May 28, 1963 R. A. O'NEILL 3,091,279

METHOD AND APPARATUS FOR FORMING CONICALLY SHAPED ARTICLES

Filed May 4, 1960 3 Sheets-Sheet 1

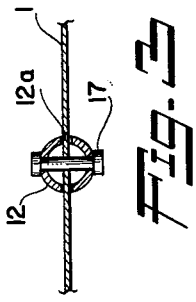


Fig. 3

Fig. 1

Fig. 4

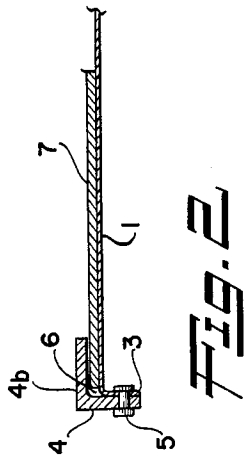


Fig. 2

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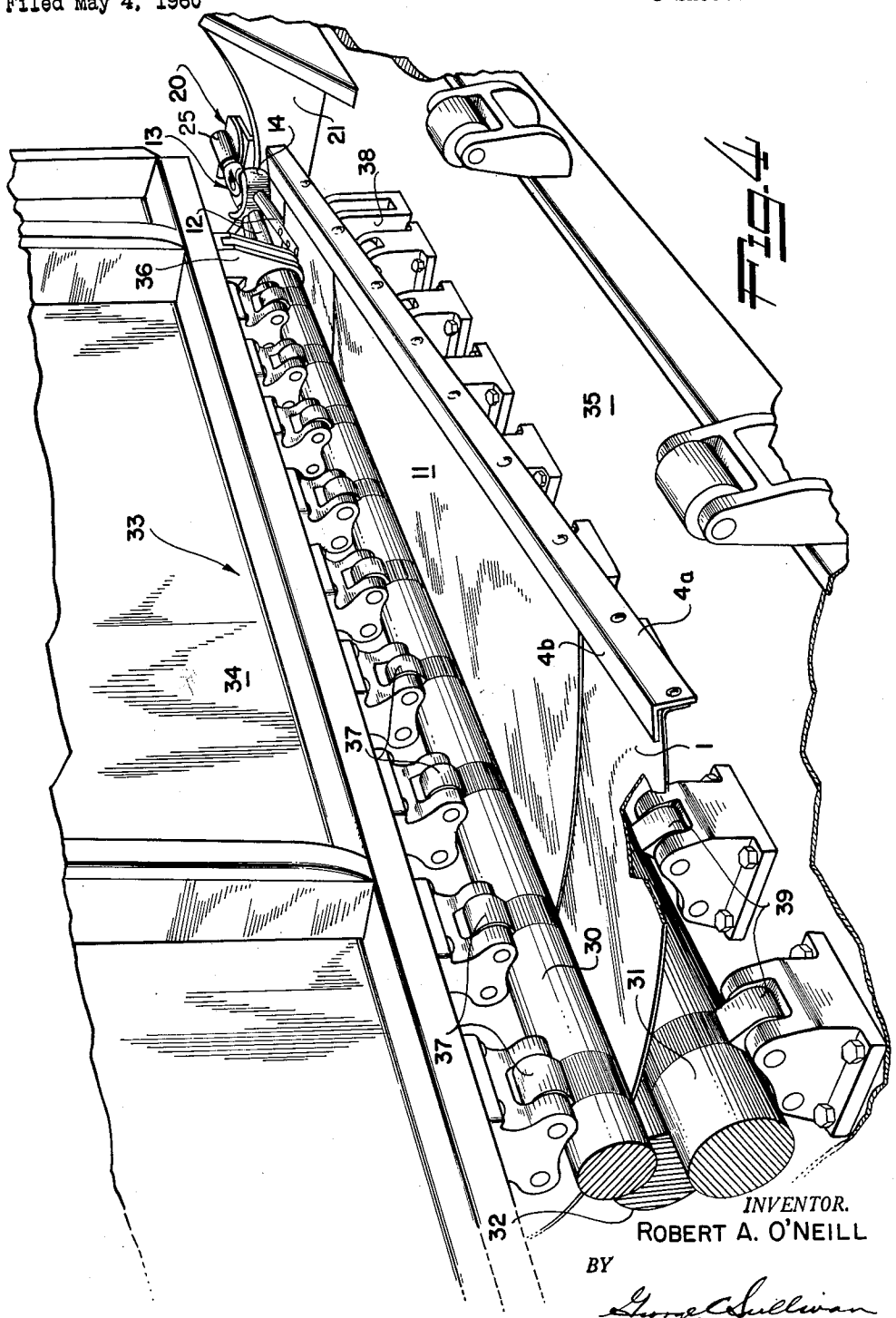


