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[redacted]

[11] **3,580,122**

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[54] APPARATUS FOR MAKING KNOCKOUTS IN ELECTRICAL BOXES FORMED OF PLASTIC MATERIAL

16 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **83/108,** 83/128, 83/182, 83/194, 83/685, 83/695
[51] **Int. Cl.** **B26d 7/18,** B26f 1/14
[50] **Field of Search** 117/49; 83/108, 124, 125, 127, 128, 181, 182, 194, 685, 690, 695

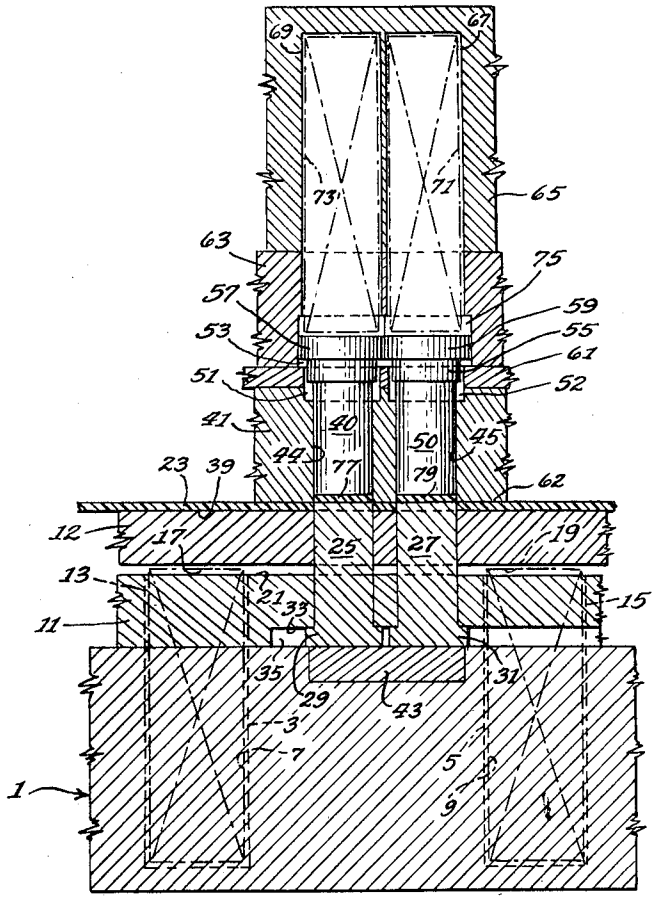
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ABSTRACT: Knockouts are formed in electrical fixtures, such as connector boxes made of plastic sheet material, by punching the knockouts from plastic sheet or blanks prior to shaping into the fixture or by shaping the fixture and then punching out the knockouts. By resiliently supporting the material surrounding the knockout area on the punch side and resiliently biasing a knockout stripper against the surface of the knockout opposite that contacted by the punch, knockouts can be punched out and replaced in the material in a single operation if the opposite biasing forces of the support and knockout stripper are properly correlated.



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SHEET 1 OF 2

Fig. 3.

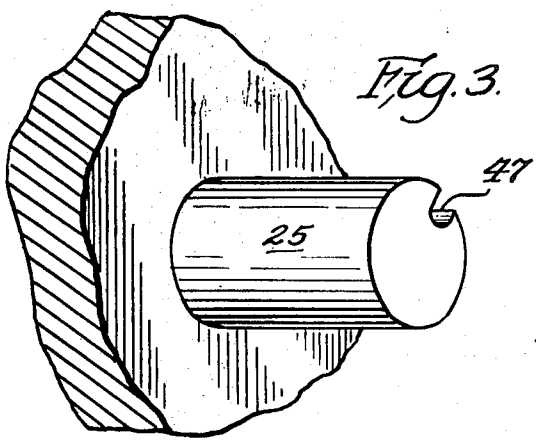


Fig. 4.

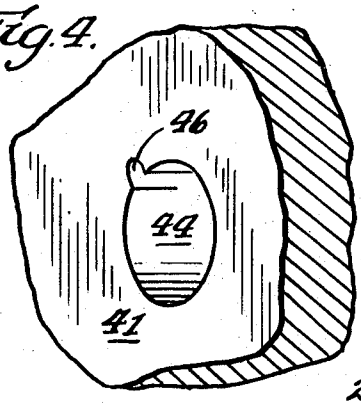


Fig. 1.

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Fig. 5.

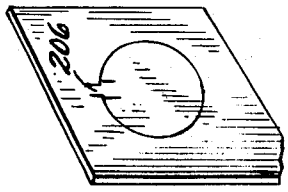


Fig. 2.

