

Sept. 23, 1941.

G. C. GAUT ET AL

2,256,642

ELECTRIC RESISTANCE ELEMENT

Filed March 9, 1939

Fig. 1

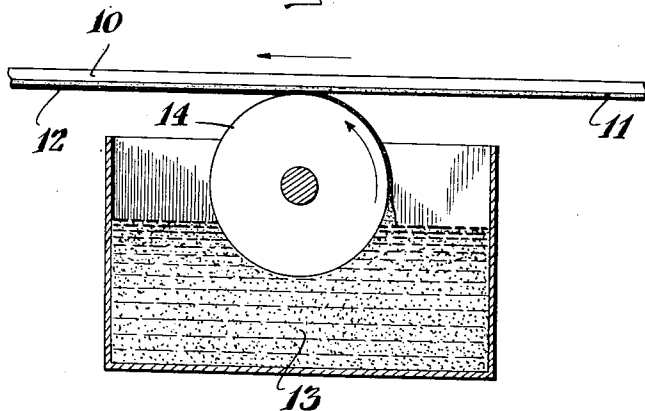


Fig. 2

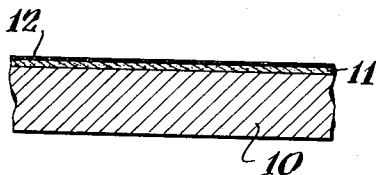


Fig. 3

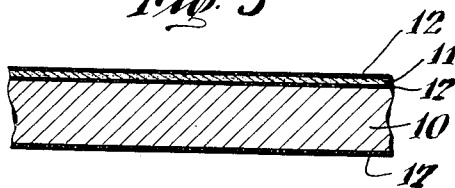
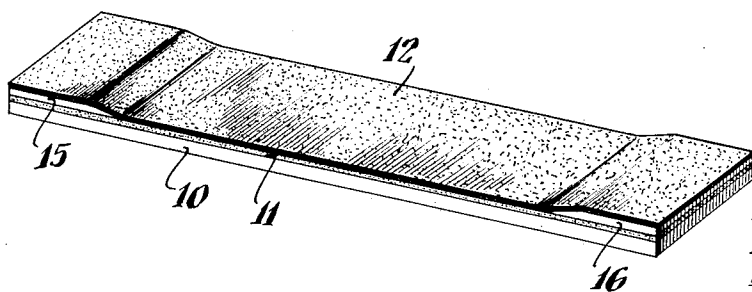


Fig. 4



Geoffrey C. Gaut
Benjamin T. Huggins
Donald Swaddle
Harold V. G. Stubbs
INVENTORS

BY

Paul Roblin

ATTORNEY

UNITED STATES PATENT OFFICE

2,256,642

ELECTRIC RESISTANCE ELEMENT

Geoffrey Charles Gaut, Romford, Benjamin Frederick Huggins, Forest Gate, London, Donald Swaddle, Ilford, and Harold Vivien George Stubbs, Clacton-on-Sea, England, assignors to P. R. Mallory & Co., Inc., Indianapolis, Ind., a corporation of Delaware

Application March 9, 1939, Serial No. 260,686
In Great Britain April 6, 1938

5 Claims. (Cl. 201—73)

This invention relates to electric resistance elements.

An object of the invention is to improve such elements, particularly elements made by photographic methods, such as are described in Gaut et al. U. S. application S. N. 91,986, filed July 22, 1936 and in British Patent 460,895 corresponding thereto.

These elements, for example, may comprise sheets or strips of paper, Celluloid, cellulose acetate or the like coated with a layer of binder material carrying dispersed therein finely divided conductive material, preferably produced photographically. The binder may, for example, be a nitrocellulose (Pyroxylin) lacquer. The conductive material may comprise silver developed in the layer by incorporating therein a silver salt such as silver bromide, chloride or iodide and exposing and developing photographically. The silver deposit may be varied or graded across the layer by controlling the time or rate of exposure prior to development. The layer may preferably also contain carbon in colloidal or substantially colloidal form (such as light soot) to increase its conductivity. Both the silver and the carbon then contribute to its conductivity.

Other objects of the invention will be apparent from the following description and accompanying drawing taken in connection with the appended claims.

The invention comprises the features of construction, combination of elements, arrangement of parts, and methods of manufacture and operation referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawing.

In the drawing:

Figure 1 represents one method of coating the resistance elements according to the invention.

Figure 2 is a section of a resistance element according to the invention.

