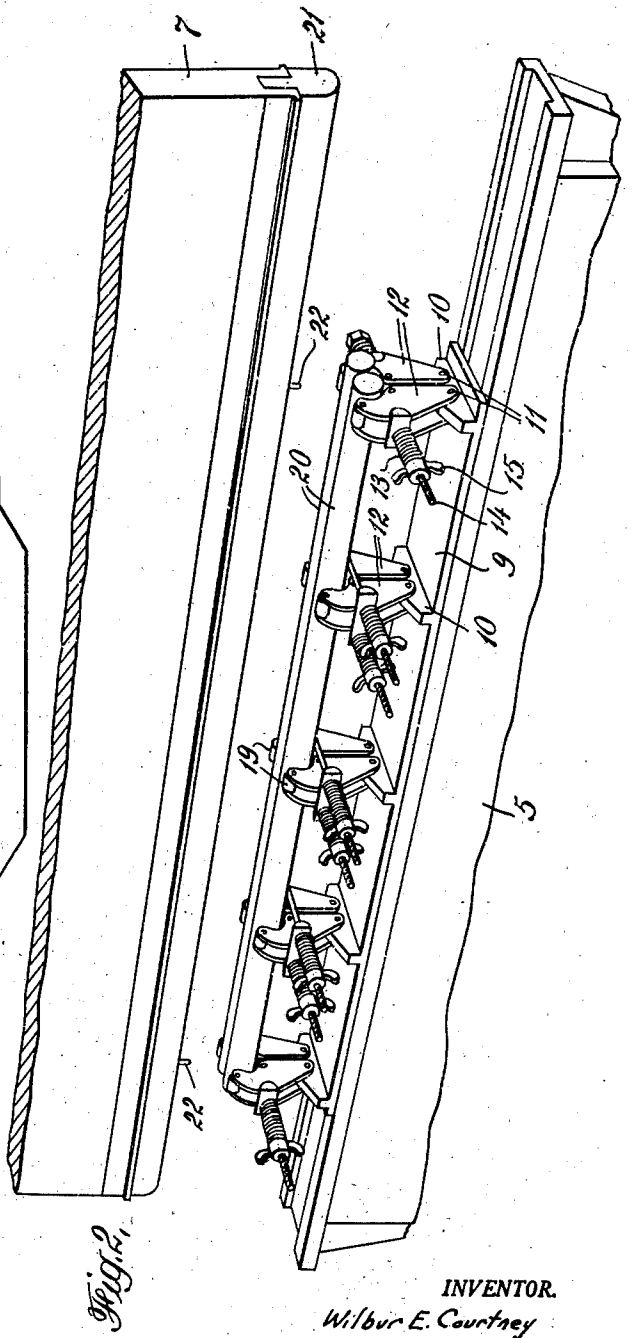


Fig. 2.