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APPARATUS FOR MAKING KNOCKOUTS IN ELECTRICAL BOXES FORMED OF PLASTIC MATERIAL

BRIEF SUMMARY OF THE INVENTION

This invention is directed to plastic electric fixtures, such as electrical boxes, containing knockouts and apparatus and method for making such knockouts. In fabricating electrical boxes and other fixtures it is necessary to form knockouts which can be easily removed from the box for the purpose of permitting electrical wires to pass therethrough and for fastening the ends of the conduits through which the wires pass.

It has been discovered that knockouts can be formed in the sheet (from which the box is formed) in a continuous manner prior to cutting the box blanks from the sheet by supporting the sheet area surrounding the punch against a spring-mounted stripper plate by means of springs which normally hold the plate in a predetermined position but which permit the plate to be depressed during the punching operation. One or more knockout punches are fixedly mounted so that they extend through holes in the plate with their end surfaces coplanar with the surface of the stripper plate when the stripper plate is in normal position. The die cavity contains a knockout stripper element which is spring-biased in the direction of the knockout punches and is slideably mounted in the die cavity. When the die is actuated on its work stroke, the spring-biased knockout stripper is biased against the plastic sheet. The plastic sheet is held tightly between the stripper plate and the die, causing the knockout to be punched out of the sheet and held between the knockout punch and the knockout stripper. On the release stroke of the die the springs force the stripper plate and sheet upwardly. The opposing biasing force of the knockout stripper and stripper plate springs is sufficient to reinsert the knockout in the hole from which it was punched in substantially coplanar relationship with the sheet, whereupon the die engages the knockout stripper causing it to move in unison with the die. The sheet is then free to be advanced to the next station.

When the article is preformed before the knockouts are punched the operation can be performed by placing the article on a fixed die shaped so as to enable the shaped article to fit snugly thereon, and the knockouts are punched with a moving punch. The articles can be placed on and removed from the die by hand or by a suitable mechanism. Otherwise the essential operation is the same as that described in connection with the punching of sheet material.

It is an object of the invention to provide apparatus for forming punched knockouts in plastic sheet. It is another object of the invention to provide an apparatus for forming knockouts in preformed plastic articles intended for use as electrical fixtures.

It is still another object of the invention to provide a method for forming punched knockouts in plastic sheet material or preformed plastic articles.

Still another object of the invention is to provide plastic bodies with punched knockouts that can be readily removed.

SHORT DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross section through the center of the apparatus for punching knockouts in plastic sheet material in accordance with the invention;

FIG. 2 is a two position vertical cross section through the center of apparatus for punching knockouts in formed plastic articles;

FIG. 3 is a fragmentary perspective view of a punch;

FIG. 4 is a fragmentary perspective view of a die; and

FIG. 5 is a fragmentary perspective view of an electrical box showing a knockout formed in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, the numeral 1 represents a die shoe which is solidly mounted to the floor. The die shoe has recesses 3 and 5 to receive helical coil springs 7 and 9 respectively.

Removably mounted on the die shoe 1 is a punch holder 11 formed with holes 13 and 15 to allow the springs 7 and 9 to pass therethrough. Tops 17 and 19 of the springs 7 and 9, respectively, extend above the upper surface 21 of the punch holder 11 so that the normal distance between punch holder 11 and stripper plate 12 is somewhat greater than the thickness of the plastic sheet 23 which is to be fed into the device to insure the forming stroke length that is desired.

Mounted in the punch holder 11 are punches 25 and 27 formed with enlarged bottoms 29 and 31 to provide shoulders for abutting against the surface 33 of the recess 35 in the bottom of the punch holder 11. Punches 25 and 27 pass through aligned holes in the punch holder 11 and stripper plate 12. Stripper plate 12 is mounted on coil springs 17 and 19 with its upper surface 39 coplanar with the upper surfaces of punches 25 and 27 when the plate is in its normal position. As shown in the drawing (FIG. 1), the plate is in depressed position as a result of the knockout die 41 being at the end of its power stroke. A block 43 fits in a recess in the upper surface of die shoe 1 to provide a bearing surface for the knockout punches 25 and 27.

