Aug. 11, 1964 C. E. BAWTINHEIMER 3,143,901

METHOD OF FORMING WORKPIECES

Original Filed July 18, 1958 2 Sheets-Sheet 1

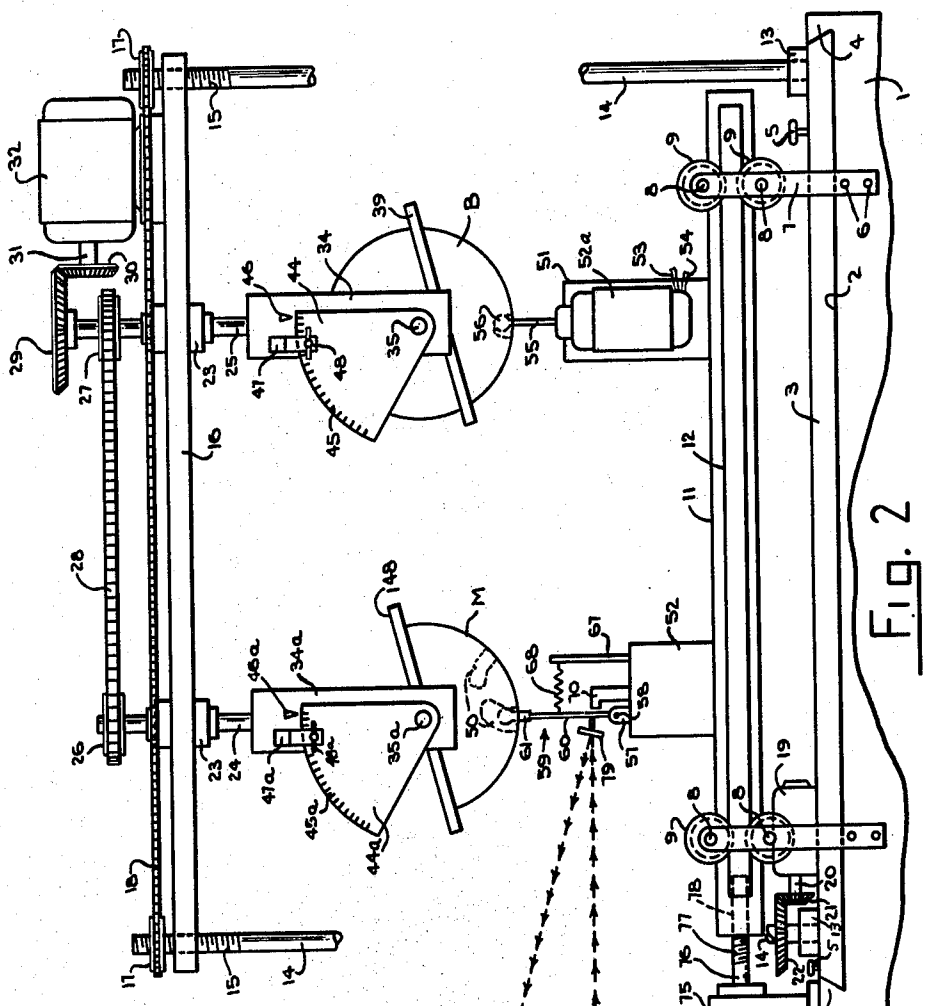


Fig. 2

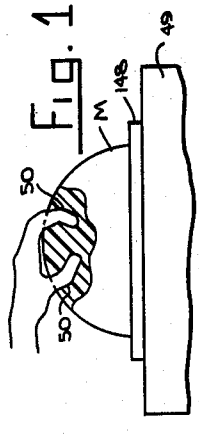


Fig. 1

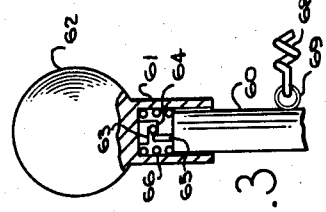


Fig. 3

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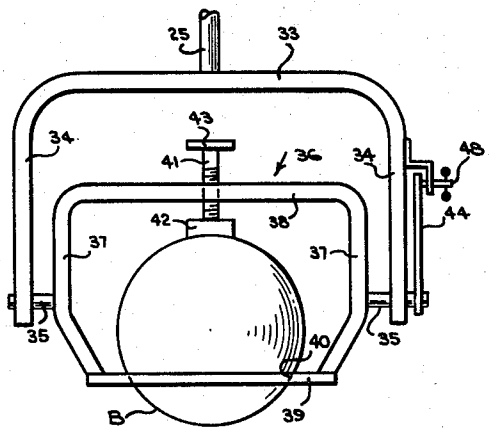