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Fig. 3,

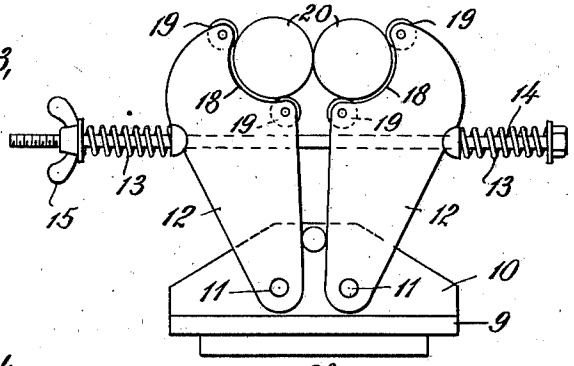


Fig. 4

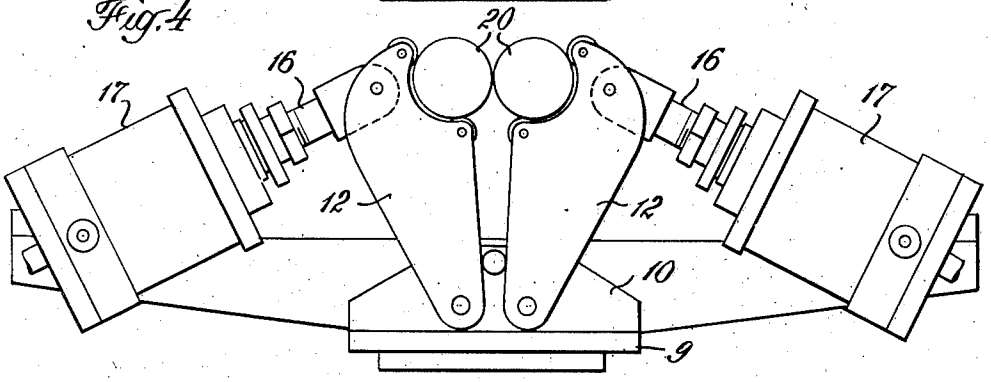


Fig. 5,

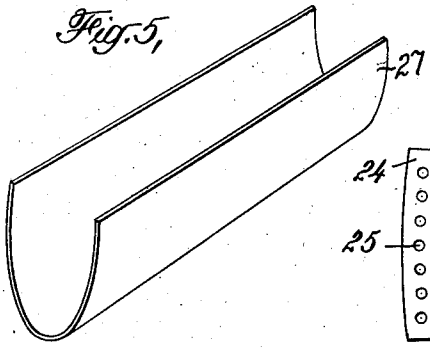


Fig. 6,

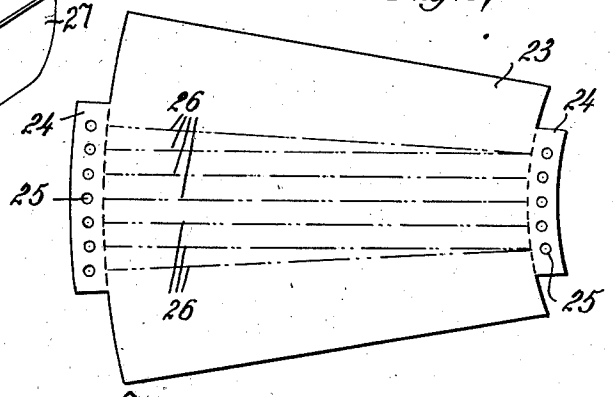
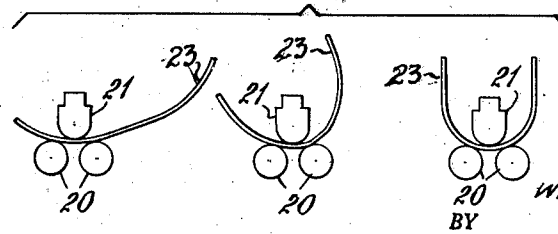


Fig. 7.



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METHOD OF DEFORMING SHEET MATERIAL ON PREDETERMINED SPACED LINES

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Application January 5, 1944, Serial No. 517,069

5 Claims. (Cl. 153—33)

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This invention relates to forming or shaping of flat sheets of metal and similar material to produce units having the required curvature for various structural purposes.

In industry there are many applications of curved parts of sheet material. As an example, modern airplanes of streamlined design include parts such as the leading edges of the wings which must be accurately formed with predetermined curvature. Frequently, as in the case of the edges of airplane wings, the radius of curvature varies longitudinally of the part. The manufacture of such parts with precision and efficiency has not been possible heretofore. Much of the work has been performed manually or with the assistance of machines which are not well adapted to the purpose. Hence production has heretofore been costly and the products often unsatisfactory.

It is the object of the present invention to provide a simple, efficient and economical method of and apparatus for forming sheet material which permits the production of accurately formed parts rapidly and satisfactorily, thereby facilitating the manufacture of various articles therefrom.

Another object of the invention is the provision of a method and apparatus which can be operated by semi-skilled labor with the minimum of loss due to defects in the product.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and the accompanying drawings, in which the preferred embodiments are described and illustrated. In the drawings,

Fig. 1 is a front elevation of an apparatus embodying the invention;

Fig. 2 is a view in perspective of a part of the apparatus;

Fig. 3 is an enlarged end view of a part of the apparatus;

Fig. 4 is a view similar to Fig. 3 illustrating a modified form of the apparatus;

Fig. 5 is a view in perspective of a typical formed sheet;

Fig. 6 is a plan view of the blank or unformed sheet; and

Fig. 7 is a diagram illustrating the successive forming steps.

The invention, though designed primarily for the handling of sheet metal, is capable of other applications. Thus sheet materials having characteristics similar to those of sheet metal and particularly of acquiring a permanent set when deformed under pressure, may be shaped by the application of the principles hereinafter set forth.

