METHOD OF FORMING COAXIAL CABLES

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This invention deals with the formation of elongated die cast bodies, such for example, as elongated insulator members between conductors of a coaxial cable. More particularly, the invention relates to a method which comprises forming an elongated die cast body of the class defined in a successive series of individual casting operations, and in such manner as to form a continuous integral body in the resulting elongated die cast member. Further, the invention deals more specifically, in the illustrated disclosure, in the formation of a spiral or helical insulator directly upon and as an integral part of an elongated conductor. Thus, from this standpoint, the method comprises the feeding of a conductor strand intermittently through a casting station in such manner as to form in a successive series of intermittent casting operations a continuous spiral or helix on said conductor. The novel features of the invention will best be understood from the following description when taken together with the accompanying drawing in which certain embodiments of the invention are disclosed, and in which the separate parts are designated by suitable reference characters in each of the views, and in which:

Fig. 1 is a diagrammatic sectional view of a machine employed for carrying my improved method into effect.

Fig. 2 is an enlarged detail view of a part of a conductor with a helical insulator thereon, and also diagrammatically showing part of the feeder mechanism.

Figs. 3 and 4 are views similar to Fig. 2, showing the operation of the feeder mechanism.

Fig. 5 is a diagrammatic cross sectional view through a coaxial cable made according to my improved method, and

Fig. 6 is a sectional detail view of a part of the construction shown in Fig. 1, and showing a modification.

In the conventional method of procedure in forming die castings, it has been the common practice to inject casting material into the cavity or impression, then separate the dies and remove the casting from the cavity or impression, and then to again close the dies and to form the next successive and independent casting.

With my present method, however, a totally different procedure is followed. In other words, an elongated die cast body, or in fact a body of more or less indefinite length is produced in a successive series of independent and intermediate casting operations in impressions or cavities of a die which remains fixed and closed at all times, and wherein one cast unit or section is formed directly upon and at the end of a previous cast section or unit so that in the finished elongated die cast product, a continuous unitary body or member is formed, substantially as though the entire elongated member had been formed in a single casting operation.

Furthermore, the present method deals with forming elongated die cast bodies of irregular contour, such for example, as a spiral or helix wherein the method comprises rotation of the die in each injection stroke of the machine or during each casting operation. The method may also include the use of supplemental dies movable relatively to the workpiece and the first named die for forming other integral rings like members at spaced intervals along the spiral or helix, as diagrammatically illustrated in Fig. 6 of the drawing.

In the accompanying drawing, and for the purpose of illustrating one adaptation and use of the invention, I have illustrated the method as applied to the formation of plastic castings from thermoplastic materials, and still more particularly in the formation of coaxial cables in which the spiral or helical plastic insulator is first formed upon a conductor strand, after which an outer conductor is arranged upon the helical or spiral insulator and then final castings or jackets of insulating material are disposed around the outer conductor.

While any type of casting materials may be employed in forming elongated die cast bodies in accordance with my method, the present illustration deals with the thermoplastic materials, and particularly materials which have the desirable dielectric properties, and I have found that such materials as polyethylene are suitable for this purpose. However, any type of plastic material capable of being cast in accordance with my method can be used.

The casting machine diagrammatically illustrated in the accompanying drawing, from the standpoint of the feed of the plastic material and operation of the plunger is substantially the same as the structures disclosed in prior Patents 2,244,423, June 3, 1941, and 2,272,220, February 10, 1942.

In Fig. 1 of the drawing only such parts of the machines of the kind disclosed in said patents are shown as to enable the present method to be understood. The casting mechanism of the machine is generally shown at 10 in Fig. 1 of the drawing, whereas the feeder mechanism of the
machine is shown at the left and generally identified by the reference 11.

The casting mechanism of the machine comprises a hopper 12 for the reception of powdered or granular plastic material. At the bottom of the hopper is a slide 13 having a measuring aperture 14 therein which measures the quantity of plastic material delivered in each stroke to the discharge chute 15 which is arranged over the funnel like member 16 arranged directly above the admission aperture 17 into the cylinder 18. The slide 13 has a depending arm 19 coupled with the outer end 20 of the tubular plunger, which plungers, through the ball bearing mechanism generally indicated by the reference 21.

