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GAP ROLLING METHOD

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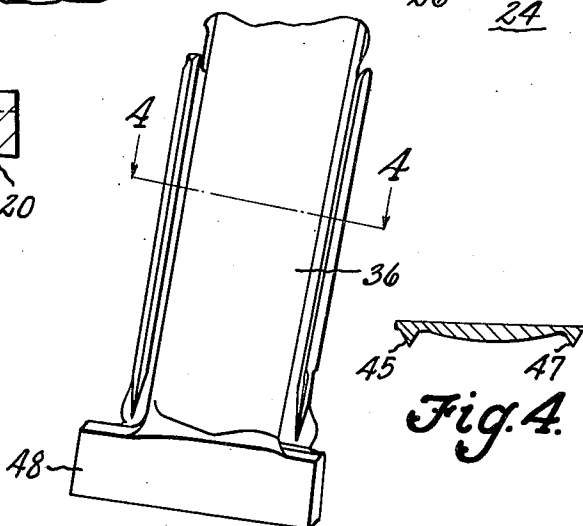
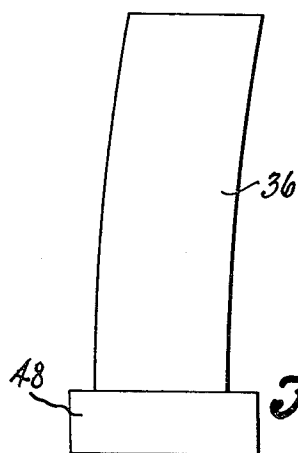
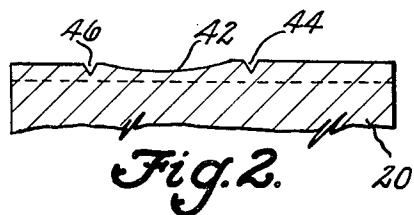
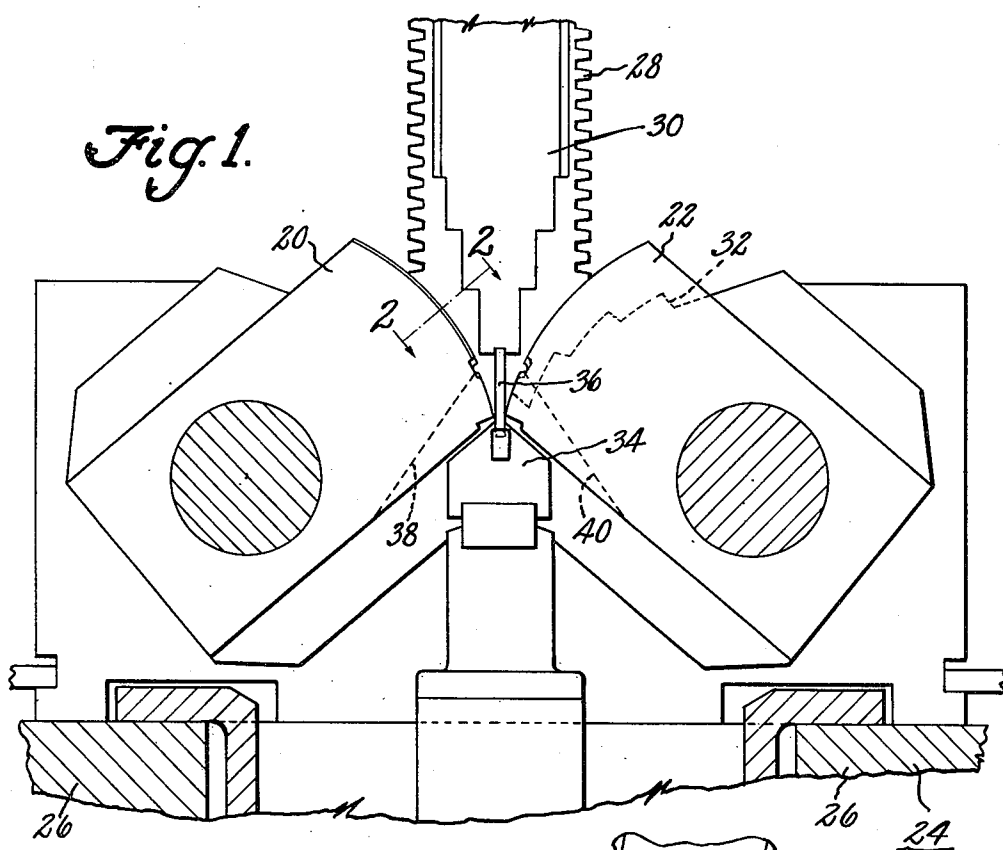


Fig. 3.

