Aug. 7, 1956 O. A. SHORT 2,758,267

SILVER CONDUCTORS

Filed June 22, 1955

FIG. 1

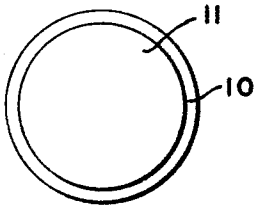


FIG. 2

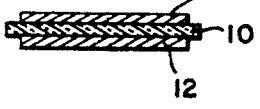


FIG. 3

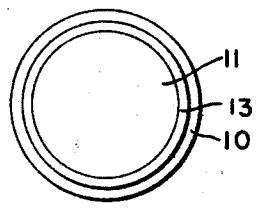


FIG. 4

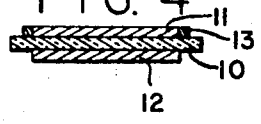


FIG. 5

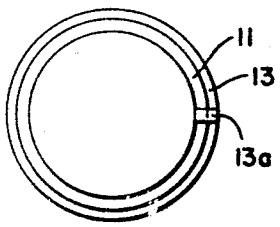


FIG. 6

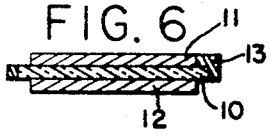


FIG. 7

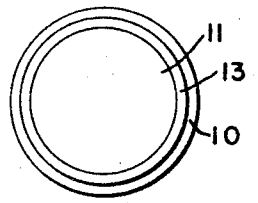
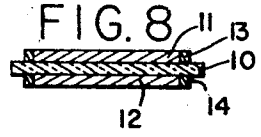


FIG. 8



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United States Patent Office 2,758,267 Patented Aug. 7, 1956

2,758,267

SILVER CONDUCTORS

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Application June 22, 1955, Serial No. 517,238

6 Claims. (Cl. 317—242)

This invention relates to an improvement in silver electrical conductors, and more particularly it relates to silver conductors which exhibit a greatly diminished tendency of the silver to migrate from one position to another on a dielectric.

Silver is being employed in constantly increased volume as a conductor of electricity. The ease and accuracy of application of silver to dielectric members has resulted in the production, in large numbers, of dielectric elements having printed thereon electrical conductive elements such as silver circuits or conductive capacitor plates. When two such silver conductors, in close proximity to each other, are in an electric circuit where one is cathodic and the other anodic, metallic silver will migrate from the anodic conductor to the cathodic conductor in the presence of moisture. The silver will build up on the cathode to gradually close the gap between the cathode and anode and thereby eventually create a "short-circuit."

Such failure of the electric circuit due to silver migration is due to the relatively high solubility of silver hydroxide in a moisture film and the ease of electrodeposition of metallic silver. The migration apparently takes place through the following mechanism. Where a film of moisture is present on the electric circuit comprised of the two conductors on a dielectric, hydroxyl ions from the ionization of water migrate to the anodic elements dissolving silver on the anode as silver hydroxide. The silver ions produced by ionization of silver hydroxide migrate through the layer of moisture to the cathode where they are deposited as metallic silver. Subsequent electrodeposits form at the outer edge of former silver deposits and thereby form a chain of metallic silver eventually extending across the gap from the cathode to the anode.

Conductors of the precious metals such as gold, platinum or palladium are not subject to the objectionable migration of silver. However, these precious metals are too expensive to use to replace the silver. For example, to obtain equal conductivity, about ninety-six dollars' ($96) worth of gold would be required to replace one dollar's ($1) worth of silver. Platinum would be more than twice as expensive as gold.

It is an object of this invention to greatly minimize or substantially eliminate the objectionable migration of silver between silver electrodes on a dielectric.

It is another object of this invention to produce greatly improved electrical circuits comprised of silver conductors on dielectric members.

Other objects of the invention will appear hereinafter.

The objects of this invention may be accomplished by interposing on a dielectric between silver conductors of opposite polarity a barrier composed of a precious metal from the group consisting of gold, platinum and palladium, which barrier is spaced from the silver conductive element of negative polarity.

The details of the invention will be more clearly apparent by reference to the following description when taken in connection with the accompanying drawings

showing illustrative embodiments of the invention, and in which:

Figures 1 and 2 are top plan and cross-sectional views, respectively, of an electrical capacitor.

Figures 3 and 4 are top plan and cross-sectional views, respectively, of an electrical capacitor provided with a barrier to prevent silver migration.

Figures 5 and 6 are top plan and cross-sectional views, respectively, of another embodiment of capacitor provided with a silver migration barrier.

Figures 7 and 8 are top plan and cross-sectional views, respectively, showing the positioning of barriers on a capacitor to prevent silver migration regardless of which silver conductive element is positive or negative.