It will thus be seen that in the forward stroke of the plunger, the slide 13 is also moved forward.

The plastic material delivered into the funnel 16 in the forward stroke of the slide 13 drops upon the forward reduced end 22 of the tubular plunger and in the retracted movement of the plunger, to the position shown in Fig. 1 of the drawing, this material then drops into the cylinder in position to be advanced in the next injection stroke. The quantity admitted into the cylinder is sufficient to form at least a single casting.

At 23 is diagrammatically illustrated the heating coil at the discharge end of the cylinder 18 for heating the plastic material in the cylinder, and this coil is automatically controlled to regulate the required temperature, as is known in this art. Arranged at the discharge end of the cylinder is a die 24, the die being mounted in the offset portion 25 of a die holder 26, this holder having a flange portion 27 adapted to bear against a ball thrust bearing 28 supported between suitable plates 29 and 30. The purpose of this construction is to provide free rotation of the holder 26 as well as the die 24 mounted therein. To simplify the construction of the die 24, it may be composed of separate parts, each part being secured to the holder 26 by screws 31. The die 24 has formed therein an impression or cavity 32 fashioned to receive a conductor 33 and to form around the conductor a portion of a continuous spiral or helical member, as more fully hereinafter set forth. The length of the spiral or helix in the die 22 is substantially equal to what might be considered a complete turn.

It will, of course, be understood that the die holder will be water cooled, as in conventional machines of this kind in order to chill the casting material, but this has been omitted in the present diagrammatic illustration, as in itself, it forms no part of the present invention.

The feeder mechanism 34 feeds the conductor including the helical insulator 34 thereon from right to left, as appearing in Fig. 1 of the drawing. The feeder mechanism comprises an elongated tubular shaft 35, at one end of which is an elongated pinion 36 which meshes with the gear 37 arranged upon one end of a shaft 38. At the other end of the shaft is a ratchet wheel 39 which is intermittently rotated by suitable mechanisms in the machine a quarter revolution in imparting one revolution to the shaft 35.

Supplied in connection with the end of the shaft 35 adjacent the die 24 are radially movable jaw members 40 which are adapted to engage and grip the conductor 33 in the intermittent feed of the conductor, as later described. Springs 41 are employed to normally support the roller ends 42 of the jaws in engagement with a conical or cup shaped sleeve 43 which is slidably mounted on the shaft 35. The sleeve 43 has a grooved end portion 44 adapted to be engaged by a yoke shaped lever 45 suitably operated in the machine to move the sleeve 43 to the right in moving the jaws 40 into their gripping position, as will be apparent.

The shaft 38 is supported in a slide 46, mounted to move back and forth in the machine with respect to the die 24, a suitable link 47 being coupled with operating mechanisms of the machine in performing this operation timely with the operation of the plunger 20.

In Fig. 6 of the drawing is shown a slight modification of the construction of the die 24 in that it includes at spaced intervals the collars or sleeve portions 53 which are partially formed by the recess 43. The remainder of the collars are formed by the recess or cavity 54 in two supplemental die members 55 and 56, which are movable toward and from the conductor 32 over the outer surface of the die 48. These supplemental dies 55 and 56 will also include cavity portions conforming with the spiral or helix 51, as will clearly appear from a consideration of Fig. 6 of the drawing. At 57 is shown the discharge end of a cylinder similar to the cylinder 18.

In producing coaxial cable, it will be understood that after the conductor 33 with its helical insulator 34 thereon or the conductor 52 with the helix 51 thereon passes from the feeder mechanism, the outer conductor 55 may be applied upon the helical insulator 34 and 51 and this conductor then covered or enclosed in insulator jackets 59 of fibrous or any other suitable material, depending entirely upon the type and kind of coaxial conductor or cable which is produced.

In the present illustration, the conductor 33, as shown in Fig. 5 of the drawing is shown as a solid rod or wire, however, in some instances, this conductor is tubular.

