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3,411,182  
**APPARATUS FOR EXTRUDING HELICAL  
WEBS ON CONDUCTORS**

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**ABSTRACT OF THE DISCLOSURE**

The electrical conductor is passed through the main orifice of an extrusion die having an exit end through which the main orifice opens and also having a sub-orifice intersecting the main orifice and extending generally radially outward therefrom, the sub-orifice opening through the exit end of the die with the radially outer portion of the sub-orifice terminating short of the outer periphery of the die. The die is supported for rotation about the conductor and is provided with an inlet to which a plasticized resinous material is supplied under pressure in all rotational positions of the die, to cause the material to be extruded continuously through the exit opening of the sub-orifice in the form of a generally radial web on the conductor. Driving means are provided to rotate the die so as to spiral the web in a helix about the conductor, the pitch of the helical web being determined by the rotational speed of the die relative to the speed at which the conductor is moved lengthwise through the die by a transport means.

*The disclosure*

This invention relates to extrusion apparatus and more particularly to apparatus for extruding a helical web around and along the length of an electrical conductor. A conductor having a web formed in accordance with this invention is useful as a component of electrical cable, such as coaxial cable wherein the helical web serves to maintain the conductor in concentrically spaced relation to a surrounding outer conductor.

In the past, such helical webs have been formed on conductors by the use of two structurally independent but functionally cooperating elements, one stationary and the other rotatable, which together form the extrusion die. An example of such an apparatus is seen in United States Patent No. 2,465,482. In order to provide perfect concentricity and uniformity of the web thus formed, perfect alignment of the two die elements must be attained and maintained, which is difficult if not impossible and is time-consuming at best. Modification of the desired web, for example, in width or cross section, requires changing one or both elements and therefore requires a realignment of these elements.

A second known type of apparatus, for forming a helical web about an electrical conductor, comprises a rotatable die having a cavity with the configuration of the helix and through which the electrical conductor passes. In addition to the need for accurately aligning the conductor within the cavity, the uniformity of the resulting helix is dependent upon the accuracy with which the die cavity is machined. Furthermore, it is necessary to provide a different die for each different helix pitch which is desired. An apparatus of this type may be seen in United States Patent No. 2,834,047.

Accordingly it is one object of this invention to provide an improved extrusion apparatus for forming a uniform helical web about a cylindrical element and in which the extrusion die is self centering with respect to the element.

Another object of this invention is to provide an extru-

sion apparatus having sufficient operation flexibility to permit variation in helix pitch without replacement of the extrusion die.

These and other objects and attendant advantages of the present invention will become apparent and better understood from the following description and accompanying drawings in which

FIGURE 1 is a partially cutaway perspective view of an electrical coaxial cable produced by apparatus in accordance with this invention;

FIGURE 2 is a schematic illustration of an extrusion system, including control circuitry, made in accordance with this invention;

FIGURE 3 is a vertical, longitudinal sectional view of the extrusion apparatus of the system of FIGURE 2, and

FIGURE 4 is a sectional view taken along line 4—4 in FIGURE 3.

Briefly stated, this invention in one form comprises an extrusion apparatus including a feeding means, which may be conventional, for directing a plasticized resinous material under pressure to an extrusion die. The extrusion die is formed with a main orifice adapted to accommodate passage of the conductor on which the web is to be formed. Intersecting this main orifice and extending radially outwardly from it is a sub-orifice through which the resinous material is extruded. This sub-orifice, at least where it opens through the exit end of the die, has the shape of the desired cross-section of the helical web, preferably rectangular, with its radially outermost portion terminating short of the outer periphery of the die, so that the sub-orifice is completely contained within and defined by the die. The extrusion die is held in a die carrier which is mounted for rotation about the conductor in the main orifice, and driving means are provided to rotate the die carrier and hence the extrusion die.

In some instances, it may be desired to extrude the helical web simultaneously with an underlying thin film of the material which completely surrounds the conductor and from which the web protrudes. In such instances, the main orifice of the die is provided with a diameter which exceeds the conductor diameter by twice the desired thickness of the film. Otherwise, the diameter of the main orifice is essentially the diameter of the conductor.

The conductor is fed continuously lengthwise to the extrusion die and through its main orifice by suitable transport means. In order to form the helical web about the conductor, the resinous material is extruded through the sub-orifice and the extrusion die is rotated during this lengthwise movement of the conductor. The pitch of the resulting helical web is determined by the rotational speed of the die relative to the linear speed at which the transport means passes the conductor through the die, and the pitch can be varied as desired by varying the ratio of these two speeds. Because the conductor is supported so that its central axis coincides with that of the main orifice in the die, and because the sub-orifice is completely defined by the die, the helical web will be concentric to the conductor axis and uniform throughout.

Referring now to the drawings, and more particularly FIGURE 1, there is illustrated an air dielectric electrical coaxial cable 8 including an electrical conductor 10 having a helical web 12 extending radially therefrom and formed by the apparatus of this invention. The web serves as a dielectric support to hold the inner conductor 10 concentrically within an outer conductor 14.

The term "conductor" as used herein refers to an electrical conductor of any conventional material having high conductivity, such as copper or aluminum.

The system as shown in FIGURE 2 includes a payoff reel 18 rotatably supported by any conventional means, such as jackstands 20, which permits free rotation of the