Fig. 4

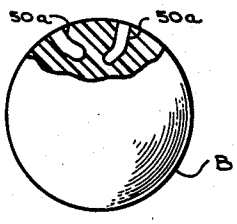


Fig. 5

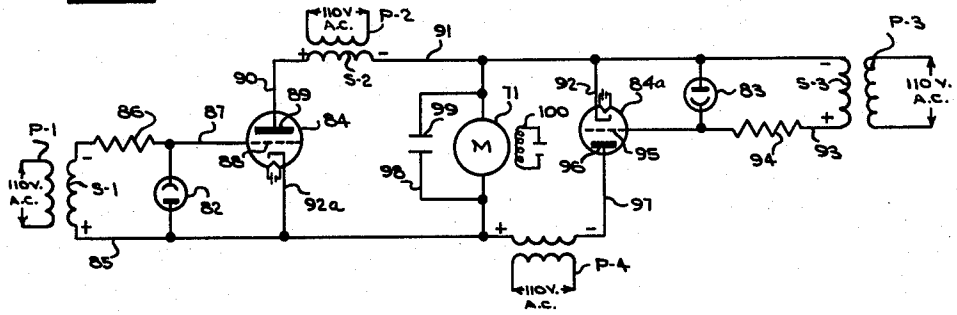


Fig. 6

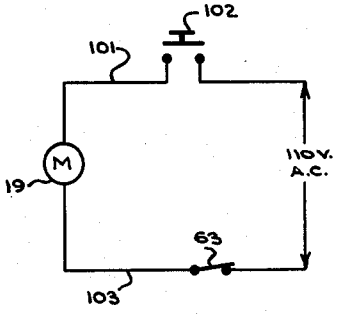


Fig. 7

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3,143,901

METHOD OF FORMING WORKPIECES

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Original application July 18, 1958, Ser. No. 749,496, now Patent No. 3,023,647, dated Mar. 6, 1962. Divided and this application Sept. 27, 1961, Ser. No. 141,126

3 Claims. (Cl. 77—32.2)

This application is a division of copending application Serial No. 749,496, filed July 18, 1958, now Patent No. 3,023,647.

This invention relates to a method of forming workpieces in strict accordance with a preformed model or pattern and more particularly the invention pertains to a method of drilling finger holes in bowling balls at such locations and of such configuration that the drilled holes will conform to the span and normal curvature of the user's fingers.

Most of the bowling balls currently in use are provided with finger holes which are drilled straight into the ball and with diameters to accommodate the thumb and one or more other fingers of a user's hand. Bowling balls formed in this manner are rather difficult to use with any great degree of control inasmuch as the ball must be supported solely by the pressure exerted by squeezing the thumb and fingers towards one another. The difficulties inherent in bowling balls formed in the described manner have been recognized heretofore and various proposals have been made to overcome them. For example, it has been proposed that rubber or the like pads be inserted in the finger holes to provide for a more secure grip and some of these pads have been shaped to approximate the curvature of the user's fingers. More frequently, the bowling ball users will coat their fingers with a chalk or rosin substance whereas others attempt to obtain a form-fitting grip by whittling the finger holes in a bowling ball. It also has been proposed to form the finger holes of a bowling ball along the arc of a circle, thereby approximating to some extent the natural curvature of a user's fingers. The difficulty with this particular construction, however, is that it, like the straight hole method, forms holes in a bowling ball which only approximate the spacing or span of a prospective user's fingers.

Ideally, a bowling ball should have its finger holes spaced according to the spacing of the intended user's fingers and of a diameter to accommodate the fingers freely, and the holes should be formed on a curvature corresponding to the natural curvature of the user's fingers. Such a bowling ball naturally would fit the user's hand better, provide a better grip, and enable the user to have more control over the ball inasmuch as there would be less chance of the ball slipping from his grasp prior to the time he intended to release it.

An object of this invention is to provide a method of forming finger holes in the bowling ball and which are so located and contoured as to correspond to the spacing and natural configuration of a user's fingers.

A further object of the invention is to provide a method of forming a workpiece such as a bowling ball in strict accordance with a preformed pattern or model.

