

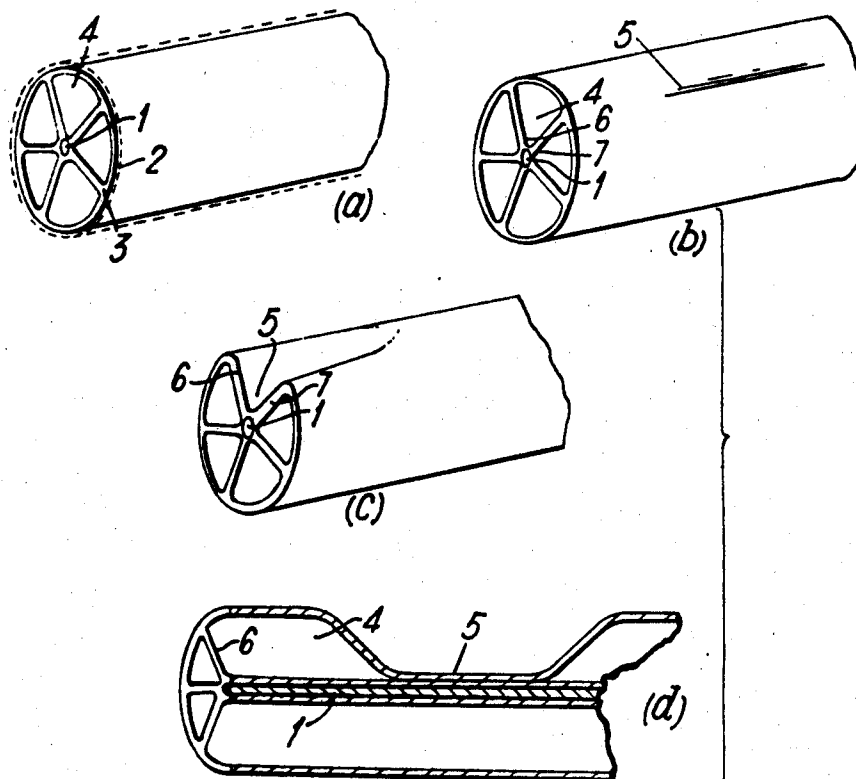
[72] Inventor **Paul Nicholas Delves-Broughton**
Caerleon, Wales
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 [73] Assignee **International Standard Electric Corporation**
New York, N.Y.
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 [33] **Great Britain**
 [31] **8741/68**