FIG. 4

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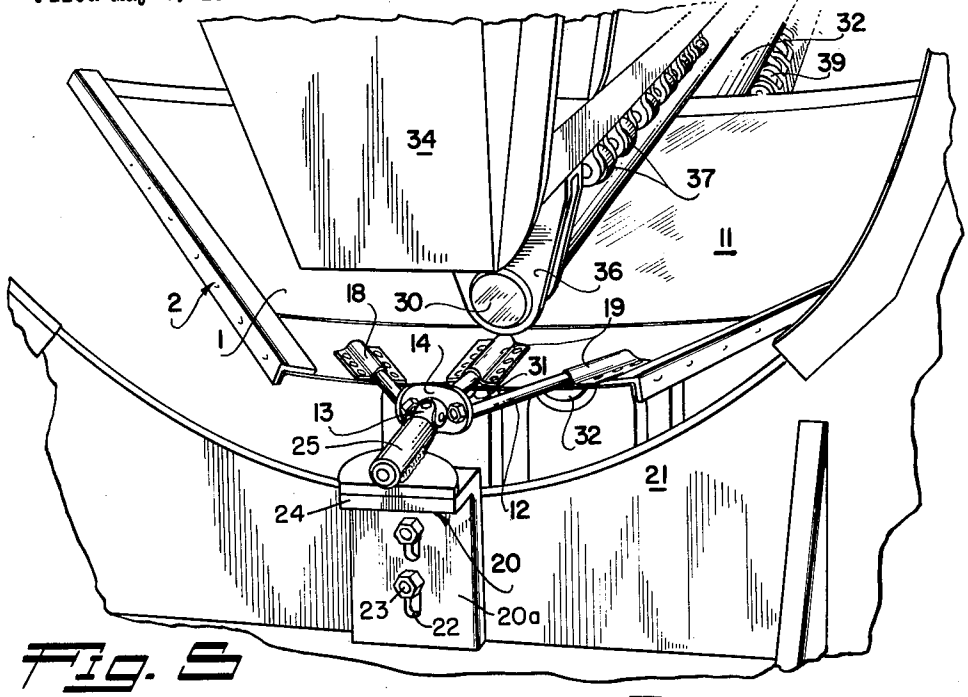