Other objects and advantages of the invention will be pointed out specifically or will become apparent from the following description when it is considered in conjunction with the appended claims and the accompanying drawings, in which:

FIGURE 1 is a fragmentary, diagrammatic view illustrating the manner of forming finger holes in a pattern or model bowling ball;

FIGURE 2 is a fragmentary side-elevational view of apparatus formed in accordance with the invention;

FIGURE 3 is an enlarged, fragmentary, partly sectional view of a portion of the apparatus shown in FIGURE 2;

FIGURE 4 is an enlarged, fragmentary, front elevational view of a detail of the apparatus shown in FIGURE 2;

FIGURE 5 is a partly sectional view of a bowling ball formed in accordance with the invention;

FIGURE 6 is a wiring diagram for a portion of the apparatus; and

FIGURE 7 is a wiring diagram for another part of the apparatus.

Apparatus suitable for practicing the method of the invention is illustrated in FIGURE 2 as comprising a base 1 having its upper surface slotted as at 2 to receive a slide 3 which is slideable back and forth in a horizontal plane between dovetail guides 4 provided on the base. The supporting plate 3 is of less width than the base 1 and may be secured in a selected position of adjustment relative to the base 1 by means of a number of set screws 5, two of which are shown in FIGURE 2. Connected by means of bolts 6 to opposite ends of the base 1 are two pairs of supporting arms 7, each of the supporting arms been provided with axles or shafts 8 on which are rotatably journaled rollers 9, the rollers on each of the arms 7 being vertically spaced from one another. Above the level of the base 1 is located a supporting plate 11 having a laterally extending flange 12 at its opposite ends which is received between the rollers 9 so as to be supported thereby for to and fro movements in a horizontal plane parallel to the plane of movement of the slide 3.

Adjacent to each of the four corners of the slide 3 is provided a journal block 13 in which is rotatably mounted a shaft 14 which is threaded at its upper end as indicated at 15. The upper, threaded end of each of the shafts 14 extends through a threaded opening formed in a mounting platform 16, and each of the projecting ends of the shafts 14 is provided with a sprocket wheel 17 around which is trained a sprocket chain 18. The platform 16 is so mounted that it is horizontal, but is capable of movement in a vertical plane upon rotation of the shafts 14.

Means is provided for rotating the shafts 14 and comprises an electric motor 19 which may be mounted on the slide 3 adjacent one of the shafts 14. The armature shaft 20 of the motor has fixed thereto a bevel gear 21 which meshes with a similar gear 22 fixed on the adjacent shaft 14. The arrangement is such that operation of the motor 19 will cause rotation of the adjacent shaft 14 and the rotation of the one shaft 14 will be transmitted to each of the others via the sprocket wheels 17 and the chains 18 so as to cause movement of the platform 16 up or down, depending on the direction of drive of the motor 19.

The mounting platform 16 is provided with a pair of openings in each of which is fixed a bushing 23 by means of which a pair of shafts 24 and 25 are rotatably supported on the platform 16. Each of the shafts 24 and 25 may carry at its upper end a sprocket wheel 26 and 27, respectively, around which is trained a sprocket chain 28, and the shaft 25 may be provided with a bevel gear 29 fixed at its upper end in a position to mesh with a similar gear 30 fixed to the armature shaft 31 of an electric motor 32 supported on the platform 16. The arrangement is such that operation of the motor 32 will cause rotation of the shaft 25 and rotation of the latter shaft will be transmitted to the shaft 24 via the sprocket wheels 26, 27 and the chain 28.

Fixed to the lower end of the shaft 25 is a yoke 33 (see FIGURE 4) having a pair of spaced apart arms 34, each of which is provided with an opening adapted to receive a stub shaft 35. Corresponding ends of each stub shaft 35 are fixed to a mounting harness 36 comprising a

pair of spaced side arms 37 interconnected at corresponding ends by a transverse bar 38 and being rigidly connected at their opposite ends to a plate 39 having a centrally located opening 40 therein. The distance between the plate 39 and the transverse bar 38 is such as to accommodate a workpiece such as a bowling ball blank B therebetween, but the diameter of the opening 40 is less than the diameter of the blank B so as to prevent the latter from falling through the opening. The crossbar 38 of the harness is provided with a threaded opening through which extends a threaded shaft 41 having a clamping block 42 at its lower end shaped to correspond to the curvature of the blank B and adapted to bear against the latter to clamp the blank firmly in the plate opening 40. The upper end of the shaft 41 may be provided with a crank or handle 43 to facilitate turning the shaft.

