The present invention relates to shot shells and a method of producing the same, and is particularly concerned with shot shells having a plastic body and an integral star crimp closure, an object of the invention being to provide a novel star crimp formation whereby an effective sealed closure is produced.

Star crimp closures have been used heretofore for paper and metal shot shell bodies, and in the case of paper bodies these have been of the so-called "flat top" type wherein a plurality, usually six, radial folds are provided to form downwardly projected radial ribs at the under side of the closure, with the triangular segments between the folds disposed in a flat plane at the upper side of the closure. Examples of this type of closure are shown in the patents to Finlay et al. 2,242,907 of May 20, 1941, Harmon 2,300,367 of October 27, 1942, Cadham 2,336,065 of December 7, 1943 and Finlay 2,373,554 of April 10, 1945. Somewhat similar closures having downwardly projected radial ribs at the under side of the closure are shown in the patent to Holland et al. 2,180,239 of November 14, 1939, wherein the top of the closure is convex, and in the patent to Paulve 2,591,286 of April 1, 1952, wherein the top of the closure is concave, the bodies in the examples being metal. The characteristics of the plastic material are quite dissimilar from both paper and metal, i.e., plastic does not take a sharp fold as does paper, being incapable of the slight delamination that takes place in folding paper, it assumes puckered shapes unlike those resulting from the crimping of paper or metal objects and methods hereinbefore employed in the formation of paper shot shell bodies have not been successful. One important reason for this is that the plastic material does not take a sharp fold as does paper, so that whereas in the case of a paper body the folds at the top of the closure are sufficiently sharp to produce a substantially smooth flat top and the folds at the bottom of the ribs are also sufficiently sharp to hold the sides of the folds in closed relation, the lack of sharpness in the folds of the plastic material not only eliminates the "flat top" appearance but prevents the tight closing of the sides of the folds at the bottom of the ribs, so that if an observer looks into the bottom of each fold near the center, shot can be seen. Any attempt to seal the closure by heat sealing or by the usual sealing methods employed with paper shot shell bodies is ineffectual. Also, a contributing factor is the profile shape of the center hole produced by the "flat top" type star crimp closure. In producing each radial rib the material is folded about a fold line perpendicular to the top edge of the cylindrical body with the two sides of the fold brought together so that there is an angle of 90° between the fold line and the edges of the fold. The fold line being at the bottom of the rib forming fold it inclines downwardly toward the center hole axis, its edges being inclined to the axis of the hole. As a result the wall of the center hole formed by the edges of the several folds diverge downwardly with a greater circumference at the bottom than at the top. Consequently, the bottoms of the folds are subject to opening up even though they are held closely together at the top of the center hole, and this is particularly the case with plastic material which does not fold as sharply as paper.

It is proposed according to the invention to provide a star crimp closure wherein the rib forming folds are disposed at the upper side of the closure with their fold lines disposed in a substantially flat plane normal to the axis of the center hole. As the edges of the folds are at an angle of 90° to their fold line the wall of the center hole formed thereby is substantially parallel to the center hole axis. Consequently, if the folds are forced into tightly closed relation at the top of the center hole they are also forced into tightly closed relation at the bottom of the center hole, and to this end it is proposed to so relate the number of folds to the wall thickness of the plastic material and the circumstances of the shot shell body and the center hole that in the cramped position of the folds their edges forming the wall of the center hole are forced into tightly closed relation, i.e., the circumference of the center hole is equal to the number of folds multiplied by twice the wall thickness of the plastic material.

A further object of the invention is to provide a sealing plug within the center hole of the star crimp closure which effectively seals the closure and functions as a key lock between the radial ribs, the latter constituting wedging struts at the upper side of the closure which effectively lock it against retrusive opening movement.

It is also an object of the invention to provide improved methods of crimping and forming a plastic closure and of providing a sealing plug in its center hole.

Other objects and advantages will become apparent from a consideration of the following detailed description taken in connection with the accompanying drawings wherein a satisfactory embodiment of the invention is shown. However, it will be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention and the scope of the appended claims.

