

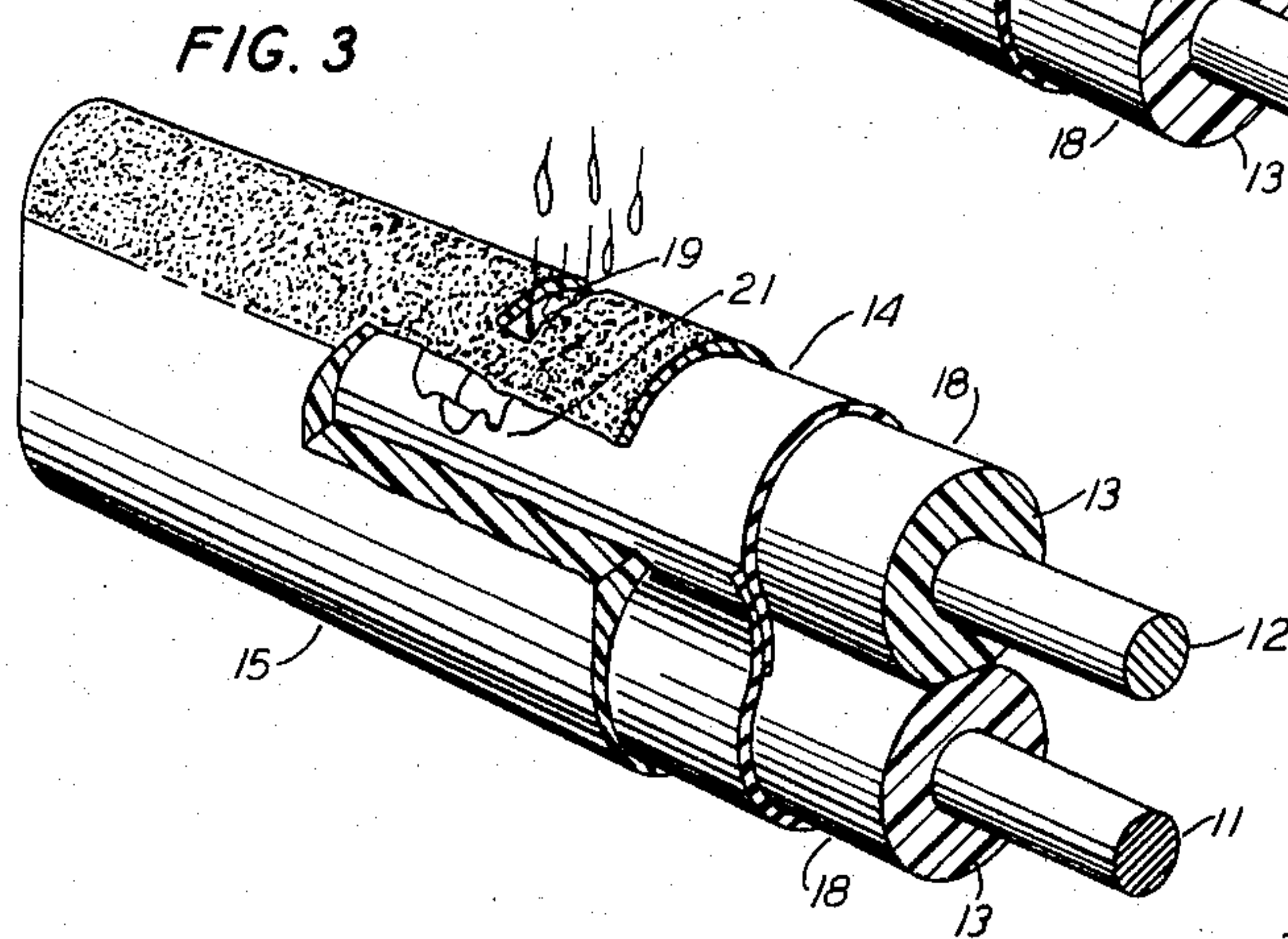
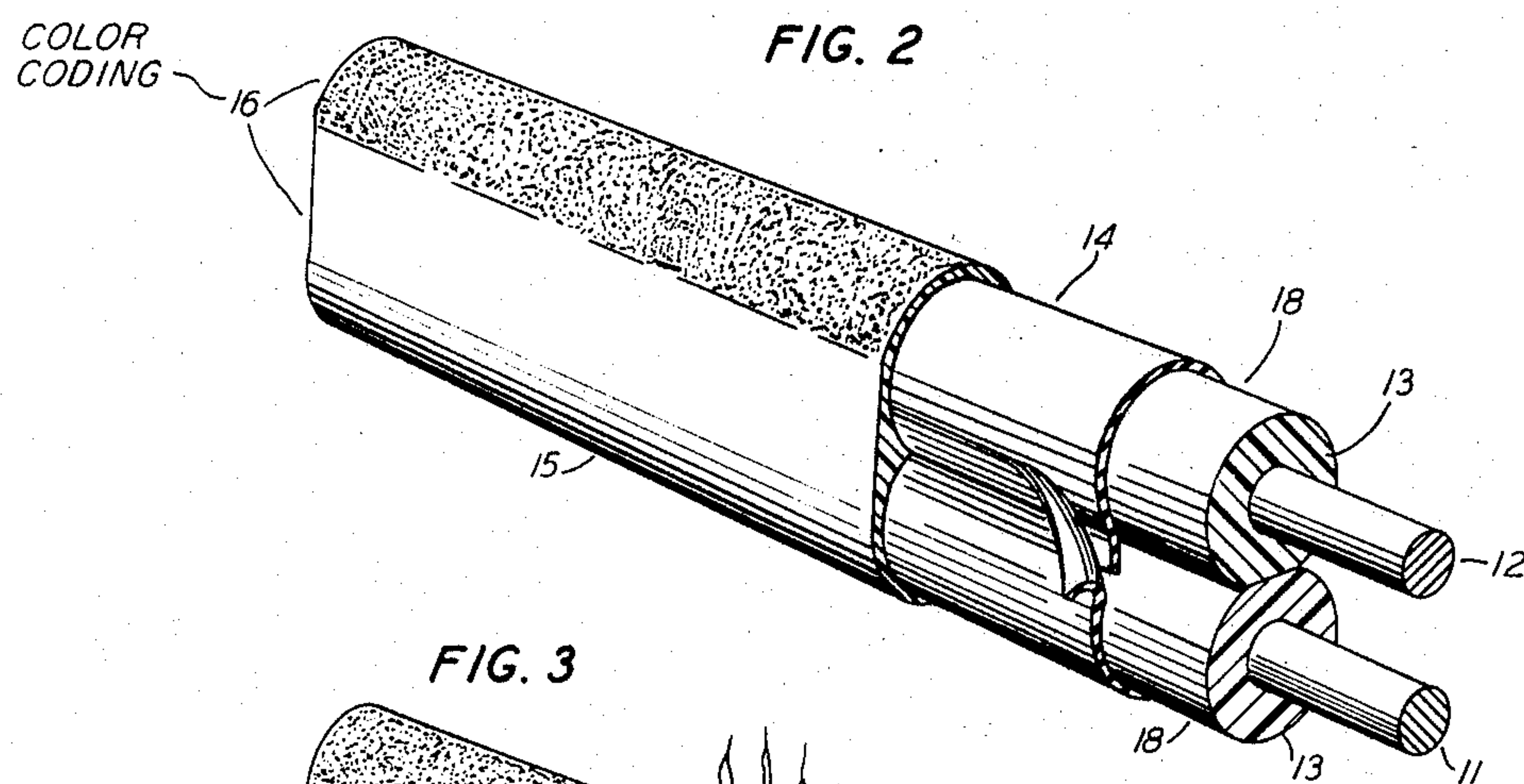
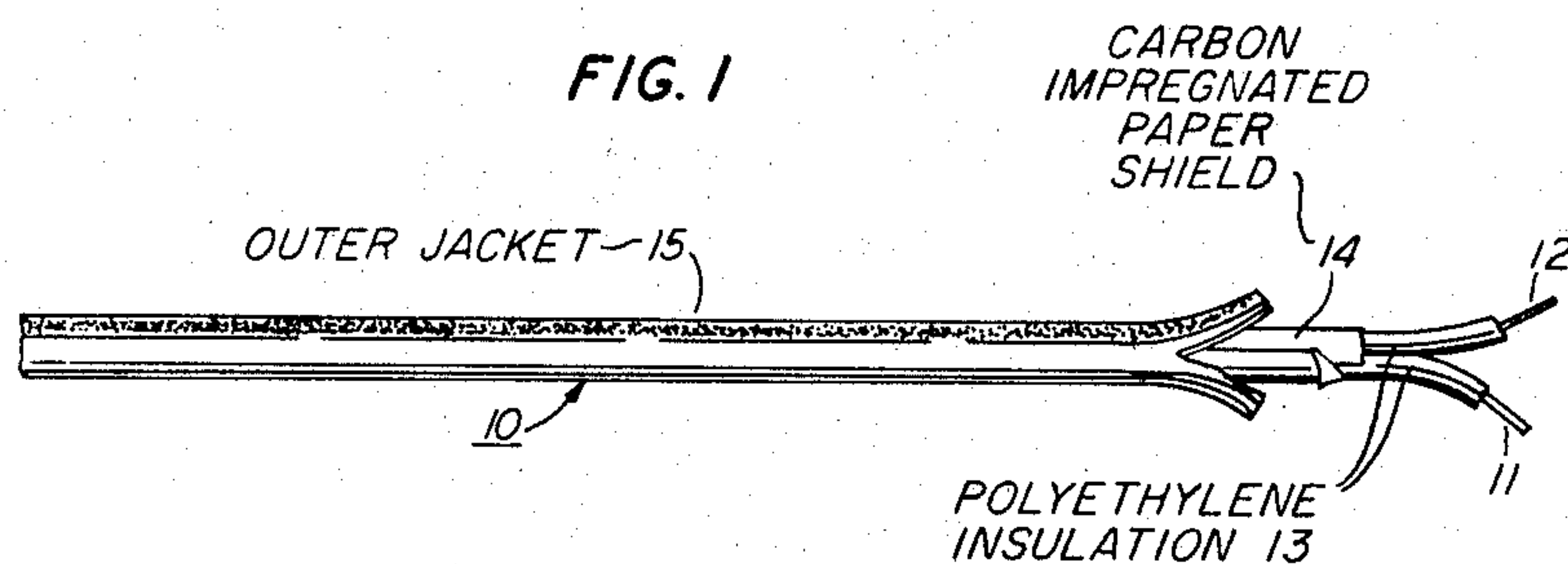
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SHIELDED JACKETED-PAIR COMMUNICATIONS WIRE

