This invention relates to a novel ammunition cartridge case and more specifically to a shot shell and a method of making such a shell using synthetic resinsous plastic material. Heretofore, attempts at using plastic in shot shells have been largely directed toward using conventional molding methods for making an all plastic shell such as that shown in U.S. Patent No. 2,232,634, granted February 18, 1941, for example, where the tubular portion and the head of the cartridge case are molded as one piece. Another approach has been to take advantage of the known moldability and a character of a suitable synthetic plastic material and to merely substitute a tube of the plastic for the paper tube in an otherwise conventional shot shell. These approaches have required further modification make up for the lack of strength of the plastic. One such modification has been to substitute linear high density polyethylene for the paper in the form of a piece of biaxially oriented pipe or a piece of tubing after it has been stretched out and drawn inwardly as a coating on an enlarged rod from which the resulting tubular coating, thinner in the wall than the tube, is stripped out and cut to desired length to provide a shot shell tube of increased strength because of orientation by stretching. This shell is otherwise fabricated in assembly with a base wad and a metal head by the same number of steps similar to those used in the paper tube shell.

In these shells the metal head is customary and its presence has come to be expected as desirable, especially in shells with an exceptionally heavy powder load, or in shells to be fired at exceptionally low temperatures, such as occur in the arctic, where cracking in the shell wall is most likely to occur, if at all. In any event, it is necessary, whenever, the metal head is provided, that it be firmly secured to the rest of the shell and remain so, even after the shell has been reloaded and fired again and again.

One object of this invention, therefore, is to provide a metal headed plastic shell of fewer components by elimination of the base wad without impairing the securement between the metal head and the rest of the shell. Another object of this invention is to provide a plastic shot shell of improved strength in the tubular wall and improved securement of the plastic despite use of fewer components.

Another object of the invention is the provision of a novel process for making a plastic shot shell having a metallic head. A further object of the invention is the provision of a novel process for shaping a shot shell having a plastic body and a metal head where the metal and the plastic are shaped simultaneously. A further feature of the invention is the provision of a novel process for making shot shells comprising plastic and metallic components where the components take the form of crude blanks or partially formed blanks and the process involves forming the plastic and metallic components simultaneously while strengthening the plastic blanks. Still another object is to provide a shell wherein the components are secured together in fewer steps for economy of fabrication.

Other objects and advantages will be evident from a description of a preferred embodiment when taken together with the accompanying drawing wherein.

FIG. 1 is an exploded perspective view partially in cross section showing one form of suitable blank from which the cartridge case is made according to this invention. FIG. 2 is a perspective view in partial cross section showing another form of suitable blank; FIG. 3 is an exploded view in cross section showing the parts of a modification of the type of blank shown in FIGURE 1; FIG. 4 is an elevational view in cross section showing part of one suitable apparatus in its open position including a blank of the type shown in FIGURE 1 after the parts of the blank are nests together and emplaced for further processing; FIG. 5 is an enlarged fragmentary view of part of the apparatus of FIGURE 4 and of part of the processed blank; and FIG. 6 is a perspective view of a finished shot shell with part of it cut away to better illustrate the structure obtained. By this invention it is proposed to provide a shell case of plastic such as of linear high density polyethylene or of polypropylene preferably of highly isotactic character, or the like polyolefin or similarly crystalline plastic susceptible of shaping to final finished configuration not only of the base, but also of the rim and the tubular side wall. It is contemplated to do this by deformation in a way enhancing the strength of the whole case including the rim secured in a new and improved way to the metal head. The body of the cartridge is formed at least in the tube wall and in the rim by compressive deformation of the plastic material to final finished shape in the solid crystalline state. Simultaneously the rim of the metal head is formed to final finished shape to press against and give better grip on a compressively formed rim portion of the plastic body forming a plastic appendage at the base of the body.