Fig. 5

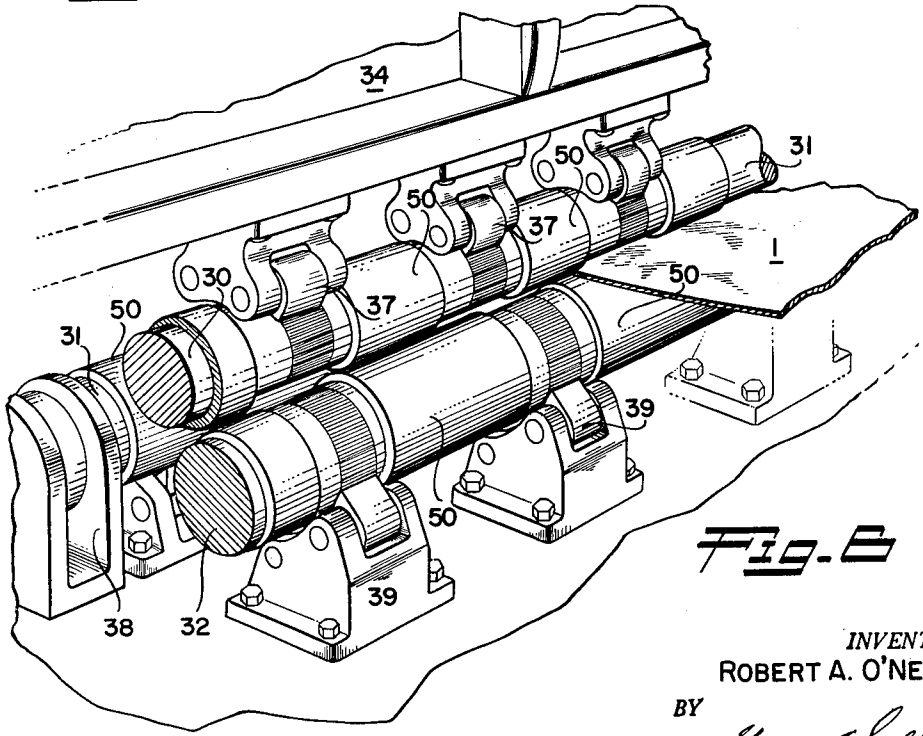


Fig. 6

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METHOD AND APPARATUS FOR FORMING CONICALLY SHAPED ARTICLES

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17 Claims. (Cl. 153—60)

This invention relates generally to the field of roll forming and is specifically directed to a novel method and apparatus for rolling conically shaped articles.

In metal working the process of producing conically shaped articles from relatively flat sheets of material has been beset by difficulty up to the present time. This has especially been true in cases where it was desired to roll heavier materials into cones having a long slant height in relation to vertical height.

Two of the more recent attempts in this particular field to produce mechanically perfect cones are illustrated by the patents to Knost, 2,759,514, and Erkes, 2,808,096, wherein cones are produced by first mechanically cutting to close pattern tolerances a flat blank which is then forced through the bending rolls of a metal forming machine with the consequent conical formation dependent upon the frictional relationship between a precisely curved surface of the blank member and a roll or arcuate segment on the forming machine. One of the disadvantages inherent in this type of operation is the fact that cones rolled thereby cannot be reworked or repassed through the machine to correct any defects which might have presented themselves from the initial pass. Additionally, as noted above, the utilization of these teachings requires a precise prestamping or preformation of a blank which it is desired to roll into a conical form.

A standard method which is commonly utilized in rolling blanks which are not precisely precut involves a tedious "bumping" operation with a power brake, making as many individual bends as possible. Templets are then used to check the large and small diameters of the cone thus produced, and the method at best has been found to be exceedingly slow, very expensive, and productive of undesirable ridges and irregularities in the surface of the resultant articles.

The increasing use of streamlined or tapering surfaces of revolution in the field of ordnance, ballistic vehicles, and the like has accentuated the need for a practical, inexpensive, and reliable procedure for producing accurate cones and conical segments.

Additionally, these uses have produced requirements for cones which have small internal prestresses applied thereto. Those familiar with the art are well aware of the difficulty and necessity to force conical segments produced by the "bumping" or "pie section" methods noted above into a predetermined configuration.

In view of the above, it is a primary object of the present invention to provide a method and apparatus for rolling conically shaped articles which is substantially faster and less expensive than the methods previously discussed.

It is an additional object of this invention to afford a cone rolling means which requires little skill to produce articles meeting strict military tolerance requirements.

Still another object of this invention is to provide such a conically shaped article which is substantially free from surface irregularities, internal stresses, and the like which adversely affect the structural properties of a resultant cone.

Another object of this invention is to provide a cone rolling process and apparatus which enables the use of more or less irregularly shaped blanks without the necessity of precisely pretrimming the blanks and which additionally affords an opportunity to reroll and make any

necessary corrections in a blank which has once passed through a rolling operation.

Manifestly, the invention may be used in connection with existing roll forming machines which require only minor modification to incorporate the teachings herein.

With these and other objects and the above discussion in mind, the invention will be described in detail hereinbelow with reference to the accompanying drawings wherein like numerals denote like parts throughout and wherein

FIG. 1 is a top view looking down upon a control fixture constructed in accordance with the teachings of this invention,

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1,

FIG. 3 is a sectional view taken along line 3—3 of FIG. 1,

FIG. 4 is a pictorial representation of a cone being rolled according to the teachings of the present invention,

FIG. 5 is a similar view of a cone rolling operation showing the manner of attachment of the control fixture to a cone rolling machine,

FIG. 6 is a side view of a forming machine modified according to a feature of the present invention, and

FIG. 7 is a top plan view of a modification of the control fixture constituting a part of the subject invention.