In the drawings:

FIG. 1 is a top plan view of a shot shell, primed, loaded, and ready for closing

FIG. 2 is a view partially in side elevation and partially in section of the shot shell as shown in FIG. 1

FIG. 3 is a top plan view of the shot shell as shown in FIGS. 1 and 2, after it has been subjected to the first step in the closing operation, namely the star crimping of the upper end of the shot shell body

FIG. 4 is a side elevation partially in vertical section of the closure end portion of the shot shell body as seen in FIG. 3

FIG. 5 is a top plan view showing the star crimped closure end of the shot shell body partially closed

FIG. 6 is a vertical sectional view taken along the line 6—6 of FIG. 5

FIG. 7 is a top plan view showing the final closed position of the closure end of the shot shell body

FIG. 8 is a vertical sectional view taken along the line 8—8 of FIG. 7

FIG. 9 is a top plan view of the completed closure showing the plug seal in the center hole of the closure

FIG. 10 is a vertical sectional view taken along the line 10—10 of FIG. 9

FIG. 11 is a bottom plan view of the shot crimping tool adapted to star crimp the closure end of the shot shell body as seen in FIGS. 3, 4 and 3

FIG. 12 is a vertical sectional view taken along the line 12—12 of FIG. 11

FIG. 13 is a view similar to FIG. 12 showing the
3 closure end portion of the shot shell body engaged with and star crimped by the star crimping tool;

FIG. 14 is a vertical sectional view of a crimping die for imparting the initial closing operation to the star crimped closure end portion of the shot shell body as illustrated in FIGS. 5 and 6 and the same being shown in crimping engagement therewith;

FIG. 15 is a bottom plan view of a rotating crimping tool for imparting the finishing crimping and forming operation to the shot shell closure;

FIG. 16 is a vertical sectional view taken along the line 16—16 of FIG. 15 and showing the rotating crimping tool in engaged relation with the closure end portion of the shot shell body;

FIG. 17 is a vertical sectional view of a second crimping seal forming punch for forming a plug seal for the center hole of the closure, the same being shown in its engaged relation therewith;

As shown in FIGS. 1 and 2, the shot shell, according to the illustrated exemplary embodiment of the invention, comprises a cylindrical tubular body 10 formed of plastic material, and a head 11 preferably of brass or other suitable metal, to which is joined and within which is contained the usual base wad, battery cup, primer cup, anvil and priming composition. Above the base wad is placed a powder charge 12 which is separated by one or more over-power wads 13 and one or more filler wads 14 from the shot charge 15. The free end of the body 10 extending above the shot charge is adapted to form the integral closure of the invention which retains the shot charge in place.

The plastic material of the body 10 is one having the desired tensile strength and stiffness for normal handling and proper functioning in the firearm, and having the necessary flexibility to enable the closure to be folded, suitable plastic materials for this purpose being linear polyethylene, copolymers of polyethylene, ethyl cellulose, cellulose acetate, and styrene butadiene acrylonitrile terpolymer. The body is preferably formed by extrusion, and other suitable processing steps which develop an adequate strength. Both its inner and outer surfaces may be smooth, or its outer surface may be provided with longitudinal ribs 16, as illustrated in the disclosure.

The first operation in the closing of the body consists in seating the inner edge of each fold in the upper recess of the crimping tool as shown in FIGS. 3 and 4, this operation being carried out by means of a star crimping tool as shown in FIGS. 11—13. The star crimp formation consists of a plurality of equally spaced outwardly projecting radial folds 17 having their fold lines perpendicular to the upper end edge 18 of the body, and having their triangular side walls connected along oblique fold lines to triangular segments 19 extending between the folds.

Having regard to the diameter of the body, the wall thickness, and the size of the center hole best suited to the firing end of the invention, experience has shown that the number of folds is an important consideration in the provision of a satisfactory closure. For example, in the case of a shot shell having an approximate outside diameter of .787", an approximate wall thickness of .022", and a center hole size capable of proper sealing in the manner contemplated by the invention, eight folds has proved to be the most satisfactory number.