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SHIELDED JACKETED-PAIR COMMUNICATIONS WIRE

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This invention relates to aerial telephone wire pairs and specifically to an improved electric field shielding feature that also provides a high degree of self-sealing to guard against seepage of moisture through a fault in the outer jacket.

An increasingly large number of telephone stations in suburban and rural areas are connected to central office equipment at least in part through aerial wire. Typically, the wire consists of a pair of copper conductors that may be insulated individually with, for example, black polyethylene and individually jacketed with colored polyvinyl chloride for further protection from the elements and other damage. Usually six or so twisted pairs of such wire are stranded around a strength member such as a steel wire which acts as a supporting member for the structure.

Although such wire pairs have proven durable and in most respects satisfactory, a persistent problem arising from the inevitable accumulations of moisture of such aerial wire has remained largely unsolved. Specifically, moisture or dampness from whatever source present upon the outer jacket of wire such as that described above has the effect of varying the transmission characteristics of such wire. This comes about because the presence of moisture about the wire pairs considerably alters the orientation and density of the associated electric field. Such factors as mutual capacitance, mutual inductance, characteristic impedance and attenuation all undergo an intolerably high percentage change from dry to wet conditions. This percentage change causes a mismatching with the remainder of the exchange cable loop which cannot be compensated for economically and which seriously degrades the transmission and reception of voice frequency signals at the subscriber's set.

Another related problem in aerial wire pairs stems from the seepage of water along the interface of the outer sheathing and the surface of the insulation around the individual pairs, usually through a fault in the outer sheath. Such moisture seepage produces the same serious variations in the transmission characteristics of the wire, as noted earlier; but because such moisture cannot evaporate it causes such changes, once established, to persist long after the outer sheath surface has dried. The deleterious effects of such moisture on the quality of the transmission and receiving have been noted.

Several solutions to the problems posed rather readily occur. For example, the thickness of the insulation materials could be increased to enlarge the distance of the moisture boundary from the electric field. Alternatively, a heavy lead sheathing could be used to contain the stranded pairs so that a further barrier would be presented to the encroachment of water upon the wires. Thirdly, an expanded or cellular polyethylene insulation around each conductor reduces to some extent the objectionable percentage difference in transmission characteristics from dry to wet states, as taught, for example, in Patent 2,805,276, issued to E. W. Weitzel on Sept. 3, 1957, and assigned to Western Electric Company, Inc. The reduction thus effected, however, is relatively slight and not sufficient to overcome the serious problems referred to. Moreover, primarily for economic reasons the other alternatives men-

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tioned are impracticable, particularly in view of the large quantities of such wire employed annually in this country.

Accordingly, an object of the invention is to reduce substantially the objectionable difference in transmission characteristics of an aerial wire that exists between the dry and the wet state.

Another object of the invention is to produce such a wire that is relatively inexpensive and readily manufactured and installed.

