United States Patent

Harvill et al.

[15] **3,664,165**

[45] **May 23, 1972**

[54] METHOD AND DIE CONSTRUCTION FOR FAN BLADE

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[73] Assignee: **Wallace-Murray Corporation,** New York, N.Y.

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[21] Appl. No.: **847,323**

[52] **U.S. Cl.** .....**72/168,** 29/156.8 CF, 72/92, 72/172

[51] **Int. Cl.**.....**B21b 15/00**

[58] **Field of Search** .....29/156.8 B, 156.8 H, 156.8 T; 72/92, 91, 168, 380, 319, 68; 113/116

[56] **References Cited**

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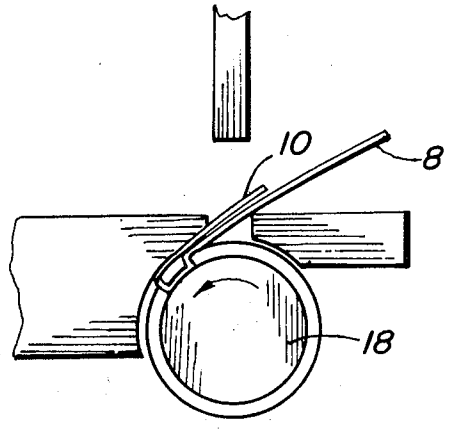
Primary Examiner—Milton S. Mehr

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[57] **ABSTRACT**

A flat metal sheet is engaged by a downwardly moving rectangular anvil. The anvil passes through a space between two planar supports, carrying contiguous sheet metal portions with it, distorting them to a U-form. The bight portion of the U is moved into a slot in a rotary drum. The anvil is withdrawn and the drum rotates, carrying the sheet against curved cam surfaces to yield the finished configuration.

6 Claims, 9 Drawing Figures



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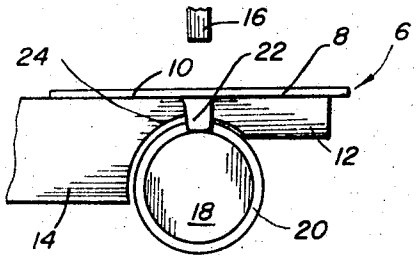


FIG. 1

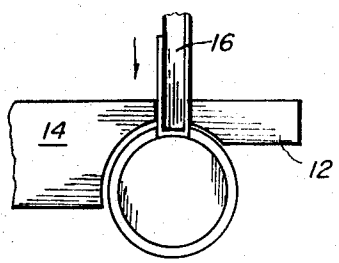


FIG. 2

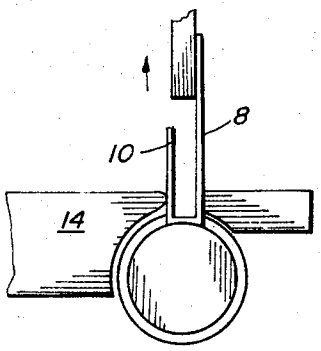


FIG. 3

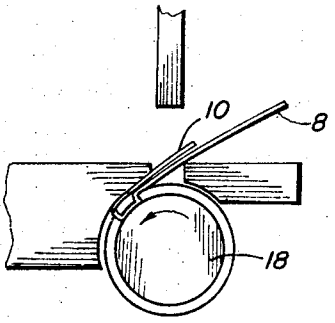


FIG. 4

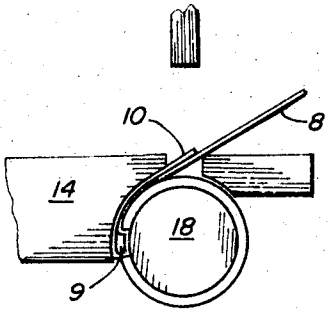


FIG. 5

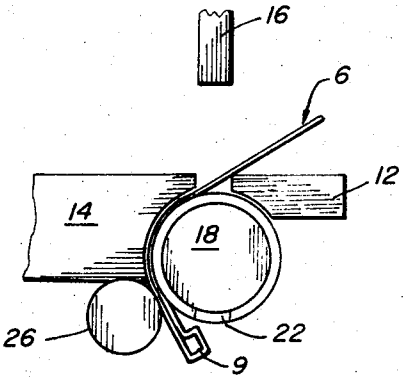


FIG. 6

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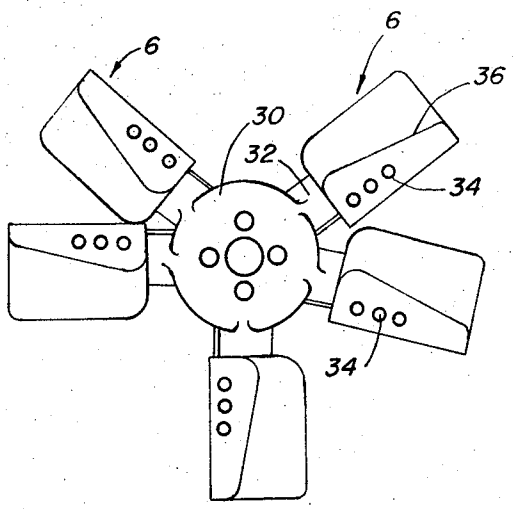


