United States Patent

Burney

[15] **3,670,058**

[45] **June 13, 1972**

[54] METHOD OF REDUCING SELF-GENERATED ELECTRICAL NOISE IN COAXIAL CABLE

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[73] Assignee: **GTE Sylvania Incorporated**

[22] Filed: **Feb. 1, 1971**

[21] Appl. No.: **111,292**

[52] **U.S. Cl.** .....**264/22,** 29/202.5, 29/203 C, 29/592, 174/36, 174/102 R, 174/107, 264/345

[51] **Int. Cl.**.....**B29c 25/00,** H01b 11/06, H01b 7/18

[58] **Field of Search**.....264/22, 27, 345; 174/36, 102 R, 174/107; 29/202.5, 203 C, 592, 624; 117/62, 93, 93.2

[56] **References Cited**

UNITED STATES PATENTS

3,316,620 5/1967 Stewart.....29/592

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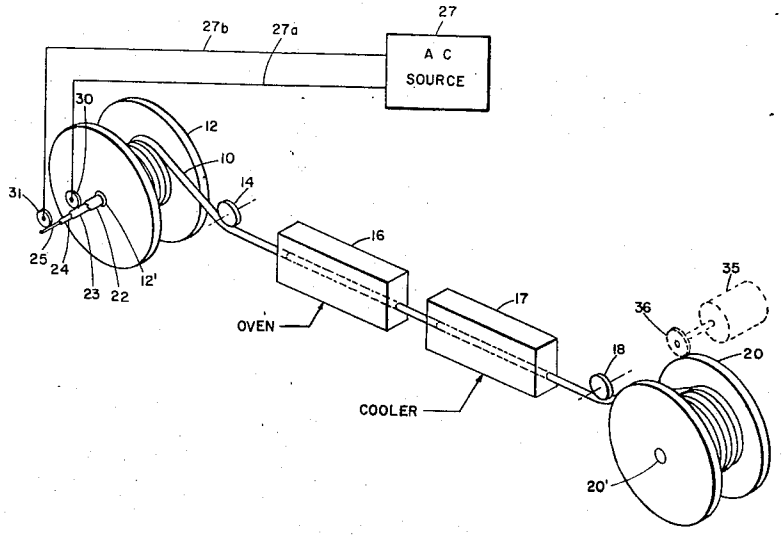
[57] **ABSTRACT**

A method of reducing or minimizing internally generated electrical noise in coaxial cable consisting of the steps of heating the cable sufficiently to heat-soften the dielectric filler, applying an alternating voltage across the inner and outer conductors of the cable, cooling the cable while maintaining the ac bias across it, and thereafter removing the ac bias.