The connection of the harness 36 to the yoke 33 is such that the harness and the blank carried thereby are rotatable about a horizontal axis corresponding to the axis of the stub shafts 35. In order to determine the angular position of the harness, one of the shafts 35 may have fixed thereto a protractor 44 having a scale 45 inscribed thereon adapted to be read in conjunction with a pointer 46 fixed on the adjacent yoke arm 34. To fix the harness in a selected position of adjustment, the arm 34 of the yoke may be provided with a brackett 47 in which is adjustably mounted a set screw 48 that is adapted to bear against the protractor 44.

The shaft 24 is provided with a pattern or model supporting apparatus similar to the workpiece supporting apparatus just described and corresponding elements of the model supporting apparatus are numbered the same as the elements of the workpiece supporting apparatus, but followed by the letter *a*. The difference between the two supporting devices is that the stub shafts 35*a*, instead of being fixed to a harness such as the harness 36, may be screwed or otherwise secured to a mounting board or panel 148 on which a model or pattern M is secured. The described mounting means for the blank and model harnesses are such that both the model and the blank are capable of conjoint, universal movement.

The model or pattern M comprises a hemispherical mass of initially workable but hardenable material such as wax, putty, plaster of Paris, or the like, which may be clamped or fixed in any suitable manner to the mounting board 148. To form the model, the mass of material, in a semiplastic state, is supported on a table 49 or the like and the user for whom a bowling ball is to be made inserts a desired number of his fingers into the mass to form finger holes therein. The user works his fingers in the mass to form holes of the desired shape and configuration and conforming substantially to the normal span and configuration of the user's fingers. Thereafter, the mass of material may be permitted to harden, whereupon the model M may be supported on its supporting apparatus in the manner shown in FIGURE 2.

On the upper surface of the supporting plate 11 is fixed a pair of mounting brackets 51 and 52, the spacing between them corresponding substantially to the spacing between the shafts 24 and 25. On the bracket 51 is supported an electric motor 52*a* having leads 53 and 54 connected through a switch (not shown) to a suitable source of electric energy. The armature shaft 55 of the motor is directed upwardly towards the bowling ball blank B and is fitted at its upper end with a cutting tool 56 of a suitable kind capable of boring into the blank. On the bracket 52 is fixed in any suitable manner a tab or ear 57 to which is pivotally connected, by means of a pin 58, one end of a feeler or follower device 59. The device 59 comprises a rod 60 which receives at its upper end a socket member 61 formed at the lower end of a knob 62 the same size and shape as the tool 56. At the base of the socket formed in the socket member 61 is a normally closed switch having blades 63 and 64 and adapted to be opened upon telescoping movement of the arm 60 and the socket member 61 by engagement with a post 65 formed at the upper end of the arm 60 and projecting towards the switch blade 63. The blade 63 and the post 65 normally are maintained out of engagement by means of a spring 66 which is interposed between the upper end of the arm 60 and the base of the socket formed in the socket member 61.

Also mounted on the supporting bracket 52 is a vertical post 67 to which is secured one end of a tension spring 68, the other end of the latter being fastened to an eye 69 fixed on the rod 60. The arrangement is such that the follower device normally is urged to rock about the axis of the pin 58 in a clockwise direction, as viewed in FIGURE 2, and the extent of clockwise rocking movement of the device 59 is limited by a stop member 70 mounted on the bracket 52 in a position between the device 59 and the post 67.

As has been pointed out earlier, the supporting plate 11 is mounted for to and fro movement between the several pairs of rollers 9. Means is provided for effecting to and fro movements of the member 11 and the parts supported thereby and comprises a reversible, D.C. motor 71 mounted on the base 1 and having its armature shaft 72 connected to a coupling 73 which also is connected to a driving shaft 74 forming part of a gear reduction mechanism 75 of known construction and supported also on the base 1. The gear reduction mechanism includes a driven shaft 76 which is threaded as indicated at 77 and which extends through a threaded opening 78 formed in the supporting member 11. The arrangement is such that operation of the motor 71 will cause the supporting plate 11 and its associated parts to be moved to the left or to the right, as viewed in FIGURE 2, depending upon the direction of rotation of the motor.