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1

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GAP ROLLING METHOD

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This invention relates to gap rolling and is particularly concerned with precision gap rolling wherein articles having closely controlled dimensions are formed.

In carrying out the invention, it is a basic object thereof to provide an apparatus and method for gap rolling articles requiring precision control in dimensions wherein a portion of the metal being gap rolled is trapped for forming a track for guiding the blank through the various operations whereby predetermined positioning thereof is always accomplished regardless of the number of gap roll passes used.

In carrying out this object, it is a further object to provide a method and apparatus for gap rolling strip material wherein a track of built-up material is formed at least on one side of the strip in the first pass through the gap rolls, which built-up material acts as a track for guiding the strip through subsequent gap rolling operations wherein the rolls are always provided with complementary tracking grooves.

A still further object of the invention is to provide a method and apparatus for preventing skewing during gap rolling of strip material.

Another object of the invention is to provide a method and apparatus for gap rolling airfoil sections, for example, vanes or blades for use in axial flow compressors and the like, wherein the blade is formed to precision dimensions by gap rolling and wherein the blade is maintained perfectly straight throughout the operations through the use of a track formed directly on the blade, said track being subsequently trimmed off.

Still another object of the invention is to provide a method and apparatus for gap rolling strip material wherein a plurality of ridges are provided on the strip during the first gap roll pass to form tracks thereon, which tracks are used in subsequent gap rolling operations to guide the blank in a predetermined path during the formation of the desired cross section thereof.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

Fig. 1 shows a pair of gap rolls, partly in section, with a workholder holding a workpiece therebetween.

Fig. 2 is a partial sectional view taken on line 2—2 of Fig. 1, showing the surface contour of one of the rolls.

Fig. 3 is a view in perspective of an airfoil section after rolling.

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3.

Fig. 5 is a view showing a distorted blade such as is often formed in the usual type of gap rolls.

In gap rolling operations, very successful formations of strip material can be carried out between two rolls wherein the cross section of the material is maintained substantially constant. However, in the manufacture of airfoil sections and the like, particularly where one side

2

of the blank is rolled to a thinner section than the other, there is a decided tendency for the blank to skew off as it passes through the rolls and curve away from the thinned out section. This tendency creates a decided difficulty in the use of gap rolls for precision operations wherein cross sections of material are desired to be formed having very definite dimensional tolerances, for example, in the manufacture of an airfoil section, such as is used in a blade for an axial flow compressor, the airfoil section is rolled so that one side thereof is thinner than the other and in this operation, it is difficult to maintain the blade straight when gap rolling same since the tendency to skew off in one direction is difficult to control.

The present invention is directed to an apparatus and method for controlling this tendency and in fact eliminating the same for providing means for gap rolling parts from metal stock wherein precision manufacture is easy to accomplish without any of the usual complicated control factors being present.

Gap rolling of blades or vanes for axial flow compressors is shown in copending applications, Serial Nos. 270,072 and 270,073, filed Feb. 5, 1952, wherein gap rolling steps are utilized in connection with other cold working steps to produce a compressor blade or the like. In copending application, Serial No. 270,074, filed Feb. 5, 1952, a specific gap rolling application is shown for twisting blades and as in copending application, Serial No. 299,316, filed July 17, 1952, a specific structure of gap rolling apparatus is disclosed wherein automatic adjustment of the position of the workholder is provided so that the work is always positioned accurately with respect to the rolls.

The present application is directed to an apparatus and method for gap rolling which may be used in conjunction with any of the aforementioned gap rolling operations with a minimum of effort and wherein as previously stated control factors are eliminated.

Referring specifically to the drawings, Fig. 1 shows a pair of gap rolls 20 and 22, partly in cross section, mounted in a punch press 24 having a stationary platen 26 and a movable upper member or plunger (not shown) attached to a rack 28 which is associated with the gap rolls 20 and 22. The rack 28 works in conjunction with gears not shown on the back side of the gap rolls while the stepped pusher device 30 works in connection with a cooperating stepped contour 32 carried by the rolls. Thus, upon gap rolling of a part, the pusher 30 actually causes the rolls to revolve as the plunger of the punch press forces the rack structure including the pusher downwardly to depress the workholder 34 through the workpiece 36 carried thereby. After the workpiece has been rolled, punch press 24 is reversed in its operation and the rack 28 operating on the gears (not shown) returns the rolls 20 and 22 to their original position. The rolls 20 and 22 have cut-aways at 38 and 40 to permit passage of the rolls past the workholder 34.

Referring specifically to the contour of the rolls, the contour of roll 20 is shown in Fig. 2, partly in section. It will be noted that this contour provides a curved airfoil section 42 bordered on either side by longitudinally extending grooves 44 and 46. These grooves are preferably of V-shaped cross section. The other roll 22 preferably has a surface complementary to the surface of the roll 20 except for the grooved portion which is substantially smooth.