4 Claims, 1 Drawing Figure



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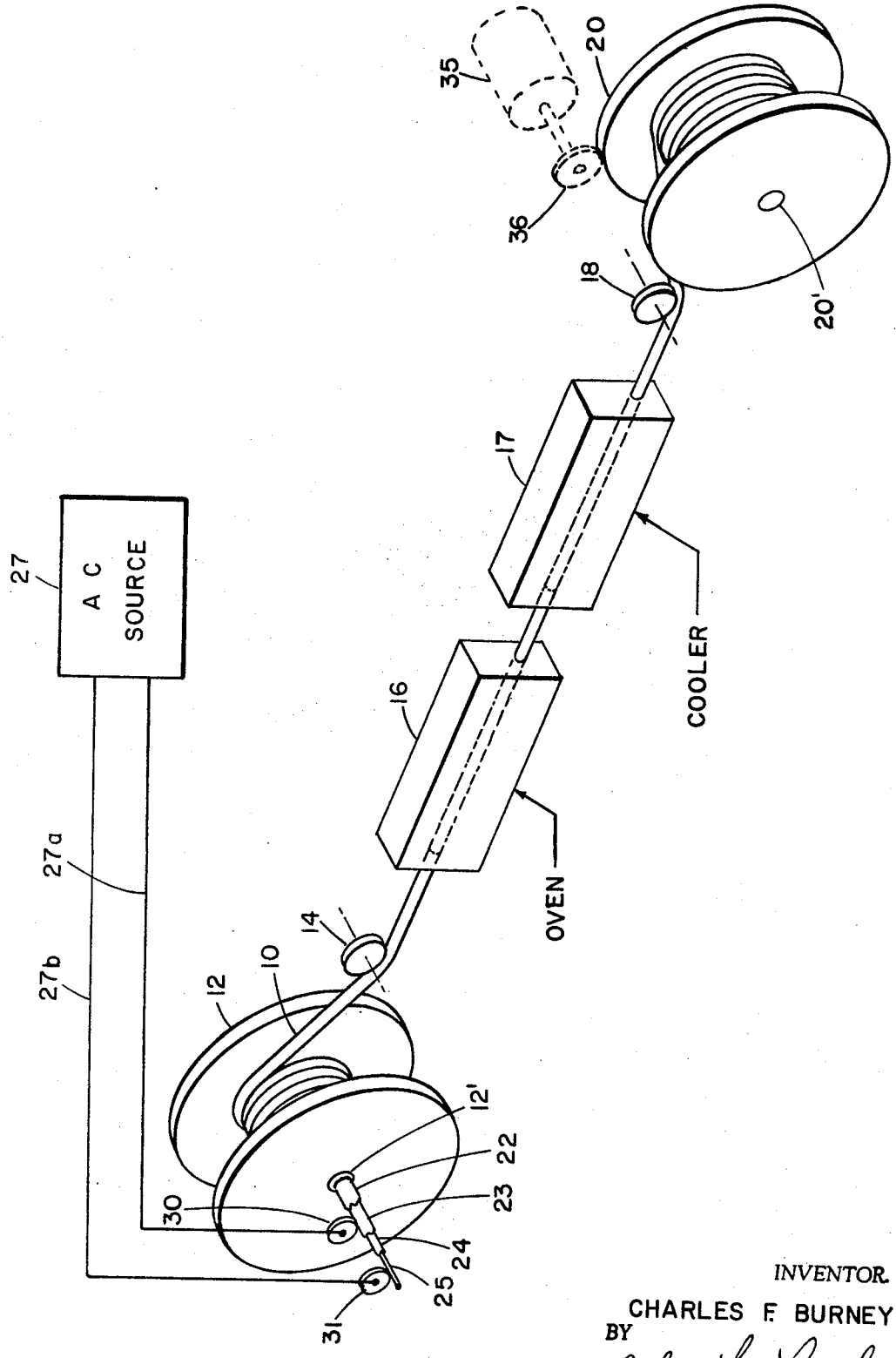

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METHOD OF REDUCING SELF-GENERATED ELECTRICAL NOISE IN COAXIAL CABLE

BACKGROUND OF THE INVENTION

This invention relates to coaxial cables, and more particularly to a process for reducing spurious electrical signals (noise) generated within the cable.

Noisy coaxial cable has long posed a problem to the electrical and electronics industry. The source of internally generated noise from such cables has been the subject of investigation over the years without significant solutions being offered or recommended. In an article entitled "Triboelectric Noise Generation in Some Cables Commonly Used With Underwater Electrocoustic Transducers" by John E. Donovan in *The Journal of the Acoustical Society of America*, Volume 48, No. 3 (part 2), 1970, pp 714–724, inclusive, the author traces these prior investigations which generally have focused on the triboelectric effect as the principal cause of such noise. The term "triboelectric" means voltages pertaining to or resulting from friction which is believed to exist between the mating surfaces of the outer conductor and the dielectric filler when the cable is bent, twisted or crushed. Less attention has been paid to the probabilities of generation of noise within cables from other causes. H. C. Roberts in *Mechanical Measurements by Electrical Methods* (The Instruments Publishing Company, Inc., Pittsburgh, 1951, at pp. 180) suggests that signal error may exist as a result of the electro-strictive effect in cable dielectric filler and proposed a shunt capacitance as a means of minimizing the results of this effect. Such shunt capacitance, however, also reduces the efficiency of the cable as a transmission line.

In accordance with this invention, I have discovered that substantial noise generated within coaxial cable from mechanical deformation by bending, twisting, crushing or the like results from an electret effect in the dielectric filler, i.e., the filler is actually an electret. An electret is a permanently electrified dielectric substance exhibiting electrical charges of opposite sign at its extremities. The conversion of unpolarized dielectric filler material into an electret is believed to occur during the cable manufacturing process as the unintended result of the basic extrusion process for the dielectric material which employs heat coupled with the friction generated charge induced by this extrusion. Processes concerned with intentional formation of electrets are described in BRitish Pat. No. 996,018 (1965) and United States Pat. No. 3,316,620. This hitherto unrecognized characteristic of the dielectric filler in standard coaxial cable is neutralized, in accordance with this invention, by the process of heating the cable to the critical temperature of the dielectric material, i.e., less than the melting temperature of the latter but sufficient to heat-soften it, applying an ac bias voltage across the ends of the outer and inner conductors, maintaining the bias voltage on the cable while it cools and after the dielectric filler hardens, and thereafter removing the bias voltage. This process essentially changes the electret filler into a neutral dielectric substance having a negligible permanent charge and thus eliminates noise generated within the cable from the electret effect.