To rotate the die holder 26, the flange portion 27 has on the periphery thereof gear teeth 60 adapted to be engaged by a gear 61, note Fig. 1. The gear 60 and the means for rotating it is only partially shown, but would be the same as the means disclosed for rotating a substantially similar gear in the companion application Serial No. 532,656 filed of equal date herewith now Patent No. 2,446,089. The gear 61 is intermittently rotated in the operation of drawing the conductor 33 through the die cavity 32 so as to allow the die 24 to rotate around the cast helix.

This method of rotating the holder 26 is primarily applicable to structures as seen in Fig. 6, where the supplemental dies 55 and 56 are arranged upon the outer surface of the die 48. In structures shown as in Fig. 1, or in other words, where the supplemental dies are not employed, the method of rotating the holder 26, as taught in the companion application can be used.

The operation of the machine will be readily understood from the foregoing description when taken in connection with the accompanying drawing and the following statement.

Let us assume that in the illustration of Fig. 1, particularly with respect to the gripper mechanism, the machine has just completed the formation of a spiral section of the spiral or helix 34 in the die 24. The sleeve 43 is then moved
to the left to release the jaws 40, which are then moved outwardly by the springs 41, this movement is slight and sufficient to disengage the conductor 33. The slide 45 together with the sleeve 45 is then moved to the right, and during this operation, the shaft 35 is rotated to move the jaws around the spiral or helix 34. During this operation, the plunger 20 has been moved to the right, assuming the position similar to that shown in Fig. 1 of the drawing, after which the powder or granular material which has previously been deposited in the funnel 16 will drop into the cylinder 10 in front of the end 22 of the plunger. During the above operation, the cast section or unit of the spiral or helix 34 remains stationary in the die 34.

The machine is now ready for the next operation which can be regarded as the casting or injection operation. The sleeve 43 is now moved to the right on the shaft to force the jaws 40 inwardly into firm gripping engagement with the conductor 33. The plunger 20 will now be advanced to move the powder or granular plastic material to the left in the cylinder 10 to a point where injection of the heated plastic material at the outer end of the cylinder is to begin. At this moment, the slide 46 is moved to the left, the feeder mechanism creates sleeve 43 in this operation. This operation feeds the conductor 33 including the pre-cast section of the spiral or helical insulator 34 to the left and out of the die 24, the die holder 25 being positively rotated in this operation and simultaneously another cast unit or section of the spiral or helical insulator is formed on the conductor, as the plunger 20 is moving forwardly simultaneously with the movement of the slide 46. At the completion of this last operation, the parts will again return substantially to the position shown in Fig. 1, excepting that in Fig. 1, the plunger has been shown in its retracted position, it being understood that pressure is relieved from the casting material immediately upon formation of the cast section as described above.

It will be understood that the above described cycle of operation is automatic and repeated at intervals to form the successive cast sections or portions of the insulator, and the speed of this operation will depend largely upon the amount of material in each unit cast section. However, each unit will be permanently united with the adjacent unit so as to form a continuous elongated spiral or helical insulator on the conductor. In other words, it will be apparent that the cavity 32 of the die is always exposed to the outer nozzle discharge end of the cylinder 18, and in this sense, the cast insulator 34 may be said to be formed from a plurality of intermittently extruded sections.

The above described operation of the feeder mechanism 11 is diagrammatically illustrated in Figs. 3, 4, and 5 of the drawing. In other words, the jaws while assuming the position of Fig. 3 are first moved radially, as indicated by the arrow of said figure, and then the jaws move to the right in the manner stated to a position similar to that illustrated in Fig. 4, and are then moved into gripping engagement with the conductor, as indicated by the arrow of Fig. 4, after which the jaws are moved to the left, moving with the conductor and the helix 34 thereon, this movement being from the position shown in Fig. 2 that illustrated in Fig. 3, and then this cycle of operation is repeated.

