

Sept. 29, 1970

J. G. BURNS

3,530,541

MOLD FOR ENCAPSULATING ELECTRICAL COMPONENTS

Filed June 13, 1968

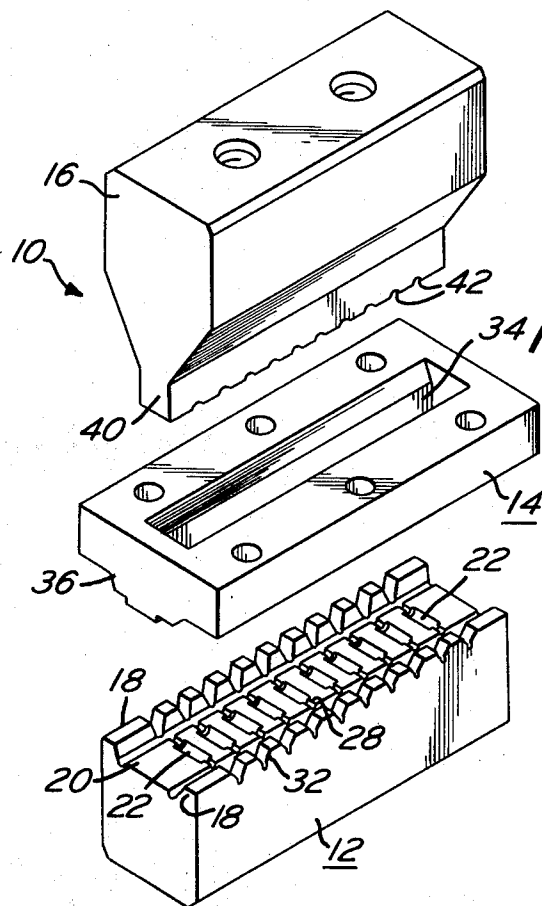


FIG. 1

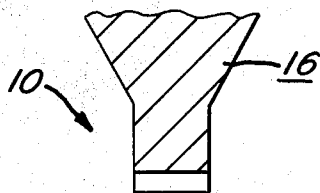


FIG. 2

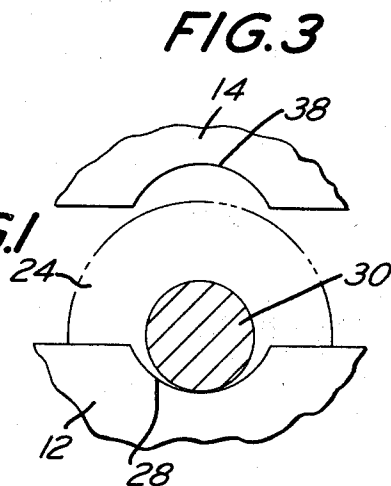
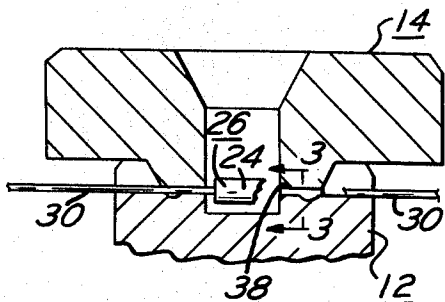


FIG. 4

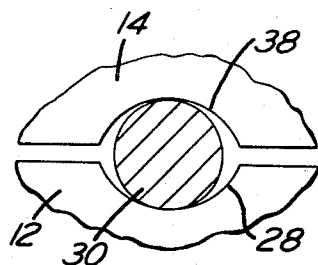


FIG. 5

INVENTOR
JEROME G. BURNS

BY *Donald B. Glen*
ATTORNEY

1

3,530,541

MOLD FOR ENCAPSULATING ELECTRICAL COMPONENTS

Jerome G. Burns, Moorestown, N.J., assignor to TRW Inc., Philadelphia, Pa., a corporation of Ohio
Filed June 13, 1968, Ser. No. 736,827
Int. Cl. B29c 6/00; B29d 3/00
U.S. Cl. 18—36

6 Claims

ABSTRACT OF THE DISCLOSURE

A mold for encapsulating electrical components in a plastic jacket by compression molding without forming any flash around the terminal wires of the components. The mold has a pair of portions which mate to provide a mold cavity. The mold cavity is adapted to receive the electrical component being encapsulated with the terminal wires of the component extending beyond an end or ends of the mold cavity. The mold also includes a pair of portions having surfaces which mate at the end or ends of the mold cavity from which the terminal wires of the electrical component extend. The mating surfaces have opposed mating grooves therein which receive and surround the terminal wires. The grooves are shaped to form a tight seal between the grooves and the terminal wires without pinching the terminal wires between the mating surfaces. This seal prevents any excess molding material from flowing from the mold cavity along the terminal wires so as to prevent the formation of flash along the terminal wires.

