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T. J. RHODES

2,465,482

EXTRUDING APPARATUS

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Fig. 3

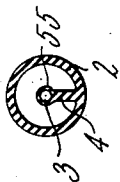


Fig. 2

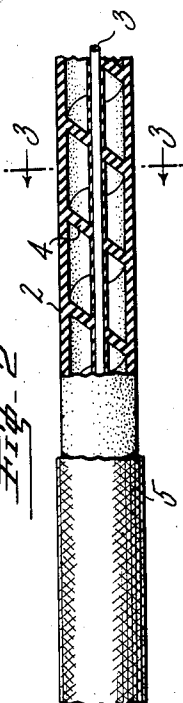


Fig. 4

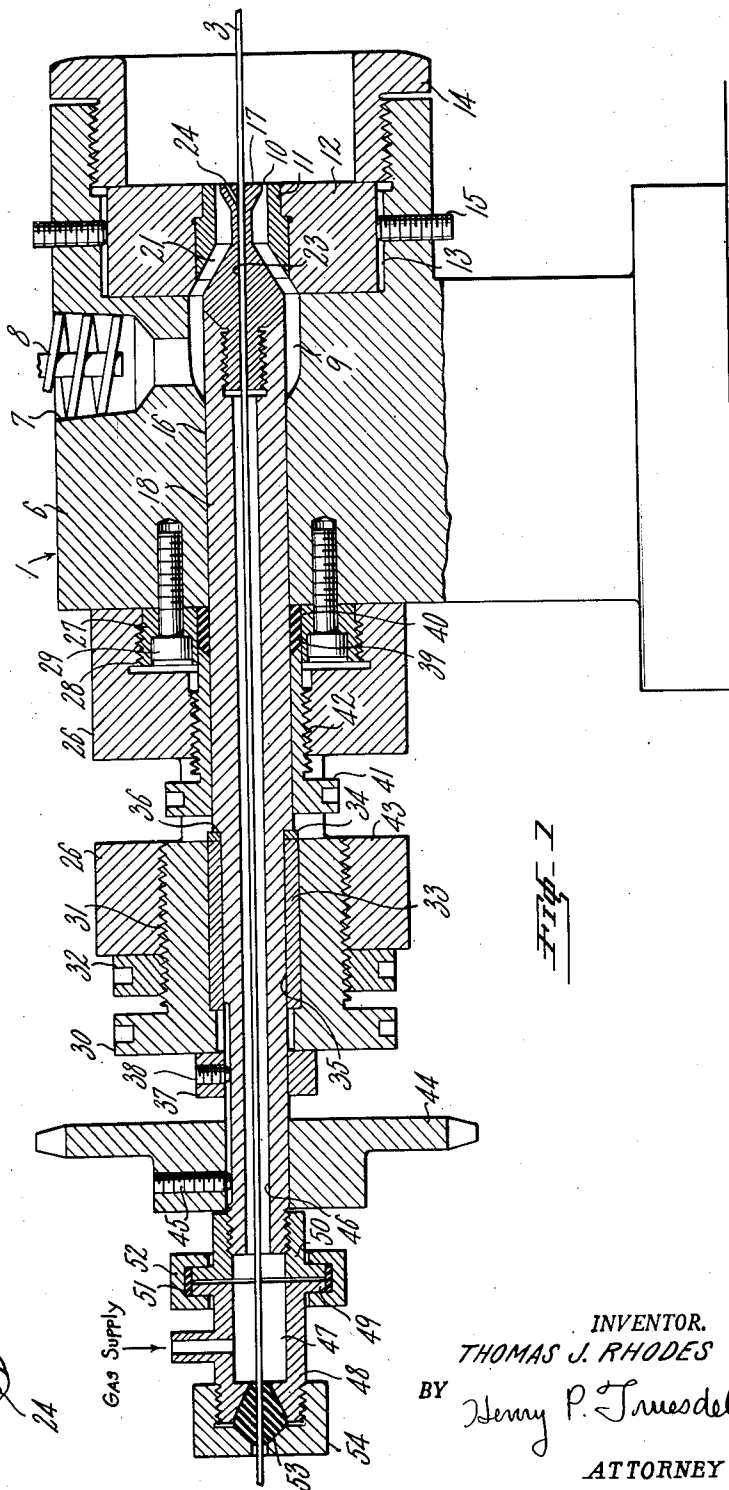
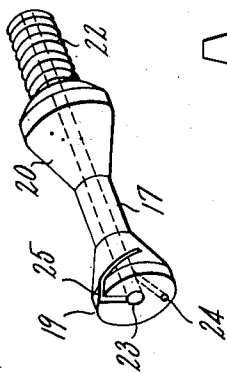


