United States Patent

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[54] **METHOD AND APPARATUS FOR FORMING THIN-WALLED CYLINDRICAL ARTICLES**
5 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **72/41,** 72/342, 72/349
[51] **Int. Cl.** **B21d 22/28,** B21d 37/16, B21d 37/18
[50] **Field of Search** ..... 72/41, 42, 342, 347, 34 (B), 349; 113/120 (H)

[56] **References Cited**

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ABSTRACT: A method and apparatus for forming thin-walled containers from flat blanks is disclosed herein. The flat blanks are precoated with a dry film lubricant and drawn and ironed through a series of dies. Apparatus is provided to prevent the thermal breakdown of the lubricant comprising an internally fluid-cooled punch and fluid-cooled dies.

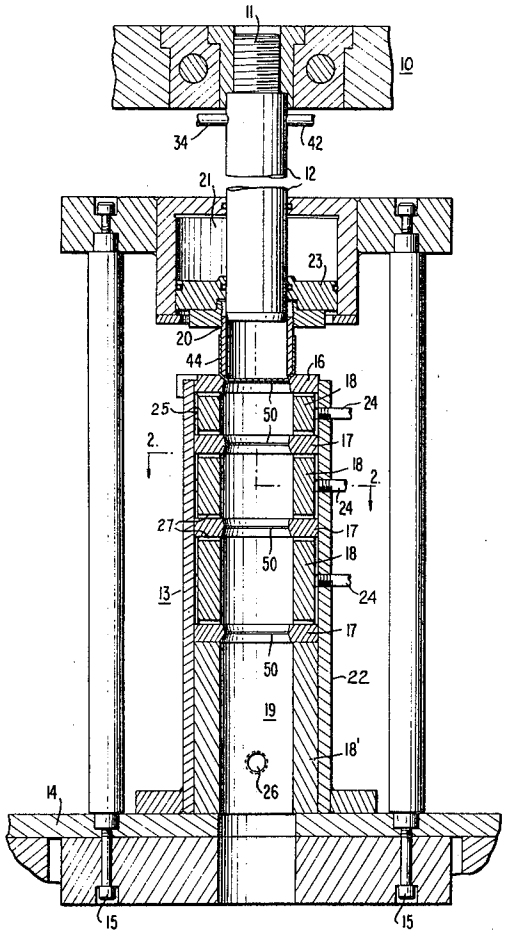

FIG. 1

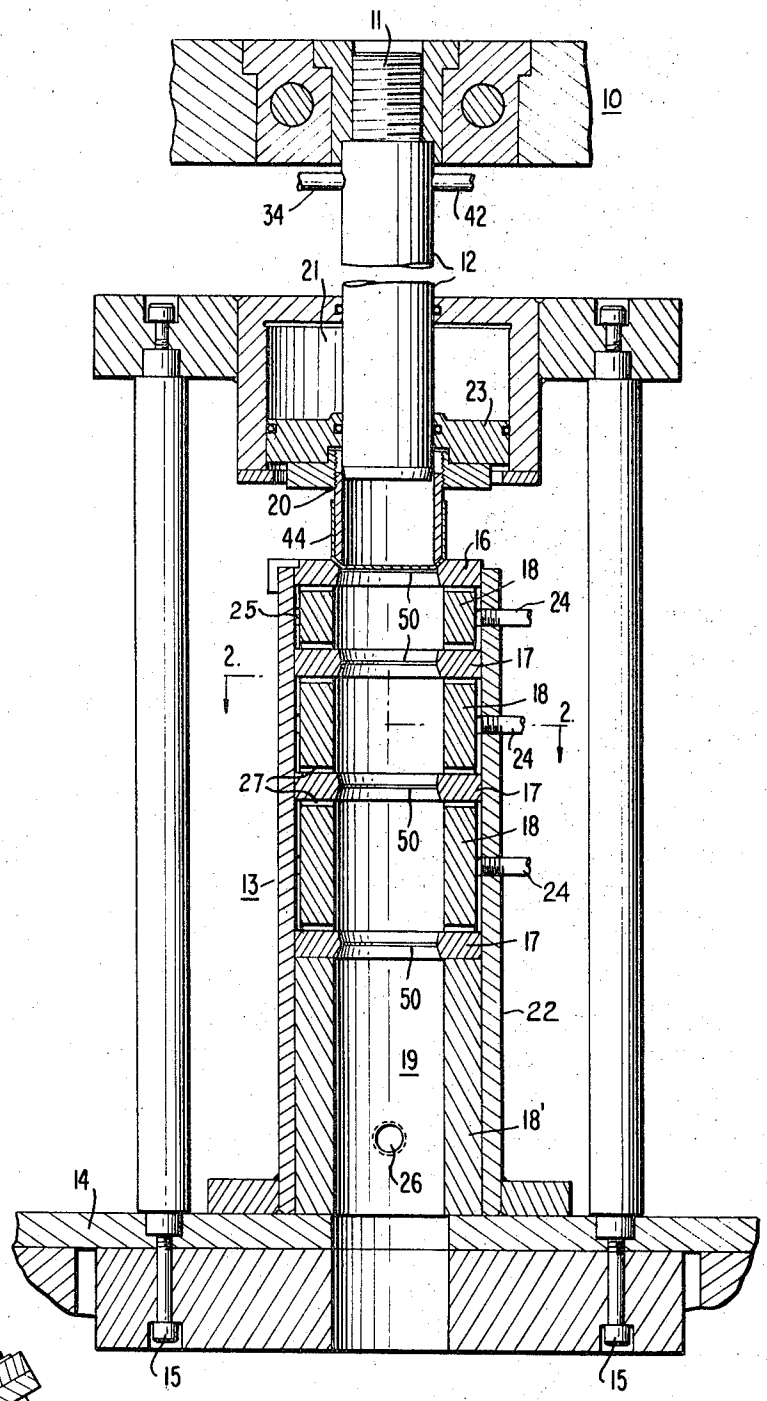

FIG. 2

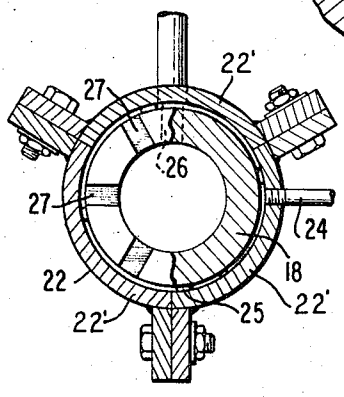

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FIG. 3

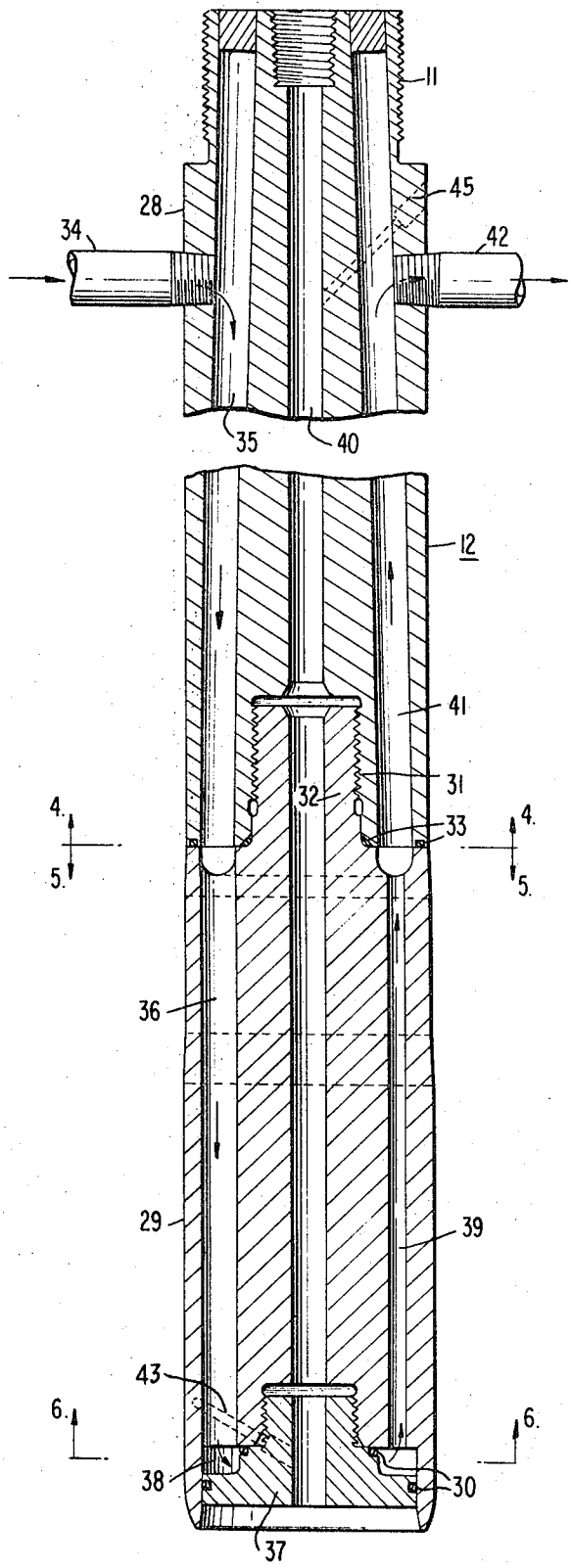


FIG. 4

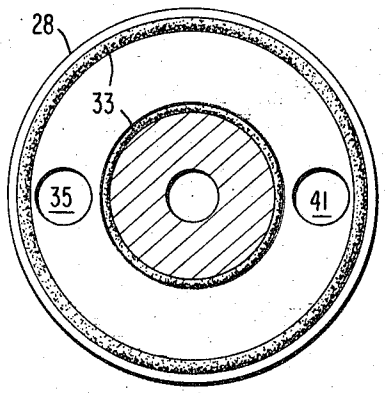


FIG. 5

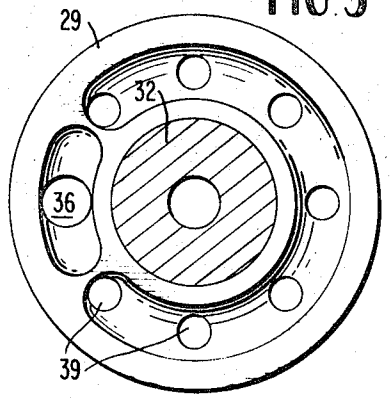
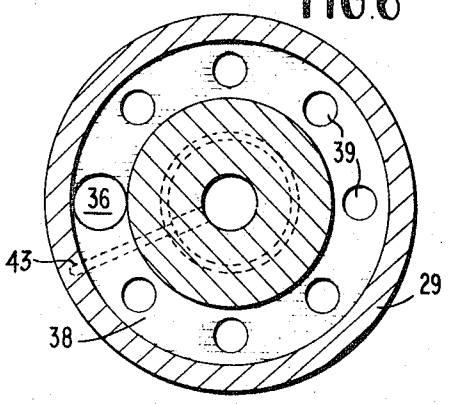


FIG. 6



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METHOD AND APPARATUS FOR FORMING THIN-WALLED CYLINDRICAL ARTICLES

BACKGROUND OF THE INVENTION