A further object of the invention is to reduce substantially the effects of moisture seepage through a fault in the outer sheath of aerial cable, thereby to extend the life of such cable.

These and other objects are achieved in accordance with the invention by a novel wire structure in which each wire includes a first waterproof dielectric layer that is intimately in contact with a layer of hygroscopic, wet-swelling material containing a concentrated electrostatic shielding substance, with the resulting structure—usually a pair of such wires—tightly enveloped in a second waterproof dielectric that serves as the outer jacket.

In accordance with the invention, a high order of transmission stability is assured by the novel structural combination; and this same mechanism also sharply curtails the internal longitudinal seepage of moisture entering the wire through a damaged outer jacket.

The invention may be embodied in a structure such as the following. A thermoplastic insulation, such as high density polyethylene which preferably has been expanded by an inert gas, is applied to copper conductor such as No. 19 AWG. Pairs of these insulated conductors are enveloped or packed in a fibrous material, such as paper, which has been impregnated with carbon. An overall thermoplastic jacket, for example, polyvinyl chloride, covers the pairs. The carbon-impregnated material is an electrostatic shield which, in conjunction with the overall jacket fixes the orientation and density of the electric field. The expanded polyethylene insulation achieves a mutual capacitance that is in itself more desirable and that further interacts with the paper shielding to achieve a several fold improvement in the wires' stability from the dry to the wet condition. Moreover, the carbon shielding is incorporated into a fibrous paper structure that can absorb water and thereby swell when employed as an intermediate layer as in the instant invention. To make the structure largely self-sealing, a single, intermediate layer, therefore, performs the dual functions of electrical stabilization and protection against moisture seepage.

Thus a feature of the invention relates to the inclusion in an electrical transmission wire of a layer of hygroscopic, wet-swelling material between the inner conductor insulation and the outer covering.

Another feature of the invention resides in an intermediate hygroscopic wet-swelling layer employed as above, in which an electrostatic shielding material such as concentrated carbon has been impregnated.

A further feature of the invention relates to the electrical interaction between an expanded polyethylene insulation and carbon-impregnated paper to achieve highly stable transmission characteristics in a communications wire.

These and other objects and features of the invention will appear explicitly in the following description of an illustrative embodiment thereof and from the drawing in which:

FIG. 1 is a side view of the wire;

FIG. 2 is an enlarged perspective of the wire; and

FIG. 3 is an enlarged perspective illustrating seepage blocking.

In FIG. 1 the improved wire is generally designated as 10 and includes a first and a second conductor 11 and 12

each of which is encased in a layer of insulating material 13. The conductor material is usually copper but may be selected from many other well-known conductive metals if desired. A shield 14 comprises a layer of fibrous, highly water absorbent paper impregnated thoroughly with carbon particles and surrounds the insulated conductors 11 and 12. In the preferred embodiment, an expanded polyethylene is employed for the insulation 13 because of its favorable interaction characteristics with shield 14 but may in fact be composed of any number of other well-known waterproof materials including rubber or solid polyethylene, without substantially diminishing the improvements made possible by the dual purpose paper shield 14. An outer jacket 15 that is strong, durable and waterproof such as polyvinyl chloride covers the shielded pair of conductors. Color coding of the wire indicated as 16, may be included in the jacket by the simultaneous extrusion of, for example, two colors equally distributed about the jacket's circumference. In usual practice these jacketed pairs are then twisted, each pair to a different twist length, and six twisted pairs are stranded in one layer about a steel wire that provides strength.

Referring to FIG. 2, insulation 13 is composed of polyethylene that is expanded about 25 percent by volume with an inert gas to produce a cellular structure in a manner such as that described, for example, in the cited patent to Weitzel.

Shield 14 is a single layer of carbon paper about 1/64 inch thick and is substantially in contact with the entire outer surface 18 of insulation 13 except for a zone of tangency where the insulation 13 surrounding each of the conductors 11 and 12 abut. The material composition of shield 14 advantageously consists of a one hundred percent rope fiber paper impregnated with carbon black. The rope fibers are specially treated to obtain a less dense and less rigid structure. The insulation resistance of the carbon paper is maintained at about 100,000 ohms per one inch square. Other generally suitable materials for the shield include semiconducting polyethylene, semiconducting polyvinyl chloride, laminates of aluminum-Mylar or copper-Mylar. However, these materials do not seal themselves against moisture to the extent and in the manner exhibited by the above-described material.