Fig. 1

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EXTRUDING APPARATUS

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5 Claims. (Cl. 18—13)

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My invention relates to extruding apparatus and more particularly to apparatus for extruding plastic material in the form of a cylinder or tube in continuous lengths. One use to which my invention may be put is in the manufacture of an extruded plastic core for high frequency coaxial cable of the type disclosed in my co-pending application Serial No. 719,868, filed January 2, 1947, for "Coaxial cable and method of making the same" and assigned to the same assignee as the instant application.

It is an object of the invention to provide a new and improved apparatus for continuously extruding plastic material in the form of a tube of any desired length.

Another object of my invention is to provide an extruding apparatus for tubing with means to prevent deformation of the tube during the extruding process.

Another object of my invention is to provide apparatus for extruding a tube of plastic material in which air or other gas is fed to the interior of the tube during the extruding process to prevent deformation of the tube as it leaves the extruding apparatus.

Still another object of my invention is to provide apparatus for extruding a tube of plastic material in which a supporting web is formed in the interior of the tube to support the tube in position.

A further object of my invention is the provision of improved apparatus for constructing the core of a coaxial cable in which a tube of insulating material is supported on a central conductor by means of a web formed integrally with the tube and extending along the length of the conductor in the form of a helix.

An additional object of my invention is to provide an extruding apparatus for the manufacture of cores for high frequency coaxial cables in which an insulating gas is fed to the core during manufacture.

In the accompanying drawing,

Fig. 1 illustrates an extruding apparatus constructed in accordance with my invention;

Fig. 2 illustrates the core of a coaxial cable made by the apparatus of Fig. 1;

Fig. 3 is a cross-sectional view through the cable core taken along the line 3—3 of Fig. 2; and

Fig. 4 illustrates part of the die construction used in the extruding apparatus.

Referring to the drawing, Fig. 1 illustrates an extruding apparatus constructed in accordance with my invention and which is so designed as to extrude a tube or sleeve 2 around the inner

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conductor 3 of a coaxial cable which is shown in Fig. 2. The sleeve 2 is supported on the inner conductor by means of a web 4 formed integrally with the sleeve and extending along the length of the conductor in the form of a helix. An outer conductor 5 of any conventional construction, such as a copper braid, completes the coaxial cable assembly. A coaxial cable of this type is used to transmit high frequency currents and is more fully described and claimed in my above identified co-pending application Serial No. 719,868. A coaxial cable has been illustrated as an example of one type of article which may be manufactured by my improved extruding apparatus although the apparatus is not limited in use to such cables.

Turning now to the construction of the extruding apparatus and referring to Fig. 1, the apparatus includes a block 6 having a chamber 7 therein for receiving the plastic material to be extruded. Any suitable material may be used. In the case of a coaxial cable core, it is desirable to use an insulating material, such as polystyrene or polyethylene. A feed screw 8 is shown in schematic form as feeding the plastic material through the chamber 7 to a cavity 9 in block 6 from which it is forced outwardly through an extruding orifice 10. The orifice 10 is formed in part by a die insert 11 which, in turn, is carried by a die block 12 mounted in a recess 13 in the block 6. A collar 14 clamps the die block 12 in the recess and set screws 15 are provided for adjusting the die block transversely for centering purposes.