Referring first to FIGS. 4 and 5, the basic concept of the apparatus and method of operation of the present invention in rolling or forming a substantially mechanically perfect conical segment is shown.

These figures illustrate a control fixture 1 operably positioned between the forming rolls 30, 31, and 32 of a rolling machine generally indicated by numeral 33.

Rolling machine 33 essentially comprises a plurality of rollers, hereinabove designated 30, 31, and 32 which are mounted upon and backed by heavy backing members 34 and 35. From the figures, it will be seen that upper roll 30 is rotatably mounted upon backing member 34 by means of end fixtures 36, and intermediate the end fixtures are provided a plurality of smaller backing roll fixtures 37 at spaced intervals along the rotatable forming surface of roll 33.

In a like manner, bottom rolls 31, 32 are attached to backing member 35 by means of end fixtures 38 and are supported along their length at spaced intervals by a plurality of smaller backing rollers 39. According to conventional practice, these rollers are angularly adjustable so that they may be positioned to converge or diverge as desired. Roll forming machines such as has been described to this point are commercially available.

A control fixture 1, according to this invention, is provided and combined with a roll forming machine of the type described which constitutes a very significant advancement in the art of providing conical shapes.

Referring to FIG. 1, a control fixture designated 1 is shown which consists basically of a flat pattern of a conical segment to be rolled, this fixture preferably being made of a thin heat-treated sheet metal material to provide strength and rigidity with a minimum of resistance to rolling force and to minimize the "set" which might otherwise be rolled into the fixture. It has been found most advantageous to manufacture cones in two segments which are later welded or otherwise fastened together.

Control fixture 1 will be seen to have a generally trapezoidal shape with two substantially linear, generally converging side edges 2. Means are provided along these side or edge portions 2 to slidably or loosely secure a "blank" flat sheet stock 7 into the fixture for forming into the conical segment desired.

An example of such means is shown in FIG. 2 where it is seen that control fixture 1 is provided with downwardly directed flanges 3 on the under side thereof, and formed

preferably at a substantially normal angle to the main body of fixture 1. (These flanges could also be formed upwardly.) Secured to flange 3 is an angle member 4 preferably a conventional "angle iron" which has one leg thereof 4*a* secured to flange 3 by means of a bolt, rivet, or weldment 5. The other leg 4*b* of angle member 4 is seen to be spaced from the upper surface of control fixture 1 and to be inwardly directed toward the center portion thereof, thus providing a "slot" 6 into which the edges of a blank sheet stock 7 may be inserted.

It is to be understood throughout that the numeral 7 designates a "blank" or flat sheet which is the "work piece" to be formed or rolled into the conical segment. This member may be metal of widely varying thicknesses, plastic, or any other material which will support the rolled conical configuration desired.

One of the features of the present invention resides in the fact that the flat sheet stock to be formed is loosely secured to control fixture 1 without its having to be precisely and accurately precut either along edges 10 or 11. It has been found useful to provide some excess material along sides 10 which are later cut off as the cone is finished or assembled. The prior cone rolling methods mentioned hereinabove generally require an extremely accurate circular edge at positions 11 noted on the drawing in order to control the feed-through of the blank to be formed. Since, according to this invention, the formation of the cone is controlled by securing the control fixture and blank stock at a rotatable apex, this undesirable feature has been eliminated.

Continuing the description in connection with FIG. 1, control fixture 1 is provided with a plurality of radial stiffener arms 12 which are attached thereto along inner edge 11 and extend in a generally converging relationship toward a universal joint 13. As shown in FIGS. 1 and 5, the actual connection of the radial stiffener arms 12 to the U-joint 13 is made by way of curved plate 14 which is attached to one "side" of the U-joint. (A "square" or angular plate may also be used.) As shown, two outer arms 12 are connected to plate 14 by way of bolts 15 while the center arm 12 is attached to plate 14 by welding as indicated at 16.