This is accomplished by operation on a blank comprising a plastic core and a thin metal jacket of aluminum, brass, or steel in which the core is first nested. The jacket may be entirely rimless or may have a partially formed bulge adapted for bulging outwardly and upsetting axially to the final finished shape of the metal rim having in the finished condition an annular recess therein for reception of a compressively deformed lip or extension of the core of plastic pinched by the metal rim as the latter is simultaneously compressed against the plastic deformation at the rim. A metal cup only partially expanded to an unfinished rim adjacent the base may be used. The plastic core may be injection molded to fill this embryonic rim and the metal cup except for the contoured upper end and a central bore therethrough. The core may be a separable cylindrical piece having no rim and is inserted just prior to the compression forming operation during which the plastic is compressed and forced to form the whole plastic lip as the metal is further shaped by the compressed plastic to the final rim contour. The binary deformation forms the attachment between the metal and plastic in the rim.

The cup may be a simple rimless shell and the plastic injection core molded therein or provided as a preformed cylindrical insert. During compression under this condition, the whole metal rim is expanded and crimped to final shape and simultaneously the plastic is forced into the so formed rim and securely locked to the metal head. This is preferred as the ultimate binary deformation contemplated. By compressive deformation instead of stretching or
mere injection molding, an increase in tensile strength is obtained in more than one part of the plastic body, i.e., at the tube and the rim, where bulk cannot be had to provide the needed strength. At the same time, such deformation makes possible simultaneous shaping of the metal head not only to finished size but also with a better securement between the head and the plastic body. Compression forming is quite possible in all parts to be made to finished dimension, an advantage especially in making a plastic-metal composite article where at least three portions of the plastic differ in shape, thickness, and function, at least one of which must be thicker than the rest which nevertheless must be as strong or stronger, and where the core must have a shape complementary to a part of the plastic body.

By partial confinement of the plastic between juxtaposed surfaces exerting a compression on the plastic in the metal cup and by driving plastic with plastic while clamping the metal against compressively deformed plastic, final shaping of a metal encased rim and to a thin-walled tube is achieved advantageously from a relatively thick metal jacketed plastic-cored slug or blank to attain high increase in strength in both rim and tube as well as fastening of the metal and plastic parts.

This is done at a relatively wide range of temperatures below the crystalline melt temperature of the plastic and at speeds of compressive deformation limited to prevent the plastic being heated to this temperature. During forming the temperature is maintained preferably at an elevated range. For the type of polyethylene contemplated the working temperatures are held well below the range from about 275° F. to about 265° F., and working occurs preferably from about 200° F. to slightly below about 300° F. for available grades and makes of the crystalline thermoplastic. Compression at about 240° F. has been found suitable for this type. For polypropylene the limiting temperature is somewhat higher and forming occurs below the much wider range from about 275° F. to about 335° F. Compression of this plastic is contemplated at temperatures from about 200° F. to about 335° F. Contrary to stretch forming, shaping need not be confined to a sharply limited narrow range hovering extremely closely to the crystalline melt temperature and difficult to maintain.

The degree of crystallinity of the thermoplastic, as determined by various methods, such as the X-ray diffraction method, is preferably as high as possible; with polypropylene a high degree of isotacticity is also preferred.

At the crystalline melt temperature the polymer appears clear when viewed through crossed Nicol prisms in a high-stage microscope, since all crystallinity of the structure is gone.

In FIG. 1 the blank is in the form of a two-piece slug the parts of which are separate and consist of a plastic core 2 insertable into a metal cup 4 as shown in FIG. 4. This metal cup is of thin walled construction and has an open end 8 and a nearly closed end 9 having a base perforation 5 with inward primer-holding tabs 6 around the perforation. These correspond with the bore 3 of the plastic core. At the bottom edge 7 this cup is rounded. At one end the core has a concavo-convex contour 2 of the type shown. This is put next to the open cup end 8 where it is adapted for coaction with the end 31 of the punch 30 of the typical processing apparatus shown where in FIG. 4 the punch end 31 is flat faced, rounded at the edge 36, and is shown as being sharply tapered than at the tapered part 32 which is of smallest diameter adjacent 31 and of largest diameter remotely from 31. The tapered external surface 32 of the punch, when the latter is driven toward die plug 61, cooperates with the reversely tapered internal surface 33 of the bore of die 60. These tapered portions form between them a tubular passage into which plastic is driven from the core 1 upwards by punch 30 and around punch surfaces 31 and 32 to form compressively the tubular shell wall 48 of a typical finished shot shell 49 as shown in FIG. 6 where the wall 48 is thickest adjacent shell base 49 and thinnest next the pier-cut inclined and indented end closure 45, the fold of which is sealed by any suitable end seal 50 which may include a globule of heat sealable plastic.