Seated within the cavity 9 and extending into the die insert 11 is a rotatable die 16 which comprises a die plug 17 carried by a shaft 18 supported for rotation in the block 6. The wall of the die plug 17 cooperates with that of the die insert 11 to form the aforementioned orifice 10. Referring to Fig. 4, it will be seen that the die plug 17 is provided with a head portion 19 for cooperation with the die insert 11, and a conical surface 20 which cooperates with the wall of an opening 21 in the die insert to form a passageway for the plastic material. A threaded shank 22 provides a means of mounting the die plug on the rotatable shaft 18. In order to guide the central conductor 3, the die plug is provided with a bore 23 extending axially therethrough. An opening 24 in the head 19 extends at an angle to and merges with the bore 23; it provides a means for feeding gas under pressure to the interior of the sleeve 2 in a manner to be described later. The die head 19 is also provided with an angularly disposed slot 25 which extends from

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the surface of the head 19 to the bore 23 so that a portion of the plastic material flowing through the extruding apparatus will be forced through the slot 25 to form the web 4. In this way the web 4 is formed integrally with the sleeve 2. It is anchored to the wire due to the fact that the slot merges with the opening of the bore 23, so that a portion of the plastic material flows through the slot 25 into the bore 23 from which it is extruded as a thin coating around the center conductor 3. Inasmuch as the die plug rotates in the block 6 during the extruding operation, it will be apparent that the web 4 will be formed in the shape of a helicoid extending along the length of the conductor 3 so that it likewise supports the sleeve 2 along the length of the conductor.

Rotation of the die 16 is provided for by means which includes a support 26 threaded to a plate 27, as indicated at 28. The plate 27 is fastened to block 6 by screws 29. An adjustable bearing support 30 is screw threaded on support 26, as indicated at 31. A lock nut 32 holds the bearing support 30 in adjusted position. The bearing support 30 carries a bearing 33 for the shaft 18, such as a bronze sleeve bearing, and which rests against a bearing ring 34 mounted on a reduced section 35 of the shaft 18. Thus, it will be seen that movement of the shaft 18 axially along the bearing 33 will be prevented by the thrust bearing ring 34 which abuts against a wall 36 formed by the reduced portion 35. Movement of the shaft in the other direction is prevented by a collar 37 fastened to the shaft by means of a set screw 38 and which rests against the outer edge of the bearing support 30. Since shaft 18 is held against longitudinal movement in support 30 in the manner described, the bearing support 30 serves as a means for adjusting the position of the shaft within the block 6 and hence an adjustment of the die plug 17 in the orifice 10. This adjustment is accomplished by threading the bearing support 30 into and out of the support 26. When suitably adjusted the bearing support 30 is locked in position by means of the lock nut 32.

To provide a seal between the rotating shaft 18 and the block 6 a packing 39 is inserted in a recess 40 in the plate 27 and is held in compressed position by means of gland nut 41 threaded in the block 26, as indicated at 42. The gland nut is accessible for adjustment through lateral openings 43 in the support 26. It will be apparent that the gland nut 41 may be mounted in position during assembly of the apparatus by slipping it over the shaft and pushing it through the opening formed in the block 26 when the bearing support 30 is removed. Rotation of the shaft 18 is obtained through a sprocket or drive gear 44 keyed to the shaft by means of a set screw 45. Gear 44 is rotated in any suitable manner as by a chain or gear drive (not shown).