The apparatus includes means for actuating the motor 71 and preferably comprises a light reflective device such as a mirror 79 rigidly connected to the follower arm 60 and arranged to receive a beam of light directed from a lamp 80 or similar device through a lens 81 and reflect it in the geenral direction of a pair of spaced apart photoelectric cells 82 and 83. The construction and arrangement of the motor actuating mechanism are such that, when the follower device 59 is in a vertical position, the light beam reflected by the mirror 79 passes between the photoelectric cells 82 and 83 so that no more light falls on one than on the other.

The photoelectric cells 82 and 83 form part of a circuit illustrated in FIGURE 6. Other elements of the circuit include a pair of triode electron tubes 84 and 84*a* and the motor 71. The circuit derives its energy from one or more transformers, preferably one, but for purposes of illustration the circuit is disclosed as including four primary transformer windings P–1, P–2, P–3 and P–4. Associated with the primary winding P–1 is a secondary winding S–1 connected at one of its ends to a wire 85 which is connected to one of the terminals of the photoelectric cell 82 and also to one of the terminals of the motor 71. The other terminal of the transformer winding S–1 is connected through a resistor 86 to a line 87 which is connected to the other terminal of the photoelectric cell 82 and to the grid 88 of the triode 84. The plate 89 of the tube 84 is connected by a wire 90 to one side of a secondary winding S–2 associated with the primary winding P–2, the other side of the winding S–2 being connected to a wire 91 which leads to one end of a secondary winding S–3 and which also is connected to one terminal of the photoelectric cell 83, the cathode 92 of the tube 84*a*, and to the remaining terminal of the motor 71. From the other terminal of the secondary winding S–3 extends a line 93 which is connected through a resistor 94 to a terminal of the photoelectric cell 83 and to the grid 95 of the tube 84*a*. The plate 96 of the tube 84*a* is connected by a wire 97 to one terminal of

the secondary winding S–4, the other terminal of which is connected to the wire **85**. The wire **85**, as is shown in FIGURE 6, also is connected to the cathode **92***a* of the tube **84**. The terminals of the motor **71** are bridged by a wire **98** in which is located a capacitor **99**. Also included as part of the electrical circuit shown in FIGURE 6 is a constantly excited field winding **100** for the D.C. motor **71**. The apparatus shown in FIGURE 6 is essentially a pair of interconnected rectifier circuits arranged to balance one another except during certain conditions yet to be explained. If necessary or desired, suitable amplification stages may be incorporated in the circuit between the photocells and the motor **71**.

Another part of the electrical apparatus is disclosed in FIGURE 7 as comprising a wire **101** leading from the motor **19** through a push button switch **102** to a source of energy such as 110 volt A.C. From the other terminal of the motor **19** leads a wire **103** which is connected to the movable switch blade **63** to the source of energy.

To condition the apparatus for operation, the model M having preformed finger openings **50** therein is mounted on the stub shafts **35***a* of the model supporting shaft **24**. Thereafter, the slide **3**, the supporting plate **11**, the supporting platform **16** and the backing member **148** are adjusted relatively to one another so that the knob **62** of the follower device **59** enters one of the preformed finger openings **50** and bears against one of the walls of the opening in such manner that the arm **60** is located in a vertical position. Simultaneously, the bowling ball blank B is inserted in its harness **36** and the latter adjusted to the same angularity as the model mounting plate **148**, as is determined by the positions of the protractors **45** and **45***a*. In these conditions of the parts, the cutting tool **56** will be in a position to bear against the surface of the blank B to bore an opening in the latter.

When the apparatus has been conditioned in the manner described, the motor **52***a* may be started to drive the cutting tool **56**. As the cutting of the blank B progresses, the push button **102** may be actuated by the machine operator to cause the motor **19** to turn the shafts **14** in such direction as to cause the platform **16** to lower, thereby feeding the blank B to the cutting tool **56**. As long as the follower arm **60** is in a vertical position, light reflected from the lamp **80** will pass between the photoelectric cells **82** and **83**, energizing neither of them, with the result that, at any given instant, the grid of one triode tube **84** will be biased negatively and its plate positively, whereas the grid of the other triode tube will be biased positively and its plate biased negatively. As a result, the motor **71** is in a condition of electrical balance and no movement of the mounting plate **11** takes place. As the platform **16** is lowered, however, the wall of the finger opening which receives the knob **62** will fall away from the latter, thereby enabling the spring **68** to swing the arm about the axis of the pivot pin **58**. As the arm swings, the mirror **79** also will swing so as to reflect light from the lamp **80** to one or the other of the photoelectric cells **82** and **83**, thereby energizing the affected cell and completing a circuit to the motor **71** to cause it to drive the mounting plate **11** and its associated parts in one direction or the other tending to restore the arm **60** to its vertical position. As a result, the knob **62** of the follower device **59** will be enabled to follow the contour of the finger opening **50** and since the motor **52***a* follows the movements of the mounting plate **11**, the opening **50***a* drilled in the bowling ball blank will conform to the preformed opening **50** in the model M. As the drilling operation of the blank B proceeds, the motor **32** may be operated so as slowly to cause rotation of the blank B and the model M about the axes of their respective shafts **25** and **24**. Rotation of the shafts **24** and **25** will assure reproduction in the blank B of the holes formed in the model.