This invention relates generally to the manufacture of seamless containers and more particularly to an improved method and apparatus for drawing and ironing said containers from flat metal blanks.

The manufacture of thin-walled cylindrical containers comprise steps including drawing, redrawing, and ironing of flat metal blanks. As referred to throughout this application the term "drawing" is applied to the operation which initially forms a shallow cup from the starting flat blank of metal. The shallow cup is produced when a punch forces the blank through a drawing die turning a peripheral portion of the blank upwardly and simultaneously smooths the sidewall thus formed. This operation does not result in any reduction of the blank, the thickness of the cup being the same as the thickness of the starting blank.

The term "ironing" refers to the operation of further forcing the drawn cup through an ironing die by means of a punch resulting in substantial reduction of the sidewall thickness thus elongating the cup. No appreciable reduction in diameter of the cup results from this operation.

Apparatus is known whereby flat blanks are drawn and ironed to form a metal container whose sidewall thickness is less than the thickness of the starting blank in a single stroke of the die punch. The die punch forces the blank through a plurality of spaced-apart drawing and ironing dies which are fixed in axial alignment with said punch in a holder. There are problems involved in the drawing and ironing of relatively thin gauge metal such as flat steel blanks, however, including the generation of frictional heat during movement of the punch through the forming dies and possible shearing and fracturing of the tubularlike workpiece. Also, conventional means for providing lubricant at each die station results in costly loss of lubricant and the residual liquid lubricant on the can must be removed by an additional processing step. Another problem of conventional drawing and ironing operations is the extensive die wear due to metal-to-metal contact between the dies and the blank.

It has been proposed to use a metal blank having a coating of dry film lubricant. However, the buildup of heat in conventional punch and die apparatus prevents such use because of the thermal breakdown of the lubricant. Therefore, the instant invention was developed to overcome this objection.

The primary object, therefore, of the present invention is to provide means for drawing and ironing thin-walled containers from blanks having a dry film lubricant coating without the thermal breakdown thereof.

A further object is to provide apparatus for producing thin-walled containers without fear of shearing or fracturing the metal.

A still further object is to provide apparatus for producing drawn and ironed articles without the addition of lubricant during the drawing and ironing process.