In order to feed gas under pressure to the interior of the sleeve 2 during the extruding operation, the shaft 18 is provided with a passageway 46 for supplying gas to the bore 23 of the die plug 17 and thence to the opening 24. The end of passageway 46 merges with a chamber 47 formed in a fixed gas supply pipe 48. The supply pipe 48 is provided with a flange 49 which rests against a coupling flange 50 threaded on the end of shaft 18. A packing 51 surrounds the flanges 49 and 50 and is held in position by means of a split collar 52. The split collar and flanges form, in effect, a coupling which permits rotation of the shaft 18

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relative to the fixed gas supply pipe 48. A packing 53 prevents the escape of gas from the end of the supply pipe 48; it is held in compressed position by means of a gland nut 54. A supply of gas under relatively low pressure is fed to the chamber 47 from which it travels along the length of the passageway 46 and thence through the bore 23 in the die plug to the opening 24 from which it is expelled into the interior of the plastic sleeve 2. As will be described presently, one of the purposes of the gas is to prevent deformation of the sleeve 2 due to differences in pressure between the interior and exterior of the sleeve during the extruding operation. It is contemplated that air will be fed to the interior of the sleeve but it should be manifest that other suitable gases may be used, such as nitrogen.

During the extruding process, plastic material is forced into the cavity 9 by means of the feed screw 8 so that it flows through the opening 21 to the orifice 10 from which it is extruded in the form of the sleeve 2 which surrounds the conductor 3. A portion of the plastic material will be forced through the slot 25 in the die plug 17 so that the web 4 will be extruded simultaneously with the sleeve 2. One edge of the web 4 will be formed integrally with the sleeve 2 due to the fact that the slot 25 merges with the orifice 10. The other edge of the web will grip the conductor 3 due to the fact that a small amount of the plastic material will be extruded outwardly from the bore 23 surrounding the wire, as indicated at 55 in Fig. 3. During the extruding operation the die 16 is rotated at any suitable speed so that the web 4 will be wrapped around the wire along its length in the form of a helicoid. The spacings of the convolutions of the helicoid will be determined by the speed at which the die is rotated. If the speed of rotation is increased the convolutions of the web will be spaced closer together. Conversely, if the speed of rotation of the die is reduced the number of convolutions per unit length of cable will be reduced.

In order to extrude a smooth and uniform sleeve it is important that the material forming the web 4 and the material forming the sleeve shall issue from the extruder head at substantially the same linear rate. For this purpose the opposing walls of the slot 25 should be spaced apart by a distance substantially the same as or slightly greater than the radial width of the annular orifice 10. It is then found in operation that the thickness of the extruded web is about equal to the wall thickness of the sleeve 2, and that the extruded sleeve has a smooth surface and a cross-section that is uniform throughout its length. If the slot is too wide, an excess of the plastic material flows through it resulting in a helical ridge being formed along the length of the sleeve 2 at the line of juncture of the web 4 with the sleeve. Conversely, if the slot is too narrow so that the rate of flow is too small, there will be a tendency for the sleeve 2 to be drawn inwardly toward its axis, resulting in a helical depression being formed along the line of juncture of the web 4 with the sleeve.

If the sleeve or tube is extruded in extremely long lengths there is some likelihood that a partial vacuum may be formed in the interior of the sleeve 2. This is objectionable because such difference in pressure between the interior and exterior of the sleeve will tend to collapse it. To overcome this difficulty during the extruding process air, or other suitable gas, for example nitrogen, is fed at a pressure equal to or slightly above

atmospheric to the interior of the sleeve 2 as the sleeve is formed around the wire. Gas from the supply pipe 48 will travel along the passageway 46 in the shaft 18 and through the bore 23 in the die plug 17 to the opening 24 in the face of the plug. Thus as the die rotates to form the helical web 4, gas is continually supplied to the interior of the sleeve 2. The pressure of the gas should be carefully regulated to assure a uniform product. If gas or air is introduced to the interior of the sleeve under excessive pressure there will be a tendency for the side walls of the sleeve to expand slightly thereby producing a core of uneven, rippled configuration. It has been found desirable during actual manufacture, to seal the end of the sleeve 2 down around the conductor 3 when the extruding process is begun so that the end of the core is closed to prevent the escape of air. In addition to preventing deformation of the core during manufacture, the gas or air serves as a dielectric medium in the cable.