BACKGROUND

Many types of electrical components, such as resistors, capacitors, diodes, etc., are encapsulated in a protective jacket of an electrically insulating plastic with the terminal wires of the components projecting from the protective jacket. The easiest and least expensive manner of encapsulating such components on a mass production basis is to compression mold the plastic jacket around the components. A problem raised by encapsulating electrical components by compression molding has been the removal of the flash which is formed completely around each of the encapsulated components, including along a portion of the terminal wires. Although the flash is thin and brittle, it has been found to be difficult to completely remove the flash from around the terminal wires right up to the encapsulated jacket. Since the complete removal of the flash from around the terminal wires of the electrical components is a specific requirement by many users of the components, it is desirable to be able to encapsulate the components by compression molding without getting any of the flash on the terminal wires of the components.

In my co-pending patent application Ser. No. 640,995, filed May 24, 1967, entitled "Mold for Encapsulating Electrical Components," now Pat. No. 3,471,900, there is described a compression mold for encapsulating electrical components without the formation of flash around the terminal wires. This mold includes mating portions which fit around the terminal wires at the ends of the mold cavities and shield the terminal wires to prevent the formation of flash around the terminal wires. This requires that a seal be provided between the shielding portions of the mold and the terminal wires which is sufficient to prevent the flow of excess mold material along the terminal wires during the molding operation. However, difficulties have been found in providing a satisfactory seal between the mold and the terminal wires, particularly in a mold for use in the mass production of the encapsulated electrical components because of slight

2

variations in the diameter of the commercial wires from which the terminal wires are made and because the alignment of the terminal wires is not exactly uniform on all the electrical components. Therefore, it is desirable to have a mold which provides a satisfactory seal around the terminal wires without damaging the terminal wires even though there may be a variation in the diameter or alignment of the terminal wires.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a novel mold for encapsulating electrical components in a plastic jacket without the formation of flash around the terminal wires of the components.

It is another object of the present invention to provide a mold for encapsulating electrical components in a plastic jacket which provides a seal between the mold and the terminal wires of the components so as to prevent the flow of the plastic molding material along the terminal wires and thereby prevents the formation of flash around the terminal wires.

It is a further object of the present invention to provide a mold for encapsulating electrical components in a plastic jacket which provides a good seal around the terminal wires to prevent the formation of flash around the terminal wires even though the diameter and the alignment of the terminal wires may vary slightly.

Other objects will appear hereinafter.

BRIEF DESCRIPTION OF DRAWINGS

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a perspective view of a mold having the sealing means of the present invention with the mold in its open condition.

FIG. 2 is a transverse sectional view of the mold of FIG. 1 with the mold in partially closed condition.

FIG. 3 is a sectional view of a portion of the mold taken along line 3—3 of FIG. 2 but with the mold in its open condition.

FIG. 4 is a view similar to FIG. 3 with the mold section in partially closed condition.

FIG. 5 is a view similar to FIG. 3 with the mold section in completely closed condition.

DESCRIPTION OF INVENTION

Referring initially to FIG. 1 of the drawings, the mold shown and generally designated as 10 is of the general construction described in my co-pending application Ser. No. 640,995. Mold 10 comprises three sections 12, 14 and 16. The bottom section 12 is the bottom cavity section. The middle section 14 is the side wall and shield section. The top section 16 is the top cavity and force section.

The bottom section 12 is rectangular having a length greater than its other two dimensions. A pair of flanges 18—18 extend upwardly from the top surface 20 of the bottom section and extend completely along the side edges of the bottom section. A plurality of spaced, parallel, semicylindrical mold cavities 22 are provided in the top surface 20 of the bottom section 12. The mold cavities 22 are arranged in alignment with the longitudinal axis of each cavity extending between the flanges 18. As shown in FIG. 2, each of the cavities 22 is adapted to receive the body portion 24 of an electrical component 26 to be encapsulated. At each end of each of the mold cavities 22, the top surface 20 of the bottom section 12 has a shallow groove 28 extending from the end of the

mold cavity to the adjacent flange 18. The grooves 28 at each end of each of the mold cavities 22 are in longitudinal alignment and are adapted to receive the terminal wires 30 of the electrical components 26 to be encapsulated. The details of the dimensions of the grooves 28 will be described later. Each of the flanges 18 has a plurality of spaced notches 32 therein with each notch 32 being located at the end of a separate one of the grooves 28 and extending to the bottom of the adjacent groove 28.