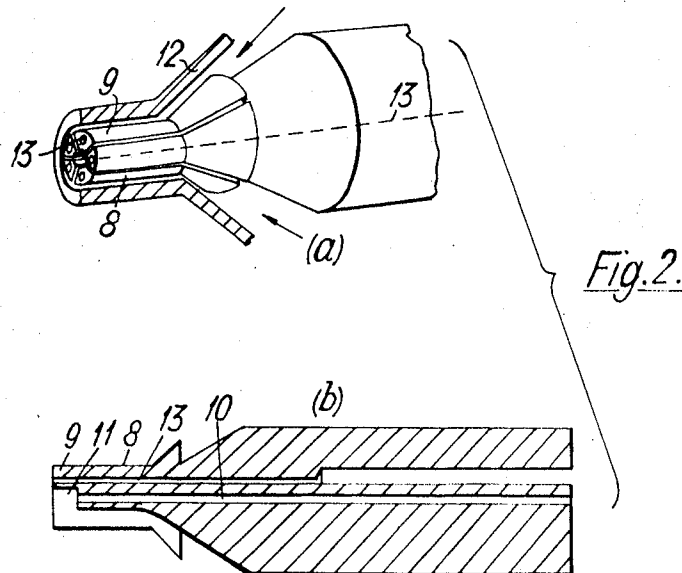
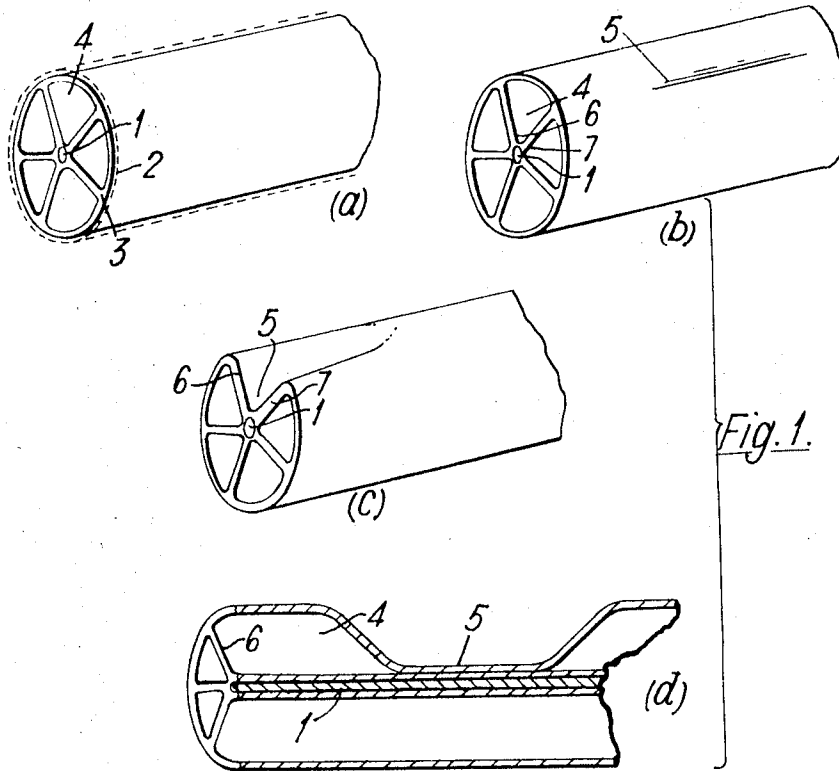
[56] **References Cited**
FOREIGN PATENTS
 430,581 6/1935 Great Britain..... 174/28
 1,325,046 3/1963 France 174/28
 165,676 3/1934 Switzerland 174/28
Primary Examiner—Laramie E. Askin
Assistant Examiner—A. T. Grimley
Attorneys—C. Cornell Remsen, Jr., Walter J. Baum, Percy P. Lantzy, Philip M. Bolton, Isidore Togut and Charles L. Johnson, Jr.

[54] **WATER-BLOCKED CARTWHEEL CABLE**
 4 Claims, 11 Drawing Figs.

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 174/101.5
 [51] Int. Cl. H01b 13/06,
 H01b 7/12
 [50] Field of Search 174/101.5,
 102, 107, 28, 29

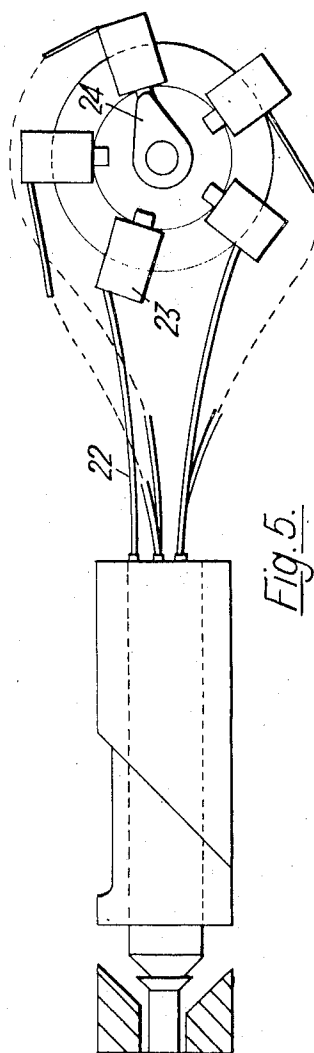
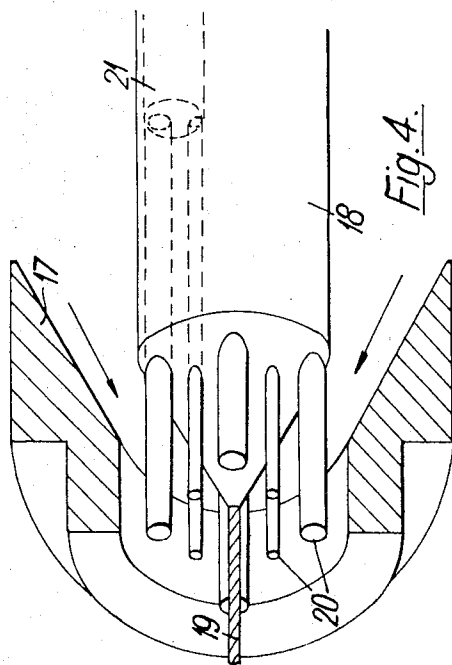
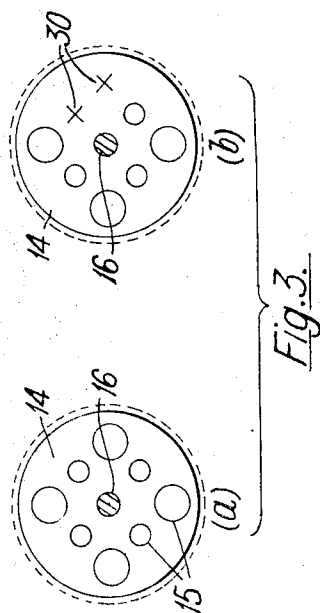
ABSTRACT: A submersible coaxial cable has a plurality of longitudinal air spaces symmetrically spaced in the dielectric material around the inner conductor with sections collapsed at regular intervals along each airspace to form water blocks in the passageways. Apparatus is provided to extrude the dielectric in the desired form and collapse the walls at selected intervals.