The invention is described in conjunction with the accompanying drawing illustrating apparatus for practicing the method embodying the invention.

Referring to the drawing, a 1,000 foot length of standard coaxial cable **10** is wound on a rotatable supply reel **12** and extends around pulley **14**, through oven **16** and cooler **17**, around pulley **18**, and finally is partially wound on rotatable storage reel **20**. The cable typically has a protective covering **22** of polyvinylchloride or the like, an outer conductor **23** of wire mesh, a dielectric filler **24** of tetrafluoroethylene (Teflon) and an inner wire conductor **25**. One extremity of cable **10** preferably projects from reel hub **12'** along and coincident with reel rotational axis X. Lead **27*a*** from ac power source **27** is connected by a roller contact **30** to an exposed portion of outer conductor **23** at this cable extremity and the other lead **27*b*** from source **27** is connected by a similar roller

contact **31** to the inner conductor at this cable extremity. In this manner the ac bias voltage output from source **27** is applied across the outer and inner conductors over the entire length of the cable as reels **12** and **20** rotate about their respective axes and transfer the cable from one to the other. The ac voltage alternately reverses its polarity.

The process of treating coaxial cable so as to reduce or minimize electrical noise generated within the cable from the electret effect is as follows: an initial short length (lead length) of the cable is unrolled from a full cable reel **12** and is passed under pulley **14**, through oven **16** and cooler **17**, around pulley **18** and around the hub **20'** of reel **20**. The other end of the cable extends from reel hub **12'** along axis X and is stripped to expose outer conductor **23** and inner conductor **25** of the cable. Oven **16** and cooler **17** are then appropriately energized to produce predetermined temperatures within each; the oven is operated at a temperature, typically 500° F., sufficient to cause dielectric filler **24** to become heat-softened as the cable passes through the oven while the cooler temperature is sufficient to cause the heat-softened filler to harden again.

Voltage from source **27** is then applied to the conductors at the end of the cable projecting from reel hub **12'** and motor **35**, through an appropriate friction drive **36**, causes reel **20** to rotate in a direction to transfer cable **10** from reel **12** to reel **20**, passing successively through oven **16** and cooler **17**. The rate of movement of the cable through oven **16** is related to the temperature of the oven and is sufficient to permit the dielectric filler **24** to heat-soften before emerging from the oven. Thus, the portion of the cable within the oven is electrically stressed by the ac bias voltage at the same time that filler **24** is heat softened. Under these conditions, the filler loses or is induced to lose its permanent polarization properties and becomes effectively neutralized as far as the electret phenomenon is concerned. This neutralization process continues until reel **12** is substantially empty; thereafter the tail end of the cable is severed at reel **20** and is discarded. In this manner, the dielectric filler in all except the lead end of the cable on reel **20** is conditioned to eliminate self-generated cable noise due to the electret phenomenon.

The invention may also be practiced simply by placing the entire length of a cable to be treated within an oven comparable to oven **16**, raising the temperature of the oven sufficiently to heat-soften (but not melt) the dielectric filler in the cable, and applying an ac voltage across the outer and inner conductors. Thereafter the oven and cable are allowed to cool to room temperature while the bias voltage remains on the cable. When the dielectric filler has hardened, the bias potential is removed and the process is complete.

I claim:

1. A method of conditioning coaxial cable to reduce self-generated electrical noise resulting from bending, twisting and/or crushing the cable consisting of the steps of

heating the cable to a temperature at which the dielectric filler becomes heat softened but does not melt,

applying an alternating voltage across the outer and inner conductors of the cable,

cooling the cable until said filler again hardens while maintaining said bias voltage across said conductors, and

removing said bias voltage from said conductors.

2. The method according to claim **1** in which successive increments of said cable are progressively heated and cooled during application of said bias voltage.

3. The method according to claim **1** in which an entire length of said cable is heated at one time and subsequently is cooled during application of said bias voltage.

4. A method of reducing electrical noise generated by a dielectric-filled coaxial cable under mechanical stress consisting of the steps of

applying an alternating voltage across the inner and outer conductors of the cable while the dielectric filler is heat-softened,

cooling the filler while maintaining said voltage across said conductors, and

removing said voltage from said conductors.

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