The form of the star crimping tool is also an important factor in carrying out the star crimping operation upon the plastic material. As shown in FIGS. 11—13, the non-rotating star crimping tool 20 is provided with a recess 21 at its lower end to receive the rear face end of the shot shell body 10, and has eight parallel walled slots 22 extending radially outward from a center opening 23 and vertically upward from the lower end of the tool through the wall of the recess to a horizontal top wall 24, the tool being thus divided into eight segments. The wall of the recess comprises an entrance guide surface 25 which may be convex as shown or beveled, a cylindrical wall surface 26, a concave inner surface 27 and an upwardly and inwardly inclined top wall surface 28. Dimensionally, the diameter of the cylindrical surface 26 is slightly greater than the outside diameter of the shot shell body 10, being for instance approximately .768" in the case of a shot shell having an approximate outside diameter. The radius of the concave corner surface 27 is approximately .035", the angle of inclination of the top wall surface 28 is approximately 12°, and the width of each of the slots 22 is approximately .078". This latter dimension is calculated as being slightly greater than twice the wall thickness of .022" of the shot shell body. In plastic material the wall thickness may vary as much as .0035" so that with such expected variation in wall thickness the slots must be wide enough so that the drag in each slot is comparable to thus give a symmetrical fold pattern.

In order to prevent bulging of the plastic body throughout the closing operation, suitable supporting means, such as a sleeve 29, encompasses the body below its upper closure-forming free end. As the free end of the body in the cylindrical form as seen in FIG. 1 the recess of the crimping tool, through relative vertical movement between the tool and the shot shell, its circular end edge 18 encounters the curve of the corner surface 27 and formation of the folds starts as the eight fold points of the edge enter and crease into the slots 22, the portions of the edge between the fold points being at the same time forced inward along the corner surface 27 and the inclined top wall surface 28. As the entering movement continues the folds gradually deepen to the point where the folds of the edge 18 come together at the apices of the segments 19 being formed between the folds, as shown in FIG. 13. During the folding operation the plastic material is cold worked as it is forced over the edges of the slots and as a consequence the fold pattern becomes permanently established. A comparison of FIGS. 13 and 4 shows that when the star crimped body is removed from the star crimping tool it recovers to the position as seen in FIG. 4 through the natural tendency of the folds to open up about their fold lines.

It will be noted that the folds 17 and segments 19 are connected to the cylindrical wall of the body by a corner surface 30, further projecting upward in the upwardly and inwardly inclined top wall surface 28 of the crimping tool. The projected fold lines of the folds blend tangentially into the curve of the surface 30, so that the portion of the corner surface immediately adjacent the cylindrical surface presents a continuously smooth annular area which has not been subjected to sharp folding or crimping.

The star crimped shot shell body is next subjected to a closing and nail-heading operation to produce the partially closed state of the closure as illustrated in FIGS. 5 and 6, and to this end it is subjected to the operation of a non-rotating nail-heading tool 31 as shown in FIG. 14. This tool comprises an outer sleeve part 32 and an inner plug part 33 adjustably assembled with the sleeve part by a screw-threaded connection 34. The inner wall 35 of the sleeve part is tapered in a downwardly convergent direction to an annular cylindrical neck 36 having a convexly rounded entrance lip 37, the diameter of the neck being such as to receive the body 10 with a snug or press fit, being approximately equal to or less, i.e., approximately .786", than the approximate .787" outside diameter of the body 10, and the angle of inclination of the wall 35 being of the order of about 12°. The lower end of the plug part 33 is provided with a conical recessed surface 38 having an angularity of approximately 12°, and at the edge of the recess there is provided a downwardly projecting annular rib 39, the outside diameter of which is...
calculated as being slightly less than the approximate .743" inside diameter of the body 10, i.e., approximately .712".