Inventor
PAUL N. DELVES-BROUGHTON

By *Edward Goldberg*
Attorney



Inventor

PAUL N. DELVES-BROUGHTON

By *Edward Goldberg*
Attorney

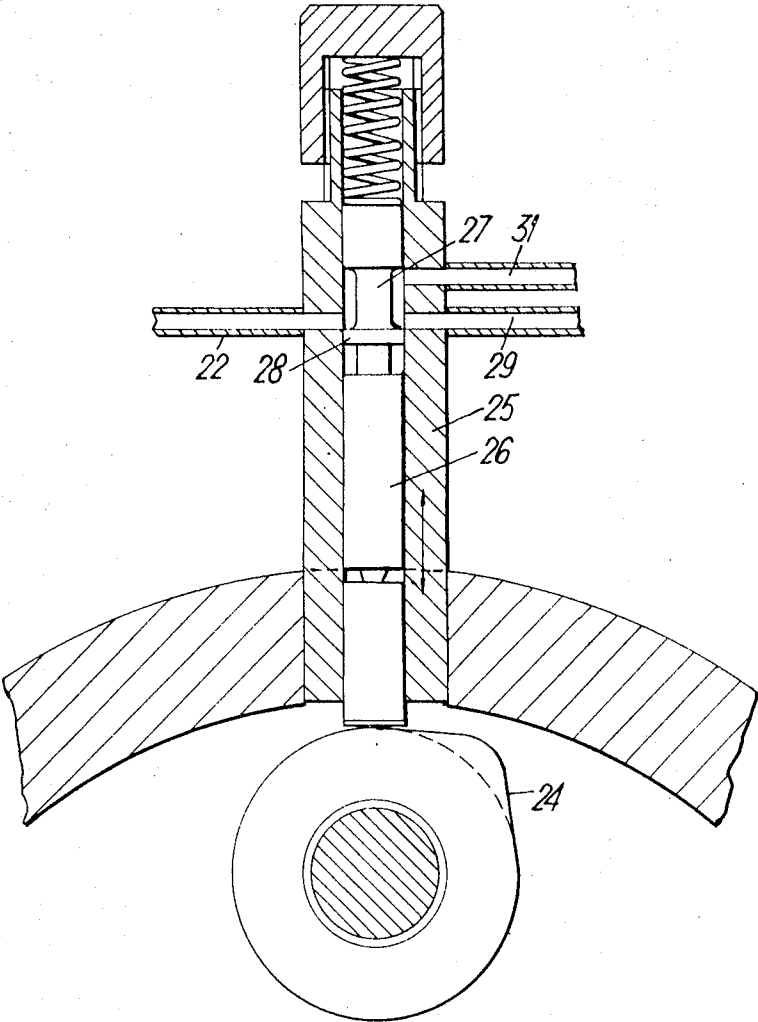


Fig. 6.

Inventor
PAUL N. DELVES-BROUGHTON
By *Edward Goldberg*
Attorney

WATER-BLOCKED CARTWHEEL CABLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to coaxial cables having an airspaced dielectric.