The middle section 14 comprises a relatively thick, rectangular plate having a length equal to the length of the bottom section 12 and a width at least as wide as, but preferably slightly wider than, the width of the bottom section. A rectangular opening 34 is provided through the center of the middle section 14. The opening 32 is of a width equal to the length of the mold cavities 22 in the bottom section 12 and of a length slightly shorter than the length of the middle section. A rib 36 extends downwardly from the bottom surface of the middle section 14 and extends longitudinally along the center of the bottom surface for the full length of the middle section. The rib 36 is shaped to fit snugly in the top surface 20 of the bottom section 12 between the flanges 18. A plurality of shallow grooves 38 are provided in and extend transversely across the bottom surface of the rib 36. The grooves 38 are of the same shape and size as and are positioned to mate with the shallow grooves 28 in the top surface of the bottom section 12.

The top section 16 is substantially rectangular and of a length equal to the length of the opening 34 in the middle section 14. A plunger 40 extends longitudinally along the full length of the top section. The plunger 40 is of a shape and size to fit snugly in the opening 34 in the middle section. A plurality of spaced, parallel, semi-cylindrical mold cavities 42 are provided in and extend transversely across the bottom surface of the plunger 40. The mold cavities 42 are of the same size as and are positioned to mate with the mold cavities 22 in the bottom section 12.

Referring to FIG. 3, each of the shallow grooves 28 and 38 in the bottom section 12 and middle section 14 respectively has a transverse cross-section which is a portion of a circle the radius of which is generated from a point offset from the "split line" of the mold. The "split line" is the surfaces of the mold sections adjacent the grooves which come into mating contact when the two sections of the mold are brought together. Thus, the groove 28 in the bottom section 12 has a radius generated from a point above the top surface 20 of the bottom section, and the groove 38 in the middle section has a radius generated from a point below the bottom surface of the rib 36. By having the radius of the grooves 28 and 38 generated from a point offset from the split line, the grooves have a width as measured parallel to the split line which is greater than twice the depth of the grooves as measured perpendicular to the split line. For reasons which will be explained later, the radius of the grooves 28 and 38 is chosen so that the width of the grooves is larger than the nominal diameter of the terminal wires 30 of the electrical components 26 and the depth of the grooves is smaller than the radius of the terminal wires. Preferably, the width of the grooves 28 and 38 is approximately 20% larger than the diameter of the terminal wires 30 and the depth of the grooves is approximately 10% less than the radius of the terminal wires.

To encapsulate electrical components in the mold 10, the bottom section 12 and the top section 16 are heated to the proper molding temperature for the molding material being used by means of suitable heating means, not shown, which may be attached to the mold sections. With the old sections 12, 14 and 16 being separated, the electrical components 26 are seated on the bottom section 12 with the body portion 24 of each of the com-

ponents fitting in a mold cavity 22 and the terminal wires 30 fitting in and extending along the grooves 26. The bottom section 12 and the middle section 14 are then brought together until the rib 36 on the middle section 14 is seated on the top surface 20 of the bottom section as shown in FIG. 2.

When the bottom section 12 and the middle section 14 are brought together, each of the grooves 38 will fit around the upper portion of a separate terminal wire 30. Since the combined depths of a groove 28 in the bottom section 12 and the mating groove 38 in the middle section 14 are less than the diameter of the terminal wire 30, the surface of the groove 38 will engage the terminal wire 30 before the bottom surface of the middle section engages the top surface 20 of the bottom section 12 as shown in FIG. 4. When the mold sections 12 and 14 are brought completely together, the terminal wires 30 are compressed and deformed to a substantially elliptical shape as shown in FIG. 5. This provides a sealing contact between the terminal wire 30 and the surface of the grooves 28 and 38 over almost the entire surface of the terminal wire leaving only small gaps at the side edges of the grooves. It has been found that by properly sizing the grooves 28 and 38 as previously described, a seal can be provided over as much as 95% of the surface of the terminal wire. However, it is highly desirable to have a small gap at each side of the groove. These gaps provide room for additional material of the terminal wire if the terminal wire is slightly oversize. Also, the provisions of the gaps substantially eliminates the possibility of the terminal wire being pinched between the surface of the mold sections at the sides of the grooves. Such a pinching of a terminal wire would not only adversely damage and weaken the terminal wire, but would also prevent complete mating of the mold sections. Thus, there is provided a seal between the mold sections and the terminal wires at the ends of the mold cavities which seal is obtained even though there may be some variation in the diameter of the terminal wires. Also, since the grooves 28 and 38 are wider than the diameter of the terminal wires 30, slight misalignments of the terminal wires will not affect the obtaining of the seal.