The operation of the structure shown in Fig. 6 will be the same as that shown in Fig. 1, with the exception that at the beginning of the casting operation the dies 55 and 56 will be separated to allow for the feed of the workpiece to the left and substantially at the completion of the injection stroke the dies 55 and 56 will be quickly moved into engagement with the conductor 52 and in the final stroke of the plunger casting material will be formed into the cavity recesses 49 and 54 in forming the ring like or sleeve like members 53 which completely encircle the conductor 52.

It will be understood that the complete coaxial conductor or cable may be produced in one continuous operation or may be cared for in a series of operations. The production of the inner conductor with its spiral or helical insulator thereon actually constitutes the formation of a product, particularly in that the operation of die casting the helix directly upon the conductor strand causes these two parts to form a more or less unitary structure. The inclusion of the encircling rings or sleeves 53 at spaced intervals simply acts to reinforce and to strengthen the conductor, and these are employed only in cable subjected to excessive bending or other strains.

From the foregoing, it will be apparent that the feeder mechanism draws the conductor 33 including the insulator 34 thereon from right to left in a series of intermittent feeds, each feed stroke being governed by the length of the cavity or impression in the die. During this feed stroke, the die is rotated to feed the die around the precast insulator as the casting material is pressure injected into the die cavity so that when the die again comes at rest, the cavity will again be filled, and a new section of the insulator formed. The ball bearing employed provides free rotation of the holder 27, and at the same time, takes up the thrust during the injection stroke of the plunger 20.

The method as herein described has been applied to the production of a specific kind of product. This is by way of illustrating one adaptation and use of the invention. In a general sense, the method comprises forming elongated castings from a plurality of independently cast sections which are cast one upon the other in producing said product.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of die casting a helically shaped insulator upon a conductor which comprises casting upon a length of said conductor a section of insulating material by injecting said material in the plastic state into one end of a helically shaped cavity of a die through which said conductor extends, simultaneously gripping the conductor between a pair of jaws at a point beyond the other end of said cavity during said casting step, releasing the grip on the conductor after the casting step by opening said jaws, moving the jaws closer to the die while coincidently rotating said jaws about the conductor, regripping the conductor between said jaws, moving the jaws and the conductor away from the die while rotating the latter to pull said cast section out of the die and bring another length of conductor therein, and casting another section of insulating material on the conductor by injecting said material in the plastic state into said die cavity simultaneously with the movement of the conductor therethrough.

2. The method of die casting an elongated helically shaped insulator longitudinally upon a
conductor which comprises feeding a charge of insulating material to a plasticizing chamber to be plasticized, pumping the plasticized material into one end of a helically shaped cavity of a die on which said conductor extends while gripping the conductor between a pair of jaws at a point beyond the other end of said cavity, thereby casting upon a length of said conductor a section of insulating material, releasing the grip on the conductor by opening said jaws, moving the jaws closer to the die while coincidently rotating said jaws about the conductor, regripping the conductor between said jaws, moving the jaws and the conductor with the cast section thereon through and out of the die while simultaneously rotating the die, thereby moving into said cavity a succeeding length of said conductor, feeding another charge of insulating material to said plasticizing chamber to be plasticized, pumping plasticized material coincidently with said last moving step into the cavity of said die so as to form a second cast section upon said conductor, halting the conductor after said last-mentioned pumping step to permit said second cast section to become united with said first-mentioned cast section in end-to-end relationship, and repeating the above described method to form on the conductor an elongated length of insulating material.

3. The method of forming an elongated helically shaped die cast member which comprises intermittently injecting heated casting material into the registering cavities of a first rotatable die and a second die relatively movable to said first die so as to form successive cast sections of said material, each section being united to the preceding section; said dies abutting each other and each having a helically shaped cavity extending therethrough and an annular recess in their abutting surfaces for forming a ring-like member on each said cast section; intermittently opening said second die by moving it relatively to said first die and away from a cast section formed therein, and intermittently discharging each said cast section from the first die coincidently with the injection of heated casting material thereto, said discharging operation being performed by intermittently rotating said first die during the discharge of each said cast section; and intermittently closing said second die substantially at the completion of said last-mentioned injection step but in time to have heated casting material forced into the cavity thereof.

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