FIG. 7

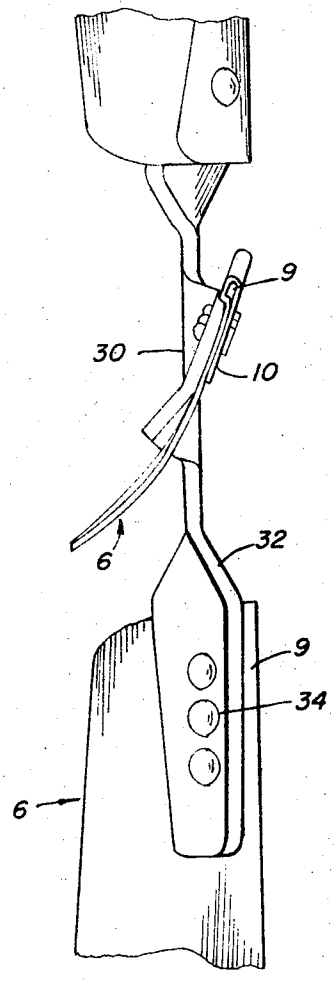


FIG. 8

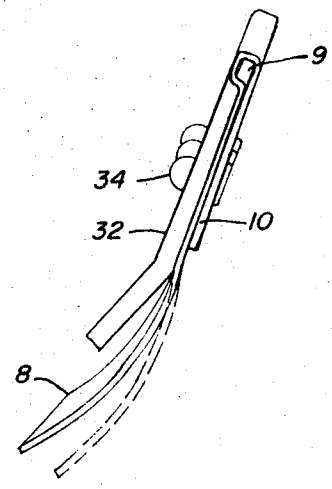


FIG. 9

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METHOD AND DIE CONSTRUCTION FOR FAN BLADE

This invention relates to the art of metal deformation and more particularly to a machine and method for deforming metal sheets into a folded over configuration particularly suitable to function as blades in a flexible blade automobile fan.

The prior art is aware of a variety of fan blade constructions in the automobile field. With the exception of relatively low power engines, the majority of internal combustion engines are provided with cooling systems which require a rotary fan for the purpose of blowing ambient air against a radiator system in order to facilitate the giving off of heat from a cooling fluid to the atmosphere. The greater the contact of ambient air with the radiator (heat exchange device), the more rapidly heat may be abstracted from the cooling liquid. This in turn permits greater efficiency of operation of the engine. One prior art construction of a fan blade is shown in U.S. Pat. No. 3,406,760 issued to Thomas J. Weir. According to the construction described in that patent, a fan blade is formed which has an enlarged bead running longitudinally of the leading edge of the blade and which has one or more folded portions adjacent the leading edge. One particularly useful construction is that described at FIG. 4 of this same Weir patent where only a single overlap or fold is adjacent the leading edge. In general, the function of a flexible fan blade is to yield or bend at relatively high rotational speeds to thereby diminish the volume of air moved by the fan. The reasons for such a desired lessening of the moved air volume, as well as other advantages inherent in this construction, are fully described in the Weir patent and further discussion of such advantages will not be here given.

In the construction of such fan blades, it is obviously desirable to employ some mechanisms/methods which will enable inexpensive and rapid fabrication. While the art of sheet metal deformation is aware of a great number of methods and machines for bending sheet metal into a variety of forms, none appear to be particularly suited for the fabrication of a blade such as shown at FIG. 4 of the above-mentioned Weir patent. According to the present invention, a machine/method is provided which will permit the rapid fabrication under closely controlled conditions of such flexible fan blades.

IN THE DRAWINGS

FIGS. 1 through 6 disclose a succession of steps performed by the machine of this invention for fabricating flexible fan blades.

FIG. 7 is a front view of a fan assembly in having fan blades formed by the present invention.

FIG. 8 is a fragmentary, side view illustrating in detail the construction of the junction between the fan blades formed according to the present invention and the spider shown in FIG. 1.

FIG. 9 is a view similar to FIG. 8, and illustrates the bending of a flexible fan blade formed according to the present invention.