The other "side" of U-joint 13 is a generally cylindrical member 18 which passes through anchor block assembly 20 permitting rotation of member 18.

By referring to FIG. 5, it will be seen that an anchor block assembly 20 is firmly secured to frame 21 of the roll forming machine 33. Basically this assembly 20 provides a means for firmly holding side 18 and U-joint 13 in proper position in relation to the rolls 33, 31, and 32. In the modification shown, anchor block assembly 20 is seen to consist of a vertical member 20*a* havng at least two slots 22 therein through which bolts 23 are positioned to secure the assembly to frame 21. At the top of bracket 20 is a substantially horizontal member 24, upon which is mounted a sleeve 25 by welding, or otherwise, and which is adapted to receive member 18 of the U-joint assembly. This member 18 must be rotatable within sleeve 25, as in a pillow block.

FIG. 3 shows the method of attaching radial stiffener arms 12 to control fixture 1. A slot 12*a* is longitudinally provided in each of arms 12 into which the edge of control fixture 1 is inserted. A rivet or bolt 17 may be used to concurrently force the two split segments of arm 12 into frictional engagement with control fixture 1 while additionally providing a stop means for control fixture 1 due to the bolt penetration thereof.

Alternatively, as shown in FIG. 5, and in addition to the method of attachment shown in FIG. 3, plate members 19 may be used to strengthen the attachment of arms 12 to control fixture 1. In this modification, a number of rivets are preferably used to secure plates 19 to control fixture 1, the plates being applied over and enclosing radial stiffener arms 12. The most important stiffener arms are the outer arms which may, if desired, be extensions of the angle iron members attached to the flanges of the control fixture sheet.

FIGURE 7 shows a modification of the invention wherein the outer radial stiffener arms are integral extensions of the angle members. In this figure it will be seen that a control fixture generally indicated at 70 comprises a backing or control plate 71 which has an upstanding flange 72 integrally formed on either side thereof. Attached to these upstanding flanges 72 are radial stiffener arms 73 which may consist of standard angle bars. These arms 73 have one (upstanding) flange attached to flange 72 by means of rivets as shown, by bolts, weldments, or the like, the other flange extending inwardly substantially parallel with the surface of the control plate 71. Stiffener arms 73 are secured to flanges 72 in such a way that a space is provided between the bottom portion of arms 73 and the face of control plate 71. In this manner a blank to be formed into a cone 74 may be removably inserted into the slot or space provided between the radial angle arms and control plate 71. It will be seen that radial arms 73 converge generally toward universal joint 75 which has one portion 76 thereof journaled in a block assembly generally indicated at 77 which is attached to the frame of the rolling machine as by bolts 78. The "operating" side 79 of U-joint 75 is attached to an angle member 80 as by welding or the like and an extension or stiffening member 81 is bolted or welded to one side of control plate 71. Radial arms 73 are attached to angular plate 80 by means of bolts 82 or the like. It is noted these connections may be "loose" enough so as to allow rotation of radial arms 73 in relation to angle bar 80. Operation of the fixture thus described is identical to the manner of operation as described hereinbelow.

Obviously, within the scope of the present invention it is contemplated that considerable modification can be made from the basic structure shown. For instance, in place of angle members 4 being utilized to attach a flat blank stock to control fixture 1 the flanges of the control fixture may be bent upwardly in two 90° angles so as to integrally form the slot which has been provided as shown at 6 in FIG. 2. Similarly, as a universal joint has been described, it is also contemplated that a conventional "ball" type joint may also advantageously be adapted to replace and perform the same function as U-joint 13.

Operation

In rolling a cone utilizing the herein disclosed invention, the dimension of the apex of the cone on a slant height from the base thereof is first calculated. This apex point is then established outside the open end of the rolls and in the plane of their surface, the plane containing a line equidistant from their center lines, and all the subsequent work of rolling is done in relation to this point. A blank sheet to be rolled is roughly cut to provide it with generally converging edges 10, U-joint 13 at the apex of the fixture is firmly secured to the frame 21 of a roll machine 34 in the manner indicated. Rolling is then begun by applying power individually or collectively to the rolls 30, 31, and 32 as conventionally done in operating roll machine 33. The apex of the control fixture 1 being secured and pivoted about the apex point of the cone will cause the material 7, as shown in FIG. 1, to be forced to arc around the apex as rolling action proceeds, and the combination of the coordinated actions produces a mechanically perfect cone, free from compromises or conflicting stresses.