Immediately above stripper plate 12 is the knockout die 41 with cavities 44 and 45 in alignment with the knockout punches 25 and 27. The die is preferably formed with a small groove 46 (see FIG. 4) extending along each die cavity and each punch is formed with a somewhat larger groove 47 (see FIG. 3) extending inwardly from the outer wall of the punch in order to allow a small tab 206 (FIG. 5) to remain holding the knockout to the sheet. Within the die cavities are mounted knockout strippers 40 and 50 which are snugly and slidably mounted. The upper portions of the die cavities are enlarged at 51 and 52 to receive the enlarged portions 53 and 55 of the knockout strippers. The heads 57 and 59 of the knockout strippers are further enlarged to form shoulders to abut against release plate 61 mounted on the top of the die 41. The release plate 61 is formed with openings to accommodate the enlarged portions 53 and 55 of the knockout strippers.

The enlarged head elements 57 and 59 are adapted to contact release plate 61 when the bottom surfaces of the knockout strippers 49 and 50 are substantially coplanar with the bottom surface 62 of die 41.

Mounted above release plate 61 is a spacer 63, the upper surface of which abuts the combination spring retainer and actuator 65. The element 65 is formed with recesses 67 and 69 in which to accommodate coil springs 71 and 73. The upper ends of the coil springs 71 and 73 abut the top of the element 65 and the lower ends of the springs abut the top surface of the knockout strippers 40 and 50 and bias them in the direction of the knockout punches 25 and 27. Springs 71 and 73 have sufficient compressive strength to resist the tendency of knockout strippers 40 and 50 to move upwardly until engaged by release plate 61. The actuator element 65 is caused to reciprocate by a power means, not shown, over a limited stroke longer than the thickness of the plastic sheet 23. The spacer element 63 is formed with a cavity 75 sufficiently large to accommodate the enlarged heads 57 and 59 of the knockout strippers 49 and 50 and permit the spacer 63 to move both downwardly and upwardly without abutting the heads 57 and 59.

The operation of the device is as follows: a roll or strip of plastic sheet material 23 is fed by an intermittent feeding means, not shown, over the stripper plate 12 between the punches 25 and 27 and the die 41. While the sheet 23 is in a stationary position, the actuating mechanism for the actuator 65 depresses the die 41, causing the punches 25 and 27 to punch circular knockouts 77 and 79 from the sheet 23. Since the punches 25 and 27 are stationary, the sheet moves downwardly with the die 41 and stripper plate 12 with the knockouts 77 and 79 being gripped between the knockout punches and corresponding knockout strippers. On its release or upward stroke, as the die moves upwardly, the release plate 61 abuts the shoulders formed by the enlarged heads 57 and 59 of the knockout strippers but only after the sheet 23

gripped between the stripper plate and the die rises to its normal position under the bias of springs **7** and **9** so that the knockouts are reinserted in the holes from which they were punched. The release plate **61** engages the knockout strippers and releases the knockouts when the knockouts are inserted flush with the surface of the sheet **23** by reason of the fact that the spacing between the release plate **61** and the lower surfaces of the heads **57** and **59** at the end of the former stroke is substantially the same as the thickness of the sheet.

When the die **41** is lifted free of the sheet **23**, the feeder automatically feeds the sheet to the next station and the process is repeated.

It will be evident that any desirable number of knockouts can be punched simultaneously in the sheet. Although I have only shown two punches, the number may be equal to the number required to punch all the knockouts out of a section of the sheet necessary to form a box. It will also be obvious that the stripper plate may be supported by a number of springs greater than two.

After the knockouts are punched and the sheet released as just described, the sheet continues to advance and may then be cut into the blanks of the desired shape and size containing the knockouts ready for cold-forming.

Referring to FIG. **2**, the numeral **100** indicates a shoe having sidewalls **102** and **104** mounted thereon. A hardened steel plate **106** is fastened to each of the walls **102** and **104**.

Spaced inwardly from the walls **102** and **104** are punch holders **108** and **110**. The punch holders are fastened to the shoe **100**. Mounted in the punch holders **108** and **110** are punches **112** and **114** respectively. The punches are formed with elongated grooves **116** and **118** similar to those shown in FIG. **3**. Punches **112** and **114** are snugly and slidably mounted in punch holders **108** and **110** respectively.