The lower side of the annular rib 39 is convexly rounded and is upwardly spaced from the restricted neck 36 a distance calculated to confine the nail-heading to the portion of the body between the annular corner surface 30 and the level of the shot charge within the body. In the illustrated tool the vertical length of the neck 36 is approximately 9/16" and the height of the rib 39 above the neck is approximately 3/32". The outer cylindrical wall of the rib 39 extends upwardly for a distance of approximately 9/32" in inward spining relation to the tapered wall 35 to thus provide an annular clearance space 40.

The star crimped body as seen in FIG. 4 is as seen in FIG. 14 engaged in the recessed lower end of the non-rotating nail-heading tool through relative vertical movement between the tool and the shot shell body causing the folds 17 to be closed downwardly to the point where their upper fold lines conform to the recessed conical surface 38 of the tool. At the same time the rib 39 forms a circular depression which indents the outer ends of the folds, while the rounded corner 36 together with the adjacent segment portions 19, the inner edges of the side walls of the folds formed from the edge 18 of the body being brought into substantially closed relation to form the wall of the center hole where they are in effect locked against opening movement. This results from toggle action which takes place as the fold lines along the bases of the sides walls of the folds, which are slightly longer than the upper fold lines, are forced below the dead center point, this action being made possible through the nail-heading operation. At this point the upper fold lines of the ribs conform to the 12° angle of the conical recessed surface 38, producing a center hole which converges toward its lower end by virtue of the disposition of the inner edges of the folds at 90° to the upper fold lines.

During withdrawal of the body from the nail-heading tool the restricted neck 36 sizes down the nail-head dimension and to the natural recovery of the plastic material the closure assumes the slightly reduced nail-headed shape shown in FIGS. 5 and 6. The sizing down action also causes the fold ribs to be further depressed so that their upper fold lines are at a slightly less angle than the 12° angle as illustrated in FIG. 14, the angle being of the order of about 8° as illustrated in FIG. 6.

The closure is next subjected to a finishing operation for the purpose of producing a drop center in which the upper fold lines of the fold ribs are disposed in a substantially horizontal plane with the wall of the center hole parallel to its axis, and of forming an upwardly projecting convexly rounded rim curved inwardly from the cylindrical wall of the shot shell body and surrounding the drop center. The finishing operation is performed by a rapidly spinning tool somewhat similar to the tool disclosed in the hereinbefore referred to patent to Finlay, 2,373,554. In this patent the finishing tool comes into the closure directly following the preliminary star crimping operation. This is possible with a paper shot shell body as disclosed in the Finlay patent, as paper will withstand the high temperature developed by the pressure and friction of the rapidly spinning tool without delaminating. Plastic material, however, will fold and tear under pressures and spinning speeds that would not similarly affect paper. It is therefore proposed in the present invention to perform the finishing operation by the spinning tool after the closure has been very nearly closed by the cold working step performed by the nail-heading tool as illustrated in FIGS. 14, 5 and 6, thus reducing to a minimum the work to be performed by the spinning tool and the time required. It is also proposed to reduce the heat developed by operating the spinning tool at a substantially lower temperature than that which would be used in the closing of a paper shot shell body. In this respect the spinning tool speed usually employed for paper is about 1800 r.p.m., and it is proposed in the present invention to rotate the finishing tool at a speed of about 900 r.p.m., and preferably also to subject the spinning tool to the cooling effect of an auxiliary air line to dissipate heat from the tool as fast as it is generated.

The finishing tool shown in FIGS. 15 and 16 comprises a body 41 provided in its upper side with a threaded recess 42 for securing to an appropriate driving means, and in its lower side with a recess 43 defined by a cylindrical side wall 44 having a convexly flared entrance surface 45 at its lower end for receiving the closure end of the shot shell body. In the case of a shot shell body of approximately .787" outside diameter the diameter of the recess 43 is approximately .790". The top wall of the recess consists of a circular planar downwardly offset drop center 44' and a boss 46 surrounded by an annular groove 47 blended into the cylindrical wall 44 of the recess for the purpose of shaping the finished rim of the closure, the base of this groove being provided with a series, three as illustrated, of lugs 48 concavely contoured in cross section to correspond to the finished cross-sectional shape of the rim. The forward side of each lug, that is, the side facing forward with respect to the direction of rotation inclines at a relatively low angle to the base of the groove and the opposite side inclines at a relatively high angle to the base of the groove.