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In carrying out the invention, I employ a standard type of press brake which is commonly used for a variety of purposes requiring the application of pressure. It comprises a bed 5, a frame 6 and a ram 7 which is movable by the application of power from a suitable source toward and from the bed. Such a press brake is usually provided with indicators 8 at each end which can be set by the operator to control the descent of the opposite ends of the ram to predetermined limits. The limit at one end of the ram may be different from that at the other, as expressed in terms of figures on the indicators 8. The limits can be changed readily by a simple adjustment under control of the operator. The details of such a press brake form no part of the present invention, and being well known in the art, require no further description.

For the purpose of the present invention, I provide a base 9 which is adapted to be mounted on the bed 5 of the press. The base 9 carries a plurality of flanges 10 projecting upwardly and each pivotally supporting at 11 a pair of vise-like arms 12. The arms 12 are biased toward each other by any suitable means, as for example by springs 13 mounted on bolts 14 which extend through the arms. The springs 13 are adapted to be tensioned by wing nuts 15 or any other suitable device.

As shown in Fig. 4, I may employ alternatively plungers 16 adapted to be actuated by hydraulic or gaseous pressure applied through the cylinders 17. By regulating the pressure of the fluid medium employed in the cylinders, any desired pressure may be exerted on the members 12 to urge them toward each other in opposition to the pressure of the work, as hereinafter described.

Each of the arms 12 has a cut-out portion 18 of arcuate form and is provided with rollers 19 which afford antifriction support for rolls 20 which are mounted on the rollers 19 and adapted to be held in engagement under the tension of the springs 13 or the pressure exerted by the plungers 16.

For co-operation with the mechanism just described, I support a die 21, preferably of wood and of suitable form to effect the desired curvature of the work upon the ram 7 and provide on the die a pair of tooling pins 22 near the opposite ends thereof. The position of the tooling pins will depend upon the length of the sheet which is to be formed in accordance with the method and by the use of the apparatus. The sheet to be formed will be provided with openings adapted to engage the tooling pins 22 which thus determine the line on which pressure is

to be exerted on the sheet between the rolls 20. The limit of descent of the ram being first fixed by adjustment of the indicators 8, the ram is permitted to descend, forcing the sheet against and between the rolls 20, thus subjecting the sheet to rolling pressure along a predetermined line and to the desired extent against the resilient counter-pressure afforded by the springs 13 or the pressure exerted by the plungers 16.

The method will be more clearly understood by reference to Figs. 6 and 7 in which 23 indicates a blank sheet which has been routed to the form necessary to provide a curved member such as that illustrated in Fig. 5 which is a section of a typical leading edge skin for an airplane. The blank 23 is provided at its ends with extensions 24, each having a series of tooling holes 25 for receiving tooling pins 22. The lines 26 connecting the tooling holes indicate the lines upon which pressure is exerted successively by the die 21 as it descends and forces the sheet 23 against and between the rolls 20 to effect the desired curvature. By the pins 22 engaging the tooling holes 25, the sheet 23 is restrained against rolling movement. The extensions 24 are thus only used to locate the routing lines 26. After the sheet has been formed, the extensions are removed to provide the finished article 27.

As indicated in Fig. 7, the operation is conducted in a series of steps whereby the sheet is gradually brought to the desired contour with assurance of accuracy in the finished product. In each of the several operations, the limit of movement of the ram is adjusted so as to effect the desired result. The first operation is repeated on each of the two outermost lines connecting the openings 25. The second operation, involving a modification of the limit of movement of the ram, is then effected on the lines on either side of the central line. The third operation, involving another adjustment of the limit of travel, is then performed on the central line to complete the desired curvature.

In carrying out the operation, the operator is provided with a formula indicating the limits of movement of the ram in each of the successive operations. These limits are fixed by adjustment of the indicators 8. As an example of such a formula, for a specific forming operation, the operator will set the indicators as follows:

	Large End	Small End
First operation	1,200	1,000
Second operation	1,290	1,080
Third operation	1,380	1,160

By successively adjusting the indicators and carrying out the successive operations on the sheet 23, as illustrated in Figs. 6 and 7, the sheet will be shaped to conform to the typical leading edge for an airplane as shown in Fig. 5, with a radius of curvature at the large end which is larger than the radius of curvature at the small end. By following the formula, the operator can repeat the operation to produce a multiplicity of identical parts, each having precisely the same contour.