2. Description of the Prior Art

In a coaxial cable of a given characteristic impedance and attenuation, a smaller overall diameter of the dielectric and hence of the outer conductor and sheath can be obtained by using cellular polythene or known airspaced "cartwheel" designs instead of a solid extruded polythene construction.

Cellular polythene, if used for buried installations, absorbs moisture unless a high integrity welded metal outer conductor is used, which adversely affects the transmission characteristics. Likewise the airspaced configuration is prone to flooding of the interstitial air passageways should a joint fail or should damage occur to the sheath when using a nonwelded outer conductor.

SUMMARY OF THE INVENTION

According to the present invention there is provided a coaxial cable having a center conductor, an outer conductor surrounding the center conductor and spaced therefrom by an extruded dielectric, and a plurality of longitudinal passageways in the dielectric each blocked with the extruded dielectric at different intervals along the cable.

The invention further provides a coaxial cable having a center conductor, an outer conductor surrounding the center conductor and spaced therefrom by an extruded dielectric, and a plurality of longitudinal passageways in the dielectric, the passageways being symmetrically spaced about the center conductor and each blocked with the extruded dielectric either singly or in groups in sequential order at regular intervals along the length of the cable.

The invention also provides apparatus for manufacturing a coaxial cable having a dielectric formed by extrusion around a moving center conductor, including an extrusion tool having a plurality of members each for the formation of a longitudinal passageway in the extruded dielectric, a vent tube in each member which normally communicates at one end with the atmosphere and communicates during extrusion at the other end with the passageway extruded around the member, and means to close or partially evacuate each vent tube during extrusion so that the associated passageway becomes blocked with the extruded dielectric material over a region adjacent the end of the tool.

Embodiments of the invention will now be described by way of example, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1(a) shows a portion of airspaced coaxial cable;

FIG. 1(b) shows the portion of cable of FIG. 1(a) formed with a water block;

FIG. 1(c) shows a section through the water block of FIG. 1(b);

FIG. 1(d) is a longitudinal cross-sectional view through the water block of FIG. 1(b);

FIG. 2(a) shows an extrusion tool for forming cable having a dielectric cross section as shown in FIGS. 1(a) to 1(d);

FIG. 2(b) is a longitudinal cross section of the extrusion tool of FIG. 2(a);

FIG. 3 is a cross-sectional view of an alternative type of airspaced coaxial cable;

FIG. 4 is an extrusion tool for forming the cable of FIG. 3;

FIG. 5 shows a system of vent valves for forming the water blocks in the cable of FIGS. 1(a) to 1(d); and

FIG. 6 shows in detail the construction of the vent valves shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1(a) the airspaced coaxial cable includes a center conductor 1, an outer tubular conductor 2, shown as a broken line, and a dielectric 3 of "cartwheel" cross section between the conductors. The spokes of the cartwheel define air passageways 4 therebetween which extend along the length of the cable. As mentioned above there is a danger of flooding of these passageways should damage occur to the cable.

FIGS. 1(b), 1(c) and 1(d) show how a passageway can be blocked to restrict the passage of water therealong in the event of such damage. A portion 5 of the outer wall of the dielectric is collapsed over a limited region onto the two spokes 6 and 7 forming the other two sides of the passageway. This operation is carried out during extrusion of the dielectric while the latter is still soft, as will be described below. Each passageway is blocked at regular intervals along its length; thus longitudinal ingress of water beyond a certain amount in each direction is prevented.

Referring now to FIGS. 2(a) and 2(b), the extrusion tool for forming the dielectric includes an extended nose 8 having five segments such as 9. The slots between each segment serve to form the spokes of the cartwheel dielectric. A central bore 10 is provided in the nose 8 along which the center conductor passes during extrusion. The bore increases in diameter over a region 11 adjacent the end of the nose and communicates with the slots over this region. The inner tubular wall of the cartwheel dielectric is formed in this region by extrusion between the center conductor and the inner surfaces of the segment. The outer tubular wall of the dielectric is formed by extrusion between the outer surfaces of the segments and the collar 12.

During operation, the dielectric is made soft enough so that it can be extruded by the extrusion tool in the direction shown by the arrows in FIG. 2(a). At the same time the center conductor is passed at a predetermined rate along the bore 10, and the cartwheel-shaped dielectric is formed as described above. A vent tube, such as 13, communicating with the atmosphere at the rear of the extrusion tool is provided in each segment. By this means the air pressure in the passageways formed by the segments is equalized to the pressure of the atmosphere.