Centrally of the boss 46 there is provided a cylindrical center pin 49 which engages the center hole of the boss 46 to prevent shot from being trapped therein, the diameter of this pin in the present exemplary disclosure being approximately .072". The effective rim shaping depth of the groove 47, that is the depth at a cross section through one of the lugs 48 as seen at the left in FIG. 16, is approximately .030" and its width is approximately .095".

In the operation of the spinning tool the shot shell as seen in FIG. 6 is engaged at its nearly closed end in the recess 43 through relative vertical movement between the shell and the tool, the first action being to displace the nail head projection of the closure inwardly to conform to the cylindrical side wall 44 of the recess, while at the same time the boss 46 engages the upper surfaces of the fold ribs and depresses the star crimp formation, thus bringing the upper edges of the fold ribs into a horizontal plane conforming to the planar surface of the boss and disposing the inner edges of the folds to form a center hole 50 having its wall substantially parallel to its axis. As the relative vertical movement between the spinning tool and the shell continues, the boss 46 depresses the star crimp formation to form a drop center, and at the same time the surrounding rim portion 51 of the shell is shaped by the rolling and forming action of the lugs 47 into a substantially semi-circular cross-sectional shape. Upon withdrawal of the spinning tool the closure has the form shown in FIGS. 7 and 8.

Finally, the center hole 50 is sealed by a multiple step sealing operation utilizing the plastic material of the closure. Whereas it has been the purpose in forming the closure to avoid or minimize the effects of pressure and friction induced heat upon the plastic material, it is proposed in the sealing operation to utilize these effects in forming the seal. Plastic is a poor heat conductor and when friction is established on its surface the heat induced thereby causes the plastic to rub and melt.
3,055,302

punch is preferably formed of steel and its cylindrical operating end is slightly larger in diameter than the diameter of the center hole 50 as produced by the closing operation. Above the operating end there is provided a heat insulating sleeve 53, of Micarta or similar insulating material, secured to the punch by a cross pin 54 and adapted to prevent or minimize dissipation of heat from the punch. A conical nose cavity 55 in the lower end of the punch forms a relatively sharp annular edge with its cylindrical surface.

In operation the punch is driven at relatively high speed, approximately 15,000 r.p.m., and as it enters the plastic material immediately surrounding the center hole the heat developed by pressure and friction causes the plastic material to be rubbed off, melted, and directed or gathered inwardly into the nose cavity so that it collects as a sealing plug 56 within the center hole, the wall of the enlarged recess left above the sealing plug being at the same time fused into a continuous annular layer 57 of the plastic material to thus seal the inner edges of the folds 17. Upon removal of the punch the sealing plug becomes set into a rigid integral key plug which effectively locks the position of the folds of the body wall.

The second and successive sealing steps consist in applying high speed spinning punches 58 to smooth and flatten the upper surface of the seal 56. These punches are also heat insulated by means of a sleeve 59 of heat insulating material such as Micarta secured by a cross pin 60, and with its lower end there is provided an insert 61, also of heat insulating material such as Micarta, the lower surface of this insert and the surrounding ring of metal being flat. The diameters of the punches 58 are the same as that of the punch 52, i.e. approximately .175", so that in operation they enter the recess formed above the sealing plug 56 and through the heat developed by pressure and friction resulting from their high speed rotation, also approximately 15,000 r.p.m., the surface of the plug is flattened as seen in FIG. 18. Upon removal of the spinning punches the sealed closure has the form shown in FIGS. 9 and 10. Although good results have been obtained by the use of only one second stage spinning punch there are advantages in sharing this work with two or more similar punches.