Figure 3 is a section through a modified element, and

Figure 4 is a perspective view of a complete resistance element.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic

in their application to similar parts as the art will permit.

According to the principal feature of the present invention an element prepared in accordance with any of the said methods is improved by the addition on one or each side of a surface coating which is sufficiently waterproof to reduce or prevent variations of resistance value due to moisture. It is not essential that a completely waterproof coating should be provided but the coating should be sufficiently waterproof in the sense that any resistance variations (due, for example to variations in atmospheric humidity) that occur are within manufacturing tolerances. If the element proper, as is preferred, is carried on one side by a base of paper or the like the water-proof surface coating need only be provided on one side of the resistive layer. If the said layer is of graduated-resistance form so as to provide a variable-resistance element the surface coating should also be of such a character as to resist wear due to the co-operating movable contact. A coating which satisfies these conditions and has no appreciable effect on the resistance of the element may be obtained by using a lacquer formed from the following ingredients:

(1) Cellulose acetobutyrate-----grs--	8
(2) Carbon (20 mesh)-----grs--	2
(3) Spermaceti wax-----grs--	1.2
(4) Diamyl tartrate-----ccs--	1.5
(5) Ethylene dichloride-----ccs--	150

In preparing the lacquer, ingredients 1 and 3 are dissolved in ingredients 4 and 5 and the carbon is then beaten in for half an hour. The resulting lacquer, which is allowed to stand for fifteen minutes before use, is applied, in carrying out a continuous process as described in the prior patent, by means of a roller dipping in a bath containing a supply of lacquer and contacting with the exposed surface of the carrier after development thereof; fixing is not necessary, but we may pass the carrier after the developing stage through a bath of heptane or hexane before applying the surface coating. If fixing is carried out the coating is applied after fixing.

Instead of using the lacquer mentioned we may employ a carbon-containing solution of any other suitable cellulose derivative (such as benzyl cellulose) or a carbon-containing solution of polystyrol. The solvent used should be one that does not soften or dissolve the resistance element.

As already stated, it is preferred that the resistance element proper should be carried by a base of paper or the like. If paper is used we

have found it desirable to protect the paper with the objects of, firstly, reducing absorption and transmission of water, and, secondly, preventing saturation of the paper with any of the liquids used in the developing process. For this purpose we provide a protective coating between the resistive layer and the paper (this reducing water transmission through the paper to the said layer) and also on the other side of the paper (this preventing saturation of the paper with any of the developing liquids). When these steps are taken and the free side of the resistive layer provided with the above-mentioned surface coating the resistance is rendered free from variations in value. Satisfactory protective coatings may be provided on the paper by applying two separate lacquers on each side thereof, for example, two lacquers formed by solutions of two different cellulose derivatives or one such solution and a solution of polystyrol. The use of two separate lacquers (i. e. lacquers which do not fuse together after application) gives better protective qualities than can be obtained with a single lacquer. The first coating applied to each side of the paper may be made in accordance with either of the following tables:

Table A

Cellulose nitrate (high-viscosity).....	grs..	70
Benzyl abietate.....	grs..	70
Butyl stearate.....	grs..	5
Ethyl acetate.....	liters..	4

Table B

Cellulose acetate.....	grs..	150
Benzyl abietate.....	grs..	30
Butyl stearate.....	grs..	5
Acetone.....	liters..	4

Other cellulose derivatives, such as benzyl cellulose, may be used, or, as already stated, polystyrol. The lacquer made in accordance with Table A is slightly better than the other from the point of view of adhesion to the paper. If the first of these two lacquers is employed the second coating may be constituted as follows:

Cellulose acetobutyrate.....	grs..	150
Benzyl abietate.....	grs..	30
Butyl stearate.....	grs..	5
Ethylene dichloride.....	liters..	4

whilst if the alternative is employed (Table B) the second lacquer may be made from the following ingredients:

Cellulose acetobutyrate.....	grs..	150
Benzyl abietate.....	grs..	30
Cellulose nitrate (low viscosity).....	grs..	15
Butyl stearate.....	grs..	5
Ethyl acetate.....	liters..	5

We have already mentioned that fixing is not necessary. Accordingly when an anti-fogging treatment is not employed the baths required for processing the exposed element are reduced to three, including the bath of heptane or hexane in addition to the developing bath and a washing bath following the developing bath. It is possible to reduce contamination or deterioration of the developing bath by providing a "seal" of cyclohexane on the surface of the developing liquid; the latter must have water added to it to cause the cyclohexane to float.