When a strip of metal or workpiece 36 is placed in the workholder 34, and the rolls are in the position shown in Fig. 1, the apparatus is in readiness to be operated. Upon downward movement of the press plunger, the stepped pusher 30 causes the rolls 20 and 22 to rotate towards one another which distorts and elongates the

3

metal in the workpiece into a contour shown in cross section in Fig. 4. It will be noted that this contour is curved on one surface and is preferably flat on the other and has a pair of V-shaped ridges 45 and 47 adjacent the outer longitudinal extremities thereof. The workpiece 36 after rolling is clearly shown in Fig. 3, wherein Fig. 4 is a section taken therethrough. It will be noted that the workpiece 36 is preferably provided with a foot 48 which is held in the workholder 34. Obviously, if some part other than the blade is being formed, this foot may take another form or may be discarded.

Fig. 5 shows in outline the skewing effect on a blade, such as shown at 36, when passed through gap rolls without the aid of ridges. This is caused by the fact that the variation in thickness from one side of the blade to the other causes the blade to turn or skew off. In this connection, the ridges 45 and 47 during their formation actually act as progressively laid tracks to prevent the blade from skewing and in the preferred embodiment of the invention, the first pass through the rolls 20 and 22 forms the desired contour without too great reduction in thickness so that there is no substantial tendency towards skewing. Thus, the blade is preferably initially formed to include two straight tracks as noted at the ridges 45 and 47. After these tracks are once provided, the blade may be passed through successive sets of gap rolls, which are always provided with tracks for the ridges, to form any desired contour in the metal between the tracks since the tracks themselves guide and hold the blade against skewing off or any other distortion.

We have found that two tracks having each a V-shaped cross-section are preferable. However, in certain instances, a single track on one side of the blade may be used or two tracks may be provided at one side of the blade with either no track or any number of tracks at the other side of the blade. In other words, the number of tracks, cross section and the disposition thereof is best decided by trial for the specific type of cross section being formed. We have found in most instances that a single track on either side is satisfactory.

Furthermore, the cross section of the tracks may vary. While we have shown a V-shaped cross section, this section may be of semi-circular form or it may be straight-sided, etc., which is generally a matter of choice. The V-shaped cross section has been found to track well and is easily formed and is therefore shown in the preferred embodiment.

After the part has been completely formed by gap rolling to its final cross section, the ridges 45 and 47 may be trimmed off and in this connection, it is to be understood that the distance between the inner edges of the tracks is predetermined to form the desired similar width of the part being rolled.

It is quite apparent that while this entire disclosure is directed to an apparatus and method for causing workpieces to pass through rolls in a straight line, that the same tracking principle may be used to cause the workpiece to skew in any desired fashion wherein the groove on the roll is formed with a shape to cause this skewing effect whereby a predetermined distortion may be accomplished in a part where such distortion is desired. In other words, the tracking principle, as disclosed here,

4

may be used to form any desired shape by gap rolling wherein the shape is to be predetermined and wherein identical pieces are to be produced.

It is preferable to form the track in a gap rolling operation. However, it is obvious that this track may be formed in other ways. For example, it may be hot rolled into the strip prior to cooling thereof if a continuous track may be used. Or it may be coined or otherwise impressed into cut-off workpiece sections, the entire principle being to provide a track on the workpiece that may be used as a guide for its travel through gap rolls.

In some instances, the track or tracks may form a desired portion of the contour of the finished article. In these cases, the final trimming step may be eliminated.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In the method for cold forming an elongated workpiece to desired cross-sectional shape by a plurality of rolling operations, wherein the desired shape includes a differential thickness in the cross section which would normally create skewing of the workpiece, the steps of forming the workpiece to avoid skewing comprising forming excess metal into at least one rib along a longitudinal side of a blank as a rolling guide and reinforcing medium, subsequently subjecting the workpiece to rolling operations to change the blank to the desired shape, utilizing the rib during such operations as a rolling guide and reinforcing medium and finally separating the rib from the workpiece.

2. In the method for cold forming an elongated workpiece to desired cross-sectional shape by a plurality of rolling operations, wherein the desired shape includes a differential thickness in the cross section which would normally create skewing of the workpiece, the steps of forming the workpiece to avoid skewing comprising forming excess metal into two opposed ribs disposed along opposite longitudinal sides of a blank as rolling guides and reinforcing mediums, subsequently rolling the workpiece to change the blank to the desired shape utilizing the ribs during said operations as rolling guides and reinforcing mediums and finally severing the ribs from the workpiece.

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