Regarding the number of folds of the closure, above described as eight, it is pointed out that a greater number than nine and a lesser number than seven have been found to be unsatisfactory, so that nine and seven folds are to be considered permissible in producing a satisfactory closure.

What is claimed is:

1. In a shot shell, a body comprising a cylindrical tubular body wall of deformable thermoplastic material and a star crimp formation body closure formed from an integral extension of the upper end of said body wall and comprising a plurality of segments extending downwardly and inwardly relatively to said body wall and external folds extending upwardly from and connecting said segments and having their fold lines lying in a substantially flat plane normal to the axis of said body wall and surrounding said segments and folds in raised relation to said flat plane.

2. In a shot shell, a body comprising a cylindrical tubular body wall of deformable thermoplastic material and a star crimp body closure formed from an integral extension of the upper end of said body wall and comprising a plurality of segments extending downwardly and inwardly relatively to said body wall and external folds extending upwardly from and connecting said segments and having their fold lines lying in a substantially flat plane normal to the axis of said body wall, the wall of which is parallel to the axis of said hole, and an annular rim extending inwardly from said body wall and surrounding said segments and folds in raised relation to said flat plane.

3. In a shot shell, a body comprising a cylindrical tubular body wall of deformable thermoplastic material and a star crimp body closure formed from an integral extension of the upper end of said body wall and comprising a plurality of segments extending downwardly and inwardly relatively to said body wall and external folds extending upwardly from and connecting said segments and having their fold lines lying in a substantially flat plane normal to the axis of said body wall, the wall of which is parallel to the axis of said hole, and an annular rim extending inwardly from said body wall and surrounding said segments and folds in raised relation to said flat plane.

4. In a shot shell, a body comprising a cylindrical tubular body wall of deformable thermoplastic material and a star crimp body closure formed from an integral extension of the upper end of said body wall having its upper edge normal to the axis of said body wall, said body closure comprising a plurality of segments and external folds connecting said segments, the fold lines of said external folds being perpendicular to said body wall and lying in a substantially flat plane normal to the axis of said body wall whereby the center hole of said body wall is parallel to said said hole and an annular rim extending inwardly from said body wall and surrounding said body wall and said segments and folds in raised relation to said flat plane.

5. In a shot shell, a body comprising a cylindrical tubular body wall of deformable thermoplastic material and a star crimp formation body closure formed from an integral extension of the upper end of said body wall having its upper edge normal to the axis of said body wall, said body closure comprising a plurality of segments extending downwardly and inwardly relatively to said body wall and surrounding said segments and folds in raised relation to said flat plane.

6. In a shot shell, a body comprising a cylindrical tubular body wall of deformable thermoplastic material and a star crimp formation body closure formed from an integral extension of the upper end of said body wall and comprising a plurality of segments extending downwardly and inwardly relatively to said body wall and external folds extending upwardly from and connecting said segments and having their fold lines lying in a substantially flat plane normal to the axis of said body wall and surrounding said segments and folds in raised relation to said flat plane.
9. last step shaping with a spinning tool a raised rim in surrounding relation to said segments and folds.

8. The combination described in claim 1 including a sealing plug within the center hole of the star crimp formation, said sealing plug being of thermoplastic material integrally fused with said folds.

9. The combination described in claim 2 including a sealing plug within the center hole of the star crimp formation, said sealing plug being of thermoplastic material diverted from the wall of said center hole and integrally fused with said folds.

10. The combination described in claim 3 including a rigid sealing plug within the center hole of the star crimp formation.

11. The method set forth in claim 5 including the step of subjecting the wall of said center hole to heat to cause the thermoplastic material of said wall to melt and gather as a sealing plug within said center hole.

12. The method set forth in claim 6 including the additional step of subjecting the wall of said center hole to heat to cause the thermoplastic material of said wall to melt and gather as a sealing plug within said center hole.

13. The method set forth in claim 7 including the step of subjecting the wall of said center hole to friction and pressure induced heat of a spinning punch engaged with said wall to cause the thermoplastic material of said wall to melt and gather as a sealing plug within said center hole.

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