Punch **112** is fastened to a spacer plate **120** and to an actuator **122** by means of bolt **124** passing through a central hole in the actuator and plate and threaded into a threaded recess in the punch **112**. Actuator **122** is formed with cam surface **125**. Punch **114** is similarly fastened to spacer **126** and actuator **128** by means of bolt **130** passing through central openings in the spacer plate **126** and actuator **128** and threaded into a threaded recess in punch **114**. Actuator **128** is formed with cam surface **132**. Punch holder **108** is provided with hardened steel plates **134** and **136** between which the spacer plate **120** and the actuator **122** are adapted to slide. Holder **110** is similarly equipped with hardened steel plates **138** and **140** between which the spacer plate **126** and actuator **128** are adapted to slide. Punch holder **108** is provided with two or more equally spaced passageways **142** through each of which is adapted to pass a coiled spring **144**, the inner end of which is seated in a recess **145** in spring retainer **146** and the outer end of which is seated in a recess in stripper plate **148**. Stripper plate **148** is slidably mounted on the punch. Springs **144** normally hold plate **148** in a position such that its surface is coplanar with the nose surface of punch **112**. Similarly, punch holder **110** is provided with two or more passageways through each of which passes a coil spring, the inner end of which is retained in spring retainer **150** and the outer end of which is retained in stripper plate **152**.

Each punch holder is also provided with two or more equally spaced recesses **154** between recesses **145** in which seat one end of coil springs **156**. The other end of springs **156** seat in recesses **157** in spring retainers **146** and **150**. The force of springs **156** is sufficient to return the punch to its normal position shown on the left-hand side of the drawing.

Mounted on the shoe **100** between the two punches is die block **158** having die cavities **160** and **162** aligned with punches **112** and **114** respectively. The end portion of each die cavity is counterbored and there is inserted therein a hardened steel inserts or rings **164** and **166**, against which knockout strippers **168** and **170**, respectively, slide. The inserts or rings **164** and **166** are formed with elongated grooves **172** and **174**, respectively, aligned with grooves **116** and **118** in punches **112** and **114** in order to allow the knockout punch to retain a tab to fasten it to the article in which it is formed.

Mounted in the die cavities **160** and **162** are knockout strippers **168** and **170** having cam surfaces **176** and **178**. The strippers **168** and **170** are biased outwardly by biasing element **180** having conical cam surface **182** which coacts with the cam surfaces **176** and **178**. Biasing element **180** is forcibly held against the knockout strippers **176** and **178** by means of a coil spring **183** or other resilient force. The lower end of the biasing element **180** is mounted in guide **184** which is fastened to shoe **100** by means of suitable bolts **186** threaded into the shoe. In addition to acting as a retaining means for spring **183**, shoulder **188** limits the upward travel of biasing element **180**.

Mounted on power actuated reciprocating beam **190** are cams **192** and **194** in alignment with the space between the wall **102** and holder **108** and the wall **104** and the holder **110**, respectively. Cam **192** and **194** are formed with cam surfaces **196** and **198** which are adapted to engage the cam surfaces **125** and **132**, respectively, during the power stroke of the beam. The width of the cams **192** and **194** is such that when they enter the spaces **200** and **202**, respectively, they force the punches toward the die block for a distance sufficient to punch a knockout from the article mounted on the die as shown on the right-hand side of the drawing.

The drawing is split into two parts; the right half showing the apparatus in position when a knockout has been punched and the left half in position of release.

The operation of the apparatus is as follows. An electrical box or other electrical fixture made of plastic sheet material is mounted on the die block **158** while the punches are in release position. As the beam **190** descends the cams **192** and **194** enter the spaces **200** and **202**, respectively, forcing the punches and the stripper plates against the outer surface of the article to be punched. As the punch moves to the left, as shown on the right-hand side of the drawing, a knockout is punched but remains fastened to the article by means of the tab **206**. Knockout stripper **170** is forced to the left as the knockout is being formed but by reason of the fact that it is biased toward the the punch, the knockout is held tightly between the knockout stripper and the punch.

During the release stroke, the stripper plate as shown on the right side of the drawing remains in contact with the face of the article in which the knockout is formed until the knockout stripper **170** forces the knockout back into the hole from which it was punched and into substantially coplanar relation with the surface of the article as shown on the left side of the drawing. The stripper plate **152** will remain pressed against the surface of the article until the cam **194** during its release stroke allows punch **114** to return to a position out of contact with the knockout. As the springs **156** force the punch, spacer and actuator rearward to fully release position as shown on the left side of the drawing, the stripper plate is released from contact with the article. The apparatus is then ready to have the punched-out article removed and another blank inserted on the die block.

The force of the springs **144** which bias the stripper plates against the surface or area surrounding the knockout and the opposing force of the resilient means **183** forcing the knockout stripper against the knockout are sufficient to cooperate to force the knockout back into the hole from which it was punched, the release stroke of the punch, so that at the end of the operation the knockout is replaced or reinserted in the material in substantially coplanar relationship therewith and held in place by a small tab as shown in FIG. **5**. The knockout can then be removed from the article in either direction simply by pushing it out with the thumb or other finger and breaking the tab by bending the knockout. The tab arrangement provided thus permits the knockout to be broken off outside the circumference of the hole formed by the knockout.