In FIG. 2 the blank again includes a piece of plastic 11 which, however, is injection molded as a hollow metal cup 36 with the exterior surface 37 compressively contoured at 12 next the open cup end 18. This core is molded to have a bore 13 aligned with the opening 15 between the primer tabs 16 at the closed end 19. At the base edge 17 the cup is bulged to less than finished outer size and shape and a filler 20 of the molded core extends into this bulge. Bolus 17 and filler 20 are adapted to be reformed in the apparatus of FIG. 4 to final rim shape 47 (FIG. 6).

FIG. 3 shows how the core 71 may be somewhat longer and more deeply contoured at end 72 and may be provided with a somewhat different and much shallower cup 74, from the open end 25 of which contoured end 72 extends quite a bit beyond as compared to FIG. 1. Cup 24 has bulge 27 around the outer edge concentric with the central perforation 25 in the cup bottom 29 having primer holding tabs 26 extending exteriorly on the metal and plastic part 24. This illustrates not only how to form a shell with "low-brass" in the head portion but also how the metal cup 24 may be partially preformed at the rim 27 to adapt the metal for final forming at the rim while the plastic core is as shown in FIG. 1 needed to provide even the initial filler at the rim. With a suitable molding device the plastic core may be molded to fill bulge 27 and extend up out of the cup 24 beyond open end 28.

When these blanks are put into suitable apparatus, to practice the invention, the blank of FIG. 1 undergoes the greatest binary deformation of compression plastically in contrast to the elastic deformation of an elastomer. The least severe binary deformation occurs at the rim of the blank of FIG. 2. Deformation of intermediate severity occurs with the slug of FIG. 3. With all, however, the compressive deformation goes beyond the elastic limit and the plastic is changed in shape plastically and permanently at least in the finished tubular shell wall 48 and in the lip portion 59 of the finished shell also sufficiently to effect a final shaping of the metal blank.

The plastic lip 59 is here pinched in finished metal rim 57 to form the whole shell extraction rim 47 composed of metal at 57 and plastic at 59.

In any event the combined metal and plastic deformation is begun as shown in FIG. 4, for example, where the blank of FIG. 1 is fed into the die cavity where the bore 68 of die 60 where punch extension 35 is alignable with the plastic bore 3 and the cup perforation 5. Die bore 68 is not only tapered as disclose but is also enlarged making an enlargement at 84 to receive the die plug 61 having a central opening 63 for receiving extension 35 acting as a guide bearing at one end of the die cavity while at the other end plunger 30 finally bears on the die guiding flange 69 in centered and guided relationship as the blank is compressed between the plunger and die to form the tubular shell wall portion 48.

At the same time, the compression of the plastic works a deformation of the metallic part of the blank at 7, 17, or 27 simultaneously with the plastic part of the blank to make a finished composite metal-plastic part of the article at the rim 47 where the projected plastic at 59 is also strengthened by compressive deformation between the body of plastic at base 49 and the body of deformed metal at 57. The result is a further improvement over a metal-plastic composite wherein the plastic is injection molded to final finished shape in a metal part of final finished shape.

According to a copending application of John S. Metcalf, Charles E. Miller, and Roy C. Olney, Serial No. 135,569, filed September 1, 1961, portion 48 is of sufficient length and improved strength to provide a terminal
part adapted to be trimmed, if necessary, and turned in to form the folded evanescent end closure 45 to which the plastic tube shell is especially adapted in combination with the skirted overpowdered rod arrangement 42 disposed in the fully loaded shell between the powder charge 41 and the shot 43, as taught in U.S. Patent No. 2,592,125 granted to R. S. Holmes. The tubular portion 48 of the shell according to the foresaid application is of a construction providing a plastic shell structure resistant to "shoot-off," i.e. severing of at least a portion of the front part of the shell from the rimmed head portion or the rest of the tubular portion.