By actual test on a large cone structure produced by the inventor, it was found that approximately eight hours were required to roll a cone which was often unacceptable because of the various imperfections resulting from previous processes. Utilizing the method and apparatus of the present invention, it was found that approximately eight mechanically perfect cones could be rolled in one

eight-hour period. Thus, it has become obvious that the apparatus disclosed herein is very inexpensive and the method essentially uncomplex to perform.

Also, it has been found desirable in practicing the present invention to set rollers such as **30**, **31**, and **32** at an angle to each other so that their inner rolling working surfaces will tend to converge at a point outside the rollers.

It has been found that cones of varying degrees of slope, i.e., different vertical heights, may be produced according to the present invention by adjusting roll **30** relative to rolls **31** and **32**. Thus, rolls **31** and **32** are separated, desirably so that they tend to generally converge toward the apex at **13**. Roll **30** is adjusted so that in addition to its general convergence toward the apex, it "penetrates" into the area between rolls **31** and **32**, the degree of penetration and convergence, as noted, generally controlling the diameter and slant height of the conical segment thus produced. There is a constant slippage on the cone surface as it rotates through the rolls. As noted hereinabove, a feature of the invention resides in the fact that a conical segment being formed may be passed through the roll machine more than one time if desired to change the final configuration produced.

As a blank sheet passes through the forming rolls and frictionally engages therewith, a "slipping" will occur which generally increases toward the edges of the sheet. Thus, at some midpoint in the blank to be formed, no slippage will occur, while on the "apex" side a retardation of movement takes place and toward the outer or opposite side an increase in speed (slippage) is effected. Should it be desirable to generally eliminate this frictional slippage, it has been found that modification can be made of the rollers **30**, **31**, and **32**.

Referring to FIG. 6, a roll forming machine is represented having rolls **30** and **31**, **32**. Roll **30** is journaled by bearings **38** along the under surface of backing member **34** and is also provided with backing rollers **37**. Inserted upon roll **30** between backing rolls **37** are a plurality of sleeves **50** which are free to rotate upon roller **30** which is itself rotated during operation. The other rollers **31** and **32** are provided with similar sleeves in like manner.

In operation as the rollers rotate, the "slippage" and friction between blank sheet **7** and rolls **30**, **31**, and **32** is practically eliminated since sleeves **50** are free to rotate relative to rolls **30** and **32** and the other sleeves **50**. In this manner, between the apex and the midpoint, the blank may rotate in one direction while the sleeve or sleeves between the midpoint and the "remote" edge may revolve in the opposite direction.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not to be limited thereto as many variations will be readily apparent to those skilled in the art, and the invention is to be given the broadest interpretation within the terms of the following claims, wherein I claim:

1. The method of forming a conically shaped article from flat sheet material which comprises the steps of inserting at least a portion of a blank sheet between the forming rolls of a bending machine, rotatably and pivotally securing said sheet at an anchor point without said rolls, and passing said sheet between said rolls as it pivotally rotates about said point.

2. The method of forming a conically shaped article from a flat sheet blank as claimed in claim 1 which includes the steps of securing said blank sheet on a control fixture having at least two substantially linear converging edges with a rotatable joint substantially at the point of convergence thereof, anchoring said rotatable joint at a point outside the forming rolls of a bending machine in such a manner that at least a portion of the control fixture is securely positioned between said rolls, and passing said fixture and said blank sheet between said rolls.

3. The method of forming a conically shaped article as claimed in claim 2 in which said sheet blank is loosely secured onto said control fixture.

4. Apparatus for forming conically shaped articles from flat sheet stock comprising, in combination with a forming machine having a frame and at least two forming rolls rotatably attached thereto, a generally flat control fixture, said fixture having at least two substantially linear converging edges, attachment means on said fixture adjacent said edges for securing a blank sheet thereto, and anchor means securing said fixture for pivotal and rotational movement in relation to the forming rolls of said forming machine.