Although the invention is applicable to various types of plastic material and articles which have the required ductility and resiliency, it is particularly applicable to the formation of knockouts in sheet and articles made from acrylonitrile-butadiene-styrene copolymers generally known as ABS, such as those sold by Rohm and Haas Company under the name

Kydex and alloys of ABS and PVC (polyvinyl chloride) sold under the names Cycovin KR and Royalite 20 by Marbon Chemical Company and Uniroyal, Inc. respectively.

I claim:

1. A device for forming knockouts in plastic sheet material comprising:
   a. a spring-supported plate;
   b. a rigidly mounted punch element extending through said plate so that the end of said element is in approximately the same plane as said plate when the latter is in its normal position;
   c. a die element in alignment with said punch element and adapted to be reciprocated toward and away from said punch element;
   d. a knockout stripper snugly and slidably mounted in the cavity of said die;
   e. spring means biasing said knockout stripper toward said punch element;
   f. spring means biasing said plate toward said knockout stripper;
   g. said die element and said knockout stripper having cooperating means to prevent said knockout stripper from projecting beyond the face of said die element and to move said knockout stripper in the direction of the die during its release stroke;
   h. said spring means being sufficiently strong to return the knockout to a position in the plastic sheet material substantially coplanar therewith at the same locus from which the knockout is cut; and
   i. said punch and die elements being formed with aligned grooves of different sizes to form a tab connecting the knockout to the plastic sheet material that is located outside the periphery of the knockout.

2. A device in accordance with claim 1 in which the punch element extends upwardly through said plate from a rigidly mounted punch holder and the plate is supported in a horizontal position by springs resistant to compression.

3. A device in accordance with claim 1 in which said knockout stripper cooperating means is a shoulder formed adjacent one end of said stripper and said die element cooperating means is a plate, extending into the die cavity, which engages said shoulder.

4. A device in accordance with claim 1 in which said spring supported plate is located above a solid base so that in its normal position the space between said base and said plate is at least as great as the thickness of the sheet material.

5. A device in accordance with claim 1 in which said knockout strippers are movable toward and away from the sheet material.

6. A device in accordance with claim 1 in which said cooperating means are arranged to move said knockout stripper free of the knockout when said die member is moved free of the sheet on its release stroke.

7. A device in accordance with claim 1 in which said knockout stripper cooperating means is a shoulder formed adjacent one end of said stripper and said die element cooperating means is a plate, extending into the die cavity, which engages said shoulder.

8. A device in accordance with claim 1 in which said spring supported plate is located above a solid base so that in its normal position the space between said base and said plate is at least as great as the thickness of the sheet material.

9. A device in accordance with claim 1 in which said knockout strippers are movable toward and away from the sheet material.

10. A device in accordance with claim 1 in which said cooperating means are arranged to move said knockout stripper free of the knockout when said die member is moved free of the sheet on its release stroke.

11. A device for forming a knockout in plastic material having substantially parallel opposite surfaces comprising:
   a. a stationary die;
   b. a movable knockout punch aligned with said die;
   c. means for reciprocating said punch to and from operational and release positions;
   d. a resiliently biased knockout stripper mounted in said die and biased toward said punch;
   e. a support surrounding said punch and resiliently biased toward said die;
   f. means for resiliently biasing said knockout stripper and said support toward each other during the release stroke of said punch with sufficient force to return said knockout to the space in said material from which it was punched during the punching stroke of said punch, in substantially coplanar relationship with said material; and
   g. said punch and die being formed with aligned grooves of different sizes to form a tab connecting the knockout to the plastic material that is located outside the periphery of the knockout.

12. A device in accordance with claim 11 in which:
   h. said punch is actuated during its punch stroke by means of a cam mechanism and is released by means of a spring mechanism.

13. A device in accordance with claim 11 in which:
   h. said knockout punch is biased by means of a combination cam and resilient mechanism.

14. A device in accordance with claim 12 in which:
   i. said die contains knockout strippers operated in opposite directions on opposite sides of said die by a common cam and resilient biasing means; and
   j. separate punches, aligned with the opposite sides of said die, are actuated by a common actuator.

15. A device in accordance with claim 11 in which:
   h. said knockout punch is biased by means of a combination cam and resilient mechanism.

16. A device in accordance with claim 11 in which:
   i. said die contains knockout strippers operated in opposite directions on opposite sides of said die by a common cam and resilient biasing means; and
   j. separate punches, aligned with the opposite sides of said die, are actuated by a common actuator.