After the middle section 14 and the bottom section 12 are brought together to provide the shield around the terminal wires 30 at the ends of the mold cavities 22, the molding material, which is in powdered form, is charged into the mold cavities 24 in the bottom section 12. The top section 16 is then lowered so that the plunger 40 extends into the opening 34 in the middle section 14. The top section 16 is forced downwardly to compress the molding material within the mating mold cavities 22 and 42 and around the body portions 24 of the electrical components 26. The heated bottom section 12 and the top section 16 will heat the molding material until the material melts and then cures. When the molding material melts, any excess material, which is normally included to insure complete encapsulation of the electrical components, will be forced out of the mating mold cavities and will flow between the bottom surface of the plunger 40 and the top surface 20 of the bottom section 12. However, because of the seal between the terminal wires 30 and the grooves 28 and 38 of the bottom section and middle section, the molding material will not flow along the terminal wires beyond the ends of the mold cavities. Although there are gaps between the terminal wires 30 and the surface of the grooves 28 and 38 at the sides of the grooves, by properly dimensioning the grooves as previously described, these gaps will be so small that none of the molding material will flow therethrough. However, even if a small amount of the mold material does flow into the gaps to form a flash, such flash can be easily removed since it does not extend completely around the terminal wire, it is substantially triangular in shape and it is seated on the

sharper corner of the now substantially elliptical terminal wires.

When the molding material is cured, the mold sections 12, 14 and 16 are separated leaving the encapsulated electrical components seated on the bottom section 12. The encapsulated electrical components are generally connected by a thin web of the flash which extends between the encapsulating jackets of the electrical components. However, since the terminal wires were sealed between the bottom section 12 and the middle section 14, the terminal wires are generally free from flash right up to the encapsulating jacket. The electrical components can then be easily separated by breaking the thin webs of flash which connect the components and removing the flash up to the surface of the encapsulating jacket.

Although the construction of the terminal wire receiving grooves for providing a seal between the terminal wire and the grooves has been described with regard to a three-section compression mold, the same construction can be used for the same purpose in a two section transfer mold. The sections of such a transfer mold include in their mating surfaces mating semicylindrical mold cavities, mating shallow terminal wire receiving grooves extending from the ends of the mold cavities and of the construction described above with regard to the grooves 28 and 38 of the bottom and middle section 12 and 14 of the mold 10, and passages extending to the mold cavities through which the molding material in a fluid state is forced into the mold cavities. In such a transfer mold the terminal wire receiving grooves seal around the terminal wires to prevent the flow of the mold material from the mold cavities along the terminal wires.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. A mold for encapsulating the body portion of an electrical component in a plastic jacket with at least one terminal wire extending from the body portion through and beyond the plastic jacket, said mold comprising mating sections having a first pair of mating surfaces, opposed mating mold cavities in said first pair of mating surfaces, said mold cavities being adapted to receive the body portion of an electrical component to be encapsulated with at least one terminal wire of the component extending from an end of the mating mold cavities, a second pair of mating surfaces, said second pair of mating surfaces adapted to mate at a split line at the end of the mating mold cavities from which the terminal wire of the electrical component extends, and opposed mating shallow grooves in said second pair of mating surfaces, said grooves extending from the said end of the mold cavities and adapted to receive the terminal wire therebetween and form a seal

therearound, the transverse cross-section of each of said grooves being a portion of a circle the radius of which is generated from a point offset from the split line of said second pair of mating surfaces and the width of each of said grooves measured parallel to the split line being greater than twice the depth of the grooves measured perpendicular to said split line.

2. A mold in accordance with claim 1 in which the width of each of said grooves is larger than the diameter of the terminal wire of the electrical component to be encapsulated, and the depth of each of said grooves is smaller than the radius of the terminal wire.

3. A mold in accordance with claim 2 in which the width of each of said grooves is approximately 20% larger than the diameter of the terminal wire and the depth of each of said grooves is approximately 10% less than the radius of the terminal wire.

4. A mold in accordance with claim 1 for encapsulating an electrical component having two terminal wires extending from the body portion in which the second pair of mating surfaces has two pairs of the said opposed mating shallow grooves extending from the mold cavities with each pair of said grooves adapted to receive a separate one of the terminal wires and provide a seal therewith.

5. A mold in accordance with claim 4 for encapsulating an electrical component having the terminal wires extending from opposite ends of the body portion in which the second pair of mating surfaces extend across opposite ends of the mating mold cavities, and the two pairs of mating grooves extend from opposite ends of the mold cavities.

6. A mold in accordance with claim 1 including three sections, one of said sections having one of said first pair of mating surfaces and one of said second pair of mating surfaces, a second section includes the other of said second pair of mating surfaces and the third section includes the other of said first pair of mating surfaces.

References Cited

UNITED STATES PATENTS

2,176,604	10/1939	Benkelman.	
2,304,461	12/1942	Knowles.	
2,338,524	1/1944	McCabe.	
2,457,440	12/1948	Booth	249—95 X
2,516,086	7/1950	Winterhalter	249—95 X
3,142,716	7/1964	Gardener	249—95 X
3,345,692	10/1967	Cobaugh et al.	18—36
3,391,426	7/1968	Hugill	18—36
3,471,900	10/1969	Burns	18—36

J. HOWARD FLINT, Jr., Primary Examiner

U.S. Cl. X.R.

249—95, 97