To form a water block in a passageway, the corresponding vent tube is closed for a short time. The pressure of air in the passageway thus decreases as extrusion continues and the pressure of the external atmosphere collapses a portion of the freshly formed outer tubular wall of the dielectric onto the two spokes forming the other two sides of the passageway. The wall collapses immediately beyond the end of the nose 8, since this is the softest region of the extruded dielectric. The length of the collapsed region can be controlled by varying the length of time for which the vent tube is closed. Eventually, as the collapsed region travels away from the tool, the dielectric cools and the outer walls become firmly sealed to the spokes.

Since the volume of the vent tube and the unblocked air passageway may tend to act as a reservoir of air tending to smooth out fluctuations of pressure when the vent tube is closed, it is preferable to apply a vacuum pump to the vent tube thus obtaining a large pressure difference in a short time.

During continuous extrusion the passageways are blocked in sequential order at regular intervals, but respectively at different locations along the length of the cable. Apparatus for carrying this out will be described below with reference to FIGS. 5, 6 and 7.

FIG. 3(a) shows an alternative to the cartwheel configuration for an airspaced coaxial cable, in which the dielectric 14 has a plurality of symmetrically spaced circular passageways such as 15 positioned round the center conductor 16.

FIG. 4 shows the extrusion tool for forming a dielectric of such a cross section. Preferably the dielectric should be heated so that it is soft enough to flow into the tool between the collar 17 and the core 18 in the direction of the arrows. At the same time the center conductor 19 emerges at a predeter-

mined rate from a central bore in the core 18. Tubular members as 20 emerge from the conical nose of the core and these give rise during extrusion to the air passageways in the dielectric.

The members 20, which are hollow and thus serve as their own vent tubes, communicate in pairs with respective vent chambers in the core, only one vent chamber 21 being shown as a broken line. When a given vent chamber is closed at the atmosphere or evacuated, the two air passageways formed by the tubular member associated with that vent chamber become filled with the dielectric material over a region adjacent the end of the extrusion tool, thus forming the required water blocks. Such a pair of blocked passageways are shown symbolically at 30 in FIG. 3(b).

Apparatus will now be described which during extrusion automatically forms the water blocks in the passageways sequentially and at regular length intervals. This apparatus will be described in conjunction with the extrusion tool shown in FIG. 2; however, it is to be understood that such apparatus can be easily modified for use with the tool of FIG. 4 to form the water blocks in pairs.

Referring to FIG. 5, each vent tube at the rear of the extrusion tool is connected by means of a small bore pipe such as 22 to the inlet of a respective cam-operated vent valve 23. The vent valves are arranged in turn by a rotating cam 24.

The construction of each valve is shown in FIG. 6. Each valve comprises a housing 25 in which a springloaded piston 26 is sliding fit. The piston has a portion of reduced diameter 27 provided with a piston valve 28. When the piston is in the lower position as shown, the small bore piping 22 is in communication with the atmosphere via the outlet 31, but when the piston is actuated by the cam 24 the pipe 22 is cut off from the

atmosphere and brought solely into communication with a closed stopcock or with a vacuum pump via the outlet 29. When this occurs a water block is formed in the associated air passageway in the manner described.

During continuous extrusion the cam 24 is operated by means of a pulley, rotated by the center conductor which passes round the pulley as it travels towards the extrusion tool, and change gears. Thus the rotary speed of the cam is proportional to the speed of the center conductor, and can be preset by means of the change gears and the diameter of the pulley. By this means the length interval between water blocks may be changed.

I claim:

1. A coaxial cable having a center conductor, an outer conductor surrounding and spaced from the center conductor and an extruded dielectric material between said conductors, said dielectric material including a plurality of longitudinal passageways spaced about the center conductor, each of said passageways being blocked with said extruded material at longitudinal and circumferential locations along the cable different than the other passageways.

2. The cable of claim 1, wherein said passageways are symmetrically spaced about the center conductor, each being blocked at said portions in sequential order at regular intervals along the length of the cable.

3. The cable of claim 2, wherein the blocked portions include an outer wall region of dielectric collapsed into the passageways.

4. The cable of claim 3, wherein the dielectric cross section is in the form of a cartwheel having spokes defining the passageways.

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