It is preferred that, in each deformation, extension of the plastic occurs insofar as possible toward a converging end of a die passage, such as that in which the shell tube and shell rim form, especially the former.

Die bore 88 and its enlargement 84 form the die shoulder 85 opposed to face 65 of the movable die plug 62 to form an adjustable annular die cavity 86. Into this cavity during compression of the blank, both the metal edge 7 and the adjacent part of the plastic core are deformed to the configuration of cavity 86. As both metal and plastic are bulged outwardly, the face 65 and shoulder 85 are brought together in final spacing. The result, after the die apparatus is put in its hereinafter described closed position, is shown in FIG. 5, where a lip 59 of the plastic has been deformed outwardly to project from the base 49 between the metal walls 57 of the finished shell rim 47. The result is not only a simultaneous fabrication of the metal cup at the rim and of the plastic base at the rim, but also a strengthening and locking action.

In the finished shell of FIG. 6, this action includes a compression of part of the plastic base 49 between metal rim 47 and the primer tabs 48 to also improve the grip on the primer 49.

By binary deformation is meant the complete simultaneous formation of metal and plastic.

The concavo-convex end shape in the blank may be varied from a rather shallow dished end to a deeply recessed end, each providing a relatively thick tapered annulus preferred for concomitant wedge action where the deformation is to be extensive as it is in the tube as compared to the rim where binary deformation is relied upon.

These skilled in the art may make various changes in the embodiments described and now believed preferred without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. The method of fabricating a metal-headed, resinous plastic shot shell case having a relatively thick generally cylindrical base portion, a relatively thin tubular wall portion extending from one end of said base portion longitudinally to at least a final finished length terminating in an open end, and a rim flange portion extending radially from the other end of said base portion, said portions being integrally formed from one piece of resinous plastic material, and a metal head encasing at least a part of said base portion to extend over the rim flange portion, said method comprising

(a) nesting a core of said material in the solid state within a mating cup-shaped piece of said metal to form a blank in a die in its open position, said metal piece having the configuration of a partially formed shot shell head, and
(b) deforming both said pieces simultaneously as said die is put into its closed position to form out of said core said wall portion to at least said length and

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form said flange portion while forming said base portion, all in said solid state, and to radially bulge by the plastic material and upset axially said metal piece at least in part to the finished shape of said head.

said method thereby providing said case having said portions and a finished metal head locked in place about said flange portion.

2. The method of claim 1 wherein the material is a polyolefinic polymer.

3. A metal-headed, resinous plastic shot shell case having a relatively thick generally cylindrical base portion, a relatively thin tubular wall portion extending from one end of said base portion longitudinally to at least a final finished length terminating in an open end, and a rim flange portion extending radially from the other end of said base portion, said portions being integral, said case being formed from a blank comprising in assembly

(1) a core of resinous plastic material in the solid state having a construction such as to include a height in excess of the thickness of said core but less than said length and to include a sufficiency of said material to be longitudinally and radially deformable out of said core to provide said wall portion to at least said length and to provide said flange portion, respectively, while forming said base portion and

(2) a cup-shaped piece of metal containing said core and being of a size so as to adapt said piece to receive said core and be received with said core concentrically in a die for simultaneous deformation with said core in said die having the final finished configuration of the finished case, said metal piece having the configuration of a partially formed shot shell head and being at least in part bulgeable radially by said plastic material,

said blank being thereby adapted to be formed into a case with said portions including a finished metal head locked in place about said flange portion.

4. The case of claim 3 from a blank including an embryonic rim bulge adapted for reception of part of the material and deformation of both said bulge and received material to the final finished shape of the shot shell rim.

5. The case of claim 3 from a blank for making a shot shell case of predetermined gage wherein the core material is a polyolefinic polymer with a central aperture and a height at least that of the metal piece, said piece having a central aperture and having at least adjacent the bulgeable part of said piece a diameter substantially of said gage.

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