Referring to Figures 1 and 2, reference numeral **10** designates a dielectric member having silver conductive elements **11** and **12** secured to opposite sides thereof. Electrical capacitors constructed as illustrated in Figures 1 and 2 are produced in huge numbers. The dielectric **10** may be composed of glass, mica, resin, or any other known dielectric material. The silver may be printed on the dielectric as a silver paste and fired to form a layer of silver on the dielectric, or the silver, in the form of a sheet or pellicle, may be secured by firing or adhesion to the dielectric. When such a capacitor is connected into an electrical circuit one silver conductor becomes positive and the other negative by reason of the passage of electrical current through the conductors. Moreover, when such capacitors are exposed to normal atmospheric conditions a film of moisture is frequently contained on the capacitor. This has been a source of trouble since the silver, as above described, will migrate from the positive to the negative silver conductor around the edge of the dielectric member.

Figures 3 and 4 show a capacitor in which silver conductor **11** will be positively charged and conductor **12** will be negatively charged. A fine line of precious metal **13**, such as gold, platinum or palladium, is positioned about the conductor **11**. When such a capacitor is covered with a film of moisture the gold line will discharge the hydroxyl ions resulting from the dissociation of water and prevent the formation of silver hydroxide. The capacitor illustrated in Figures 3 and 4 will only function to prevent migration of silver if conductor **11** is positive and conductor **12** is negative.

The embodiment illustrated in Figures 5 and 6 is a capacitor in which the precious metal barrier, for convenience of application, is provided on the edge of the dielectric.

This capacitor, like that shown in Figures 3 and 4, is designed to be connected to an electric circuit in such a manner that silver conductor **11** will be positively charged and conductor **12** will be negatively charged. Since silver would soon fill the space between the positively charged conductor **11** and the barrier **13**, it is generally preferable to provide a conection **13***a* between these elements. If it were desirable to connect this capacitor to a circuit in such a manner that the polarity of the conductors were reversed, then the barrier **13** would be connected to conductor **12** instead of to conductor **11**.

Figures 7 and 8 show a capacitor designed to be connected to an electric circuit in any desired manner, it being immaterial which silver conductor is negative or positive. Such a capacitor may also be connected to an alternating electric current without being subject to silver migration from one conductor to the other. In this modification a precious metal barrier **13** is positioned in contact with silver conductor **11** and a similar barrier **14** is positioned in contact with conductor **12**.

The present invention is illustrated with reference to one kind of electrical device; however, it is obviously applicable to any electrical device comprising two or more

electrical conductors positioned on a dielectric member in which at least one of such conductors is positive and composed of silver and at least one is negative and composed of a metal on which silver will electrodeposit. The use of precious metal barriers in the manner above set forth have particular utility with silver circuits printed on a dielectric. Such printed silver circuits have become very popular in the construction of many different electrical apparatus, such as hearing aids, radios, and the like.

The precious metal barrier may have any dimension, regardless of how thin its application, as long as it blocks the positive conductor. The barrier may be applied by painting, printing, electrical deposition, or in any other desired manner.

Since it is obvious that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that this invention is not to be limited to said details except as set forth in the appended claims.

I claim:

1. An electric device comprising a silver conductive element of positive polarity and a metallic conductive element of negative polarity and on which silver can electrodeposit, both conductive elements positioned on a dielectric, and a barrier composed of a precious metal from the group consisting of gold, platinum, and palladium on said dielectric between said conductive elements and spaced from said element of negative polarity.

2. An electric device comprising silver conductive elements of opposite polarity positioned on a dielectric and a barrier composed of a precious metal from the group consisting of gold, platinum, and palladium on said dielectric between said silver elements and spaced from said silver element of negative polarity.

3. An electric device comprising silver conductive elements of opposite polarity positioned on a dielectric and a barrier composed of a precious metal from the group consisting of gold, platinum, and palladium on said dielectric between said silver elements, spaced from said silver element of negative polarity and in contact with said silver element of positive polarity.

4. An electric device comprising silver conductive elements of opposite polarity positioned on a dielectric and a barrier composed of a precious metal from the group consisting of gold, platinum, and palladium on said dielectric on opposite sides of said silver elements.

5. An electrical capacitor comprising silver conductive elements of opposite polarity separated by a dielectric and a barrier composed of a precious metal from the group consisting of gold, platinum, and palladium on said dielectric between said silver elements and spaced from said silver element of negative polarity.

6. An electrical capacitor comprising silver conductive elements of opposite polarity on opposite sides of a dielectric and a barrier composed of a precious metal from the group consisting of gold, platinum, and palladium on said dielectric and surrounding said silver element of positive polarity.

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