The quality of the product can be maintained more uniform and the manufacturing process speeded up if gas is supplied to the interior of the cable core, in the manner indicated. Although the use of the gas supply facilitates production, it should be manifest that in certain instances the gas feed may be omitted. For example, if low extruding speeds are used together with a quick-setting thermoplastic insulating material, it has been found possible to extrude the sleeve 2 and have it set in position without the use of the gas pressure.

In the cable construction illustrated, only a single helicoid web 4 is formed, which supports the sleeve in spaced concentric relationship with the inner conductor throughout its length. It accomplishes this result with a minimum of material. In certain cases, however, such as where larger diameters of cable cores are required, the number of webs may be increased to provide a greater supporting area for the sleeve 2. Such constructions are illustrated in my aforementioned application Serial No. 719,868. The number of webs is easily increased by providing additional slots in the die plug 17.

Although for the purposes of illustration the extruding apparatus has been shown extruding a core for a high frequency coaxial cable, it should be manifest that it may be used to extrude other hollow articles of various shapes. For example, it may be used to extrude decorative plastic coatings on rods or wires. Also, the wire 3 may comprise other types of center supports such as a thread or core of plastic material on which an outer covering is wrapped.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. In apparatus for extruding plastic material, a member having an opening therein, means for supplying plastic material to said opening, a die rotatable in said opening, said die being provided with a bore therein through which an element to be covered may be pulled, the die cooperating with the wall of the opening to form an orifice for extruding a tube of plastic material around and spaced from the element, and means carried by the die for extruding a web between the element and the tube, a portion of the material flowing through said bore to form a thin coating surrounding the element, the web being wrapped around the element in the form of a helicoid by the rotating die and being formed integrally with said tube and said coating.

2. Apparatus for extruding a tube of plastic

material about an element in continuous lengths comprising, in combination, means including a rotatable die forming a ring-like orifice, said die being provided with a bore through which an element to be covered may be pulled, said die likewise being provided with a slot merging with said orifice for forming a web integral with the plastic tube as plastic material is forced through the orifice to form the tube, and means including the bore in the die for supplying a fluid to the interior of the tube to prevent deformation of the tube during the extruding process.

3. An extruding apparatus comprising, in combination, a member having an opening therein, a die rotatable in said opening, said die being provided with a bore through which continuous lengths of an element to be covered may be pulled, means for supplying plastic material to said opening whereby a tube is extruded around and spaced from the element as the element is pulled through the die, said die being provided with a slot merging with said opening for receiving a portion of the plastic material whereby a web of plastic material is disposed between the element and the interior wall of the tube, said slot also merging with said bore so that a thin coating of the material is applied around the element, said web being formed in the shape of a helicoid around the element by rotation of said die, and means for supplying a fluid to the bore of the die whereby the fluid is fed to the interior of the tube to prevent deformation thereof during the extruding process.

4. An extruding apparatus comprising, in combination, a member having an opening therein, a die rotatable in said opening, said die being provided with a bore through which continuous lengths of an element may be pulled, and means for supplying plastic material to said opening whereby a tube is extruded around and spaced from the element as the element is pulled through the die, said die being provided with a slot merging with said opening and said bore for receiving a portion of the plastic material whereby a web of plastic material is disposed between the element and the interior wall of the tube, a portion of the material flowing through said bore to form a thin coating surrounding the element, said web being formed in the shape of a helicoid around the element by rotation of said die.

5. In apparatus for extruding plastic material, a member having an opening therein, means for supplying plastic material to said opening, a die rotatable in said opening, said die being provided with a bore therein through which an element to be covered may be pulled, the die cooperating with the wall of the opening to form an orifice for extruding a tube of plastic material around and spaced from the element, means carried by the die for extruding a web between the element and the tube, a portion of the material flowing through said bore to form a thin coating surrounding the element, the web being wrapped around the element in the form of a helicoid by the rotating die and being formed integrally with said tube and said coating, and means for supplying a fluid to the bore of the die, said rotatable die being formed with an opening connected with said bore for feeding fluid to the interior of the tube to prevent deformation of the tube during the extruding process.

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