5. Apparatus for forming conically shaped articles from flat sheet stock as claimed in claim 4 in which said anchor means comprises a universal joint attached to said fixture at substantially the point of convergence of said linear converging edges, and an anchor block without said rolls located on a line extending substantially equidistantly therebetween, said universal joint being detachably secured to said anchor block.

6. Apparatus for forming conically shaped articles from flat sheet stock comprising, in combination with a forming machine having a frame and at least two forming rolls rotatably attached thereto, a control fixture, attachment means for securing a blank sheet thereto, and anchor means for rotatably securing at least a portion of said fixture for pivotal movement through a line substantially equidistant between said rolls.

7. Apparatus for forming conically shaped articles from flat sheet stock as claimed in claim 6 in which said attachment means comprises a flange integral with said control fixture and extending substantially normally from the surface thereof, and an angle member having one leg thereof secured to said flange and the other extending inwardly of said jig member and spaced from the face thereof, thus forming a groove into which the edge portions of said blank stock are adapted to extend.

8. A cone rolling attachment for roll forming machines comprising a control fixture having at least two substantially linear converging edges, attachment means mounted along said edges for slidably positioning a substantially flat blank sheet on said fixture, and pivot means located substantially at the point of convergence of said linear edges.

9. A cone rolling attachment for roll forming machines as claimed in claim 8 in which said attachment means comprises a flange extending substantially normally from the under surface of said control fixture, and an angle member having one leg attached to said flange and the other leg extending inwardly over the upper surface of said control fixture to form a slot into which the edges of a blank sheet are adapted to be inserted.

10. A cone rolling attachment for roll forming machines as claimed in claim 9 in which a plurality of stiffening arms extend radially from said pivot point at least to the edge of said control fixture.

11. A cone rolling attachment for roll forming machines as claimed in claim 10 in which the outer two radial stiffener arms extend from and are integral with said angle members.

12. A cone rolling attachment for roll forming machines as claimed in claim 11 in which said pivot point is a universal joint.

13. Apparatus for forming conically shaped articles from flat sheet stock comprising, in combination with a forming machine having a frame and at least two forming rolls rotatably attached thereto with their respective axes adjustably converging in the direction of a common apex point, an anchor block located substantially at said apex point, a control fixture having at least two substantially linear converging edges, a universal joint attached to said control fixture substantially at the point of convergence of said edges, means for detachably securing said universal joint to said anchor block, and

means attached to said control fixture for slidably positioning a blank sheet stock thereon.

14. A cone rolling accessory for roll forming machines comprising a control fixture of generally trapezoidal configuration having a pair of substantially linear, converging edges, a universal joint located substantially at the point of convergence of lines extended from said edges, a plurality of radial stiffening arms secured at one end thereof to said fixture and at the other to one side of said universal joint, said converging edges having flanges bent therefrom, an angle member having one leg secured to said flange and the other leg extending inwardly over the upper surface of said fixture in spaced relation thereto.

15. Apparatus for forming conically shaped articles from flat sheet stock comprising a forming machine having a frame and at least two forming rolls attached thereto, a plurality of freely rotatable sleeves coaxially mounted upon at least one of said rollers, a generally flat control fixture, said fixture having at least two substantially linear converging edges, attachment means on said fixture adjacent said edges for securing a blank sheet thereto, and anchor means securing said fixture for pivotal and rotational movement in relation to the forming rolls of said machine.

16. Apparatus for forming conically shaped articles from flat sheet stock comprising a forming machine having a frame and at least two forming rolls attached thereto, a plurality of freely rotatable sleeves coaxially mounted upon at least one of said rollers, a generally flat control fixture, said fixture having at least two substantially linear converging edges, one surface of said control fixture being adapted to frictionally engage a blank sheet, and anchor means attaching said fixture for pivotal and rotational movement in relation to the forming rolls of said machine.

17. A cone rolling attachment for roll forming machines comprising a control fixture having at least two substantially linear converging edges, one surface of said control fixture being adapted to frictionally engage a substantially flat blank sheet thereupon, and pivot means connected to said cone rolling attachment in the vicinity of the point of convergence of said linear edges.

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