When the platform **16** has been lowered to an exent such that the knob **62** of the follower device **59** engages the base of the opening **50** in the model, further lowering movement of the platform **16** will compress the spring **66** interposed between the arm **60** and the socket part **61** so as to enable the projection **65** to engage the spring switch arm **63** and open the switch, thereby causing operation of the motor **19** to cease. Thereafter, the motor **19** may be operated in the reverse direction to withdraw the model and the blank in a direction away from the mounting plate **11** so as to free the follower device and the cutting tool from the bores of their respective holes.

When one of the holes **50***a* has been formed in the blank B, the model M may be readjusted relative to the follower device **59**, and the blank B adjusted an equal amount to the cutting tool **56**, so as to effect the cutting of a second opening **50***a* in the blank B corresponding to a second opening **50** in the model M. This procedure may be repeated for as many finger openings as are to be formed in the blank B. Ultimately, a bowling ball such as is shown in FIGURE 5 will be formed with finger openings **50***a* conforming exactly to the openings **50** which were preformed in the model M. In this connection, it is not necessary to conform to the configuration of the user's fingers those regions of the finger holes which would be adjacent the back of the user's fingers when the ball is in use, inasmuch as these regions of the finger holes are not in contact with the user's fingers. Accordingly, whenever reference to conformation of the finger holes to a user's fingers is made, it is intended to refer to those portions of the finger holes which would lie adjacent the inner surfaces of the user's fingers. However, it is not intended to limit the invention to conforming only the inner portions of the finger holes to the user's fingers, as the holes may be formed in such manner as to approximate the shapes of the user's fingers.

The disclosed embodiment is representative of a presently preferred method according to the invention, but is intended to be illustrative rather than definitive thereof. The invention is defined in the claims.

I claim:

1. The method of cutting curved finger openings in a bowling ball blank in accordance with the natural span and curvature of the prospective user's fingers, said method comprising the steps of forming a mass of material in a semiplastic state to simulate a bowling ball; inserting the prospective user's fingers in said material to form curved finger openings therein; mounting said material and said blank for conjoint universal movements relative to a cutting tool associated with said blank and to a follower associated with said material moving said blank and said material relatively to said tool and to said follower to cause the latter to enter a finger opening in said material; and controlling the relative movements of said cutting tool and said blank in accordance with the curvature of the openings formed in said material to cut openings in said blank according to the openings in said material.

2. The method of cutting curved finger openings in a bowling ball blank in accordance with the natural span and curvature of the prospective user's fingers, said method comprising the steps of forming a mass of material in a semiplastic state to simulate a bowling ball; inserting the prospective user's fingers in said material to form curved finger openings therein; introducing a follower to a selected opening in said material; presenting a cutting tol to said blank; effecting conjoint, universal movement of said material and said blank relative to said follower and said cutting tool to cause said follower to follow the curvature of said selected opening in said material; and relatively moving said cutting tool and said blank in accordance with the following movements of said follower to cut in said blank an opening corresponding to said selected opening in said material.

3. The method of cutting curved finger openings in a

bowling ball blank in accordance with the natural span and curvature of the prospective user's fingers, said method comprising the steps of forming a mass of material in a semiplastic state to simulate a bowling ball; inserting the prospective user's fingers in said material to form a number of curved finger openings therein; introducing a follower to a selected opening in said material; presenting a cutting tool to said blank; effecting universal conjoint movement of said material and said blank relative to said follower and said cutting tool to cause said follower to follow the curvature of said selected opening in said material; relatively moving said cutting tool and said blank

in accordance with the following movements of said follower to cut in said blank an opening corresponding to said selected opening in said material; and repeating said steps for the cutting of each of the remaining openings to be formed in said blank.

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