Referring now to FIGS. 1 through 6 of the drawings, the numeral 6 generally denotes a metal sheet, here rectangular, which is to form the flexible fan blade. Numeral 8 denotes, as viewed in FIG. 1, the right hand portion of the sheet and the numeral 10, the left hand portion. The numeral 12 denotes a right hand planar support, such as a metal table, and the numeral 14 denotes a corresponding support on the left. In general, the top surfaces of supports 12 and 14 are on the same horizontal plane and the support 14 is thicker than the support 12. The numeral 16 denotes a vertically reciprocating rectangular anvil whose width along the axis of shaft 18 is normally the same as the length of the opening between the support tables 12 and 14, but which could be shorter if particular circumstances so require. The shaft 18 is of relatively massive construction which carries an enlarged cylindrical portion 20 about its periphery. The numeral 22 denotes a slot in the enlarged portion 20, the length of the slot along the rotary shaft 18 being at least as long as the width of the anvil 16 and the width of the slot being such as to provide sufficient clearance to the anvil and a double thickness of fan blade material (sheet 6). The numeral 24 denotes a cam surface at the indicated left portion of planar support 14. This surface extends from the upper right edge of table 14 to its lower right edge.

In practice, a plurality of sheets 6 may be fed by conventional means to the table defined by the halves 12, 14. Any one of a great number of conveyor or dispensing mechanisms may be employed, their precise form and mode of operation forming no part of the present invention.

FIG. 2 illustrates the next step in the process after the sheet 6 has been placed as indicated in FIG. 1. The anvil 16 has been moved downwardly to engage the top surface of the sheet 6 and to force it through the opening defined by the space between the facing edges of the table portion 12 and 14. A mid-portion of sheet 6 is forced downwardly into the bottom of the slot 22 in the rotary shaft 18. FIG. 3 illustrates the next step wherein the anvil 16 is withdrawn from the position indicated at FIG. 2. It will be noted that a generally U-shaped configuration is now defined by the sheet, with the left and right portions 8 and 10, respectively, now being vertical and the bight portion between these portions lying in the slot 22. At FIG. 4 of the drawings the next step in the process is illustrated and comprises rotating the shaft 18, thus carrying slot 22 and the associated bight portion counterclockwise. This rotation causes the lower part of left portion 10 to abut the cam surface 24 and slide therealong. With continued rotation, as indicated at FIG. 4, the left portion 10 is folded into abutment with portion 8 so that the portions now are in contact along their facing surfaces.

FIG. 5 illustrates continued rotation of shaft 18, causing the formation of a curve in the sheet metal adjacent the bight portion. It will be observed that the bight portion has assumed the form of a generally rectangular bead denoted by the numeral 9 at FIGS. 5 and 6.

FIG. 6 of the drawings illustrates continued rotation of the shaft 18 in the same direction, and the bead 9 pulled out of the slot 22 by the natural resiliency of the sheet metal. An auxiliary cylinder 26 is illustrated at FIG. 6 (having been omitted from FIGS. 1–5 for simplicity) and functions to draw and frictionally convey the entire sheet 6 widthwise along the cam surface 24, it being understood that the rotary shaft 26 contacts the outer surface of the portion 10 of the blade. The cooperation between the shafts 18 and 26 and the cam surface 24 is such that a blade curved throughout its width is formed, the blade being seen best by reference to FIGS. 7, 8 and 9.

Referring now to FIGS. 7, 8 and 9 of the drawings, the numeral 30 denotes a spider of conventional construction having a plurality of arms 32 to which are secured, as by rivets 34, the curved and flexible fan blades 6 formed by the process and machine of this invention. FIG. 8 shows the general curved configuration of the blade 6 after final bending and final mounting on the spider 30. FIG. 9 illustrates the flexing of the portion 8 of the blade 6 during rotation at high speeds, the flexing being illustrated by the dotted lines.

It will be apparent that bead configurations, other than rectangular, may be realized by suitably shaping the lower longitudinal surface of the anvil 16 and the bottom of slot 22.

What is claimed is:

1. A method for deforming metal sheet to define a curved blade having a continuous bead along one edge thereof, including the steps of:
   a. supporting the sheet on a surface having a gap,
   b. forcing a portion of said sheet downwardly through said gap so that a bight portion is formed in the sheet,
   c. grasping said sheet adjacent said bight portion and drawing it laterally against a cam surface,
   d. whereby a continuous bead is defined from said bight portion and portions of said sheet are bent.

2. The method of claim 1 wherein,
   a. said step (c) includes drawing the sheet through the gap.

3. The method of claim 2 wherein

a. the portions of the sheet extending from said bead are pressed together while said bight and said sheet are drawn along said cam surface.

4. A machine for deforming sheet metal including,

a. a supporting surface having a gap running thereacross,

b. said gap defining two edges which face each other,

c. a cylinder mounted for rotation and whose longitudinal axis is aligned with said gap,

d. a slot on the surface of said rotary cylinder, said slot being parallel with the longitudinal axis of the cylinder,

e. a reciprocating anvil of less thickness than said gap and adapted to reciprocate down into and up out of said gap.

5. The machine of claim 4 including,

a. a cam surface carried by a part of said supporting surface, one portion of said cam surface merging into one of said facing edges.

6. The machine of claim 5 including,

a. a second rotatable cylinder having a longitudinal axis parallel with that of said first cylinder, and contiguous thereto, said second cylinder being adapted to pull sheet metal through the space defined by and between said cylinders.

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