It will be understood, of course, that variation in the form of the desired part will necessitate routing of the sheet to a form which is a development of the desired part, and the proper adjustment of the tooling holes and of the formula which determines the limit of movement of the ram for each successive operation on the sheet. In each particular case, the formula must be determined in part by successive trials until the desired shape is attained. This is necessarily so because adjustment must be made for variation in spring-back according to the material used, its thickness and the particular contour to be formed. However, the formula for any particular operation can be determined readily, and once determined repetitions of the operation will produce identical parts.

The relation of the forming holes and of the lines connecting them as shown in Fig. 6 is that determined in view of the developed sheet and the shape which is to be given to it during the forming operation. A developed sheet of different contour which is intended to be bent to form a member having a different curvature will necessarily be designed with forming holes adjusted to meet the requirements. Moreover, the succession of operations as well as the formula will vary, depending upon the shape of the desired product. These conditions preliminary to the operation can be determined with accuracy. The operator is supplied then with developed sheets of proper form, with the tooling holes therein. With a suitable formula, he can proceed, without further supervision, to duplicate the operation and produce accurately formed parts. Obviously the operation of the method and apparatus requires only a limited degree of skill. If the operator follows the formula and makes the necessary adjustment of the indicators in accordance therewith, the resulting product will be uniform with substantially no losses due to inaccurate curvature of the finished part.

The method and apparatus afford, therefore, a practical and highly desirable procedure for the formation of parts with irregular curvature. It may be used also in forming parts where the radius of curvature is equal at both ends of the part formed. Owing to the speed and accuracy of the operation, it is economical and in fact effects a very material saving as compared with crude methods of operation which have been utilized heretofore in the formation of similar shapes.

Various changes may be made in the details of procedure and in the apparatus as described without departing from the invention or sacrificing the advantages thereof.

I claim:

1. The method of forming sheet material which comprises placing a sheet of material at one side of a pair of yieldably mounted rolls mounted to rotate on spaced axes extending in the same general direction, successively applying force to the side of the sheet material remote from the rolls, lengthwise in the direction in which the rolls extend, said force being applied on predetermined, spaced lines extending in the same general direction and in planes between parallel planes passing through the axes of the roll, the force applied in each successive operation being in amount sufficient to deform the sheet by at least partially forcing it between the rolls, whereby, during the deformation, the rolls are caused to yield and to rotate and to exert a rolling counter pressure against the side of the sheet in contact with them, and varying the limit of application of force at opposite ends of the material.

2. The method of forming sheet material which comprises deforming a sheet of material successively on predetermined lines extending in the same general direction against rolling counter pressure afforded by an elongated roll by applying the deforming pressure along said lines

lengthwise in the direction in which the roll extends and in a direction non-radial with respect to the roll, whereby during the deformation the roll is caused to rotate and to exert the rolling counter pressure against the side of the sheet of material in contact therewith, and varying the limit of application of force at opposite ends of the material.

3. The method of forming sheet material which comprises deforming a sheet of material successively on predetermined spaced lines extending in the same general direction, exerting rolling counter pressure against the sheet being deformed by an elongated roll extending in the same general direction as the successive lines of deformation, the deforming forces being applied in a direction non-radial with respect to the roll so that during the successive applications of such force the roll is caused to rotate and exert the rolling counter pressure.

4. The method of forming sheet material which comprises deforming a sheet of material successively on predetermined spaced lines, extending in the same general direction, against an elongated roll and another member spaced therefrom and extending in the same general direction, the deforming forces being applied to the side of the sheet remote from said elongated members, lengthwise in the direction in which the elongated members extend and at planes between those at which the sheet initially makes contact with the elongated members, the force applied during each successive operation being in an amount sufficient to deform the sheet by at least partially forcing it between the elongated members, whereby during the successive deformations the roll is caused to rotate and exert a rolling counter pressure against the side of a sheet in contact therewith.

5. The method of forming sheet material which comprises placing a sheet of material at one side of a pair of yieldably-mounted rolls mounted to rotate on spaced axes extending in the same general direction, successively applying force to the side of the sheet material remote from the rolls, on predetermined spaced lines extending in the same general direction and in planes between parallel planes passing through the axes of the rolls, the force applied in each successive operation being in an amount sufficient to deform the sheet by at least partially forcing it between the rolls, whereby during the deformation the rolls are caused to yield and to rotate and to exert a rolling counter pressure against the side of the sheet in contact with them.

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