SUMMARY OF THE INVENTION

The above objects are accomplished by providing fluid-cooled apparatus which is adapted to draw and iron a flat metal blank precoated with a dry film lubricant into a thin-walled cylindrical container. The apparatus is adapted to prevent the thermal breakdown of the lubricant and at the same time to cool the punch and dies.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of the apparatus of the instant invention,

FIG. 2 is a section through the die holder taken on line 2–2 of FIG. 1,

FIG. 3 is a detailed sectional view of the punch,

FIG. 4 is an enlarged sectional view through the punch taken on line 4–4 of FIG. 3,

FIG. 5 is an enlarged sectional view through the punch taken on line 5–5 of FIG. 3, and

FIG. 6 is an enlarged sectional view through the punch taken on line 6–6 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will now be described in detail with particular reference to the drawings. FIG. 1 is a sectional view of the arrangement of the various elements of the apparatus of the invention. A reciprocable press ram 10 is adapted to receive the threaded end portion 11 of punch assembly 12. Die holder 13 which is affixed to the press bed 14 as, e.g., by bolts 15 comprises blank holder 20 and die jacket 22. Blank holder 20 is adapted to reciprocate within cylinder 21 by pneumatic means which operates piston 23 to which said blank holder is removably attached. The die jacket 22, which is seen in section in FIG. 2 comprises flanged segments 22' for easy removal, bolted to the press bed 14, and a set of dies including a redraw die 16 and three ironing dies 17 separated in a predetermined arrangement by spacers 18. The outside diameter of spacers 18 is somewhat smaller than the inside diameter of the jacket 22 to allow space for circulation of a cooling medium. As seen in FIG. 2 the spacers are provided with pins 25 located 90° apart on the outside diameter of the spacer and integral therewith to facilitate its alignment within the jacket and are further provided on top and bottom surfaces with radially disposed grooves 27 to allow a cooling medium to circulate around the dies. Conduits 24 supply each of the spacers with the cooling medium. The inside diameter of jacket 22 is slightly larger than the outside diameter of the dies to enable the dies to free float and thus aid in aligning the dies as the punch descends. Dies 16 and 17 are of conventional design each having an aperture 50 through which the punch passes. Filler 18' is provided at the bottom of the die jacket to support the dies and establish a chamber 19 for the purpose of receiving the completely drawn and ironed product. An opening (not shown) is provided in the lower section of one of the flanged segments for ejecting the cams sideways to a collecting station upon withdrawal of the punch. Conduit 26 supplies a blast of air to blow the can out of the chamber 19.

Referring now to FIG. 3 the punch assembly 12 is seen in longitudinal section and will be described in detail. The pictured embodiment discloses a two-piece punch comprising punch adapted 28 and punch body 29 which when assembled provides an internally fluid-cooled punch for drawing and ironing precoated metal blanks. The punch adapter 28 is provided with male threads 11 at one end thereof for attachment to the press ram 10. A female connection 31 at the other end of the punch adapter 28 is threaded to receive the upper male threaded end 32 of the punch body 29 to unite the punch parts into an operating unit. O-rings 33 at the interfaces of the connection provide a positive liquid seal between the mating surfaces of the punch body and adapter. A coolant is supplied through an inlet pipe 34 to a longitudinal bore 35 through the punch adapter 28 thence through a longitudinal bore 36 in the punch body 29. A plug 37 is adapted to receive the coolant and distribute it by means of an annular channel 38, FIG. 6, to seven radially spaced longitudinal bores or outlet holes 39 adjacent the surface of punch body 29, and somewhat smaller in diameter than the inlet bore 36. The base cap or plug 37 combines with O-rings 30 as a sealant to accommodate continuous flow of the cooling medium in the system. This arrangement provides effective cooling of the surface of the punch. The upper end of the punch body 29, see FIG. 5, is provided with a partial annular channel communicating with the upper or discharge ends of the outlet holes 39 for collecting the cooling medium and discharging it into outlet bore 41 which is a longitudinal bore in the punch adapter 28 substantially diametrically opposite aforesaid longitudinal bore 35, FIG. 4, and communicating with an outlet pipe 42.

The punch assembly **12** is further provided with a longitudinal bore **40** extending through the axis of the punch through which an air blast is directed to strip the drawn and ironed can off the punch as the press ram and punch start the return stroke. The punch body **29** is provided with a bore **43** at the lower end extending at an angle generally upwardly from the center bore **40** to a point just beneath the surface of the punch body for insertion of a thermocouple (not shown). Leads from the thermocouple are passed up the center bore **40** to angular bore **45** near the top of punch adapter **28**. The leads exit from the punch through the bore **45** and then are attached to a device for recording the surface temperature of the punch body so that a substantially constant temperature of approximately 50° F. can be maintained on the surface.