Multiple layer wire is produced automatically and continuously by a variety of machines well known in the art. Of special value in the manufacture of the inventive embodiments described is the outer jacket extruder head described in Patent 3,121,255 issued to G. E. Henning-M. F. Richter on Feb. 18, 1964 and assigned to Western Electric Company, Inc. The shield 14 is applied by a well-known folding operation at the extruder; and outer jacket 16 is applied tightly around the shielded pair.

The table below illustrates the greatly improved transmission characteristics of a wire pair employing the present inventive concept as compared with a typical widely used prior art wire comprising two No. 19 AWG conductors individually insulated with solid black polyethylene and individually jacketed with polyvinyl chloride, with no intermediate shielding layer:

PERCENT CHANGE—DRY TO WET

Description	Freq., Kc./sec.	Mutual Capacitance	Mutual Conductance	Charac- teristic Impedance	Attenuation
Prior Art Wire.....	1	94.0	39.0	28.0	39.0
	100	90.0	102.0	27.0	37.0
Wire Embodying Instant Invention....	1	0.7	6.0	0.3	0.3
	100	0.1	33.0	0.2	8.4

FIG. 3 illustrates very simply the self-sealing feature attributable to the swelling action of the fibrous paper employed as the intermediate layer. A fault 19, due to tree damage, falling object, inherent defect, faulty splicing or the like is sufficiently deep to allow rain or condensation 21 to penetrate through to the shield 14. With no

shield 14 present at all, such moisture would seep along for possibly dozens of feet, thereby impairing significantly the transmission characteristics of the wire. In the instant invention, however, the fibrous paper of the shield 14 absorbs the water 21, eventually absorbing enough so that a swelling occurs to thwart further absorption. For most common faults to which such aerial wire pair is subjected any moisture seepage through such a fault would be limited by the swelling action of the shield to a matter of a few feet. The effect of such minimal seepage upon wire's transmission characteristics is negligible.

Any number of variations upon the foregoing illustrative embodiment of the present invention will be apparent to persons versed in the art without departing from the spirit and the scope of the invention.

What is claimed is:

1. An insulated wire for use in environments of varying moisture content comprising:

- a conductor;
- a first waterproof dielectric layer surrounding said conductor;
- an envelope of hygroscopic wet-swelling rope fiber paper surrounding said first layer, said envelope containing an impregnation of electrostatic shielding substance;
- and a second waterproof dielectric layer surrounding and tightly confining said envelope, the latter being responsive to contact with moisture for expanding against said first and second waterproof dielectric layers to prevent further travel of said moisture.

2. A wire in accordance with claim 1 wherein said electrostatic shielding substance is carbon black sufficient to produce an insulation resistance of about 100,000 ohms per one inch square.

3. A wire in accordance with claim 2 wherein said first dielectric layer is a high density expanded polyethylene of cellular structure, and wherein said second dielectric layer is polyvinyl chloride.

4. An insulated wire for use in environments of varying moisture content comprising:

- a conductor;
- a first waterproof dielectric layer surrounding said conductor;
- a layer comprising a hydroscopic wet-swelling material surrounding said first layer and including an impregnation of electrostatic shielding substance; and
- a second waterproof dielectric layer surrounding and tightly confining said hygroscopic layer, the latter being responsive to contact with moisture for expanding against said first and second waterproof dielectric layers to prevent further travel of said moisture.

5. A wire in accordance with claim 4 wherein said shielding substance is carbon black sufficient to produce an insulation resistance of about 100,000 ohms per one inch square.

6. An aerial telephone wire comprising:

- a pair of conductors;
- a substantially cylindrical layer of expanded cellular

polyethylene surrounding each said conductor, the layers being disposed tangentially to one another; a continuous envelope of hygroscopic, wet-swelling rope fiber paper surrounding said tangential layers, said fiber paper containing:

an impregnate of carbon black sufficient to pro-

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duce an insulation resistance of about 100,000 ohms per one inch square;
 an outer jacket of waterproof dielectric material surrounding and tightly confining said hygroscopic layer, said last-named layer being responsive to contact with moisture for expanding against said first and second waterproof dielectric layers to prevent further travel of said moisture.

7. An aerial telephone wire pursuant to claim 6 wherein the tangential layers comprise a figure-eight shape in cross section and wherein said hygroscopic envelope comprises a single layer approximately $\frac{1}{64}$ inch thick and having a longitudinal overlapping portion at the indented portion of the figure-eight, said outer jacket having an inwardly-protruding lip compressing said overlapped portion inwardly against the zone of tangency of said cylindrical layers, thereby to effect a substantial seal between

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said overlapping portions of said envelope, said outer jacket and said cylindrical layers.

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