In order to provide improved contact with the ends of the element and give low end values of resistance the exposed and developed layer may be provided with a high-conductivity coat-

ing at each end, these coatings being plated if desired; they should be provided before the element is passed through the above mentioned bath of heptane or hexane. The coatings may be formed in any convenient way, e. g. with the use of a silver-containing solution, and the plating may be effected by traversing the coating (acting as cathode) past a silver anode with the interposition of a pad to which is supplied a silver acetate or silver cyanide plating solution.

Referring to the drawing Figure 1 shows how the surface coating 12 is applied to the strip 10 (of paper or the like) carrying the resistive layer 11 by passing the strip over a roller 14 dipping in a bath 13 of one of the lacquers described herein.

Figure 2 illustrates a portion of the finished strip in cross section. Figure 3 is a cross section of the modified form in which the paper layer 10 is coated on both sides with a protective lacquer layer 17, after which resistive layer 11 is applied and then the carbon-containing protective layer 12 is applied over layer 11.

Figure 4 is a perspective view of a finished resistance element comprising a narrow strip of the paper 10 carrying the resistive layer 11 on one side thereof and having deposited metal terminal layers 15 and 16 at the two ends of the resistance layer, the protective layer 12 coating the resistance layer and terminals, although in some instances it may obviously be left off the terminals or part of them. The element may be used flat or bent into a cylinder. Obviously a flat circular element could also be provided by punching from the original sheet.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:

1. An electric resistance element for a moving contact variable resistance device comprising a base of sheet insulating material, a first layer of resistance material thereon, said layer being subject to humidity changes, and a second layer of resistance material on top of said first layer, said second layer being resistant to moisture penetration, said first layer comprising finely divided silver suspended in a matrix of humidity sensitive material, the density of the silver particles in said matrix varying over the length of said layer in a predetermined manner whereby a corresponding variation in specific resistance lengthwise of the layer is obtained, said second layer providing a contacting surface for engaging the moving contact of said device.

2. An electric resistance element for a moving contact variable resistance device comprising a base of sheet insulating material, a first layer of resistance material thereon, said layer being subject to humidity changes, and a second layer of resistance material on top of said first layer, said second layer being resistant to moisture penetration, said first layer comprising finely divided silver suspended in a matrix of humidity sensitive material, the density of the silver particles in said matrix varying over the length of said layer in a predetermined manner whereby a corresponding variation in specific resistance lengthwise of the layer is obtained, said second layer providing a contacting surface for engaging the moving contact of said device and comprising a lacquer containing carbon suspended therein.

3. An electric resistance element for moving contact variable resistance devices comprising a

base of sheet insulating material, a first layer of resistance material thereon, said layer being subject to humidity changes, and a second layer of resistance material on top of said first layer, said second layer being resistant to moisture penetration, said first layer comprising finely divided silver suspended in a matrix of humidity sensitive material, the density of the silver particles in said matrix varying over the length of said layer in a predetermined manner whereby a corresponding variation in specific resistance lengthwise of the layer is obtained, said base comprising a paper sheet having a protective lacquer coating on each side thereof.

4. An electric resistance element for a moving contact variable resistance device comprising a base of sheet insulating material, a first layer of resistance material thereon, said layer being subject to humidity changes, and a second layer of resistance material on top of said first layer, said second layer being resistant to moisture penetration, said first layer comprising finely divided silver suspended in a matrix of humidity sensitive material, the density of the silver particles in said matrix varying over the length of said layer

in a predetermined manner whereby a corresponding variation in specific resistance lengthwise of the layer is obtained, said second layer providing a contacting surface for engaging the moving contact of said device and comprising a lacquer containing carbon, a cellulose derivative and a solvent therefor.

5. An electric resistance element comprising a base of sheet insulating material, a first layer of resistance material thereon, said layer being subject to humidity changes, and a second layer of resistance material on top of said first layer, said second layer being resistant to moisture penetration, said second layer comprising a lacquer containing carbon in proportions sufficient to render said layer conductive in the direction of its thickness, a cellulose compound of the type comprising a water insoluble binder, and a wax compatible therewith sufficient to render said layer resistant to the penetration of moisture.

GEOFFREY CHARLES GAUT.
BENJAMIN FREDERICK HUGGINS.
DONALD SWADDLE.
HAROLD VIVIEN GEORGE STUBBS.