The following description will point out with particularity the unique features of the present invention which provides means for deep-drawing and ironing thin cylindrical articles such as beer and beverage containers and the like. The starting blank is a flat circular piece of thin metal such a black plate or the like which is prepared in a conventional manner for the deep drawing operation by vapor degreasing and then cathodically cleaning the blank to remove the oxide film in order to achieve a strong chemical bond of the lubricant film with the metal surface. After cathodic cleaning, blanks are thoroughly rinsed in hot water and dried in an oven. The blanks are then coated with a lubricant film which may be composed of a phosphate coating and an organic lubricant applied in a single bath in which the blank is immersed for a sufficient length of time to insure proper bonding of the coating to the metal surfaces. The coated blanks are then dried in a drying oven to produce the desired dry film lubricant. Other lubricant coatings may also be used as e.g. soap lubricants omitting the phosphate coating or commercially known quick-drying lubricants which eliminate the drying step. However, it has been found that the best results are obtained when using the combination phosphate coating and organic lubricant.

In the pictured embodiment the coated blank **44** is a shallow cup preform produced in another press. This procedure was merely an expedient means of using available equipment. It will be understood by those skilled in the art, however, that this initial step can be included with the subsequent drawing and ironing steps in a one step, single-stroke operation.

The shallow cup blank **44** is fed to the press and is seated in the recess provided by the redraw die **16** at the top of the die holder **13**. The blank holder **20** is actuated by the operator or on a signal activated responsive to the presence of the blank on the die holder **13** and moves downward from its retracted position to establish a predetermined holddown pressure. The punch **12** is then actuated to drive the precoated metal blank through the series of redraw **16** and ironing dies **17** to produce the desired end product. No other lubricant is applied to the blank during this redrawing and multiple ironing operation. When the punch **12** reaches the bottom dead center position, a microswitch-controlled air valve is triggered releasing an air blast through the center hole **40** in the punch assembly which strips the can off of the punch. When the punch passes a preselected position on its return stroke means is activated to supply a side blast of air through air blast hole **26** at the bottom of die holder **13** to push the can out into a collecting station, thus making the press ready for the next cycle.

Cold air is circulated over the dies during the redraw and ironing operation to keep the dies cool as well as to supply a cooling medium to the outside surface of the container being drawn. A fluid coolant is also passed through the punch assembly as hereinbefore described in order to cool the surface of the punch body **29** maintaining an optimum temperature of said surface of about 50° F. Throttling devices are provided to control the flow of the fluid coolant in both areas. A thermocouple (not shown) is inserted in bore **43** to record the temperature of the punch body just beneath the surface thereof. It has been found that 50° F. is the desired temperature for the punch to prevent thermal breakdown of the dry film lubricant. An evenly textured dull gray can is thus produced and a minimum of die wear results from the absence of metal-to-metal contact due to the stability of the dry film lubricant on the metal blank maintained by the fluid cooled punch of the instant invention.

The instant invention, therefore, provides a practical method for drawing and severe ironing flat metal blanks into predetermined configuration by a unique tooling system. The novel means employed for cooling the punch and blank results in a highly acceptable product which is readily adaptable to subsequent processing such as the application of enameling.

We claim:

1. A method of drawing and ironing thin-walled cylindrical articles from a flat blank comprising the steps of:

a. coating said blank with a dry film lubricant,

b. forcing said blank through a series of drawing and ironing dies, and

c. maintaining the surface temperature of said blank less than the breakdown temperature of said lubricant.

2. The method according to claim **1** wherein the provision of step (c) includes cooling the working surface of said punch.

3. The method according to claim **2** further including cooling said series of drawing and ironing dies during the die stroke.

4. In apparatus for multiple stage drawing and ironing of thin-walled cylindrical articles from a flat blank coated with a dry film lubricant, the improvement comprising, in combination:

a. an internally fluid-cooled punch,

b. a first die and a second die, each of said dies having an aperture,

c. spacer means to maintain said first die and said second die in spaced relation, said spacer means having a passage in alignment with said first and second die apertures, and

d. means to pass a cooling fluid into said spacer means passage to cool said blank as it is drawn through said spacer means passage.

5. Apparatus according to claim **4** wherein said punch is provided with a plurality of radially spaced longitudinal bores adjacent the surface of said punch adapted to receive a circulating cooling medium.