

(No Model.)

2 Sheets—Sheet 1.

J. H. KELMAN.  
FLEXIBLY INSULATED CONDUCTOR.

No. 586,554.

Patented July 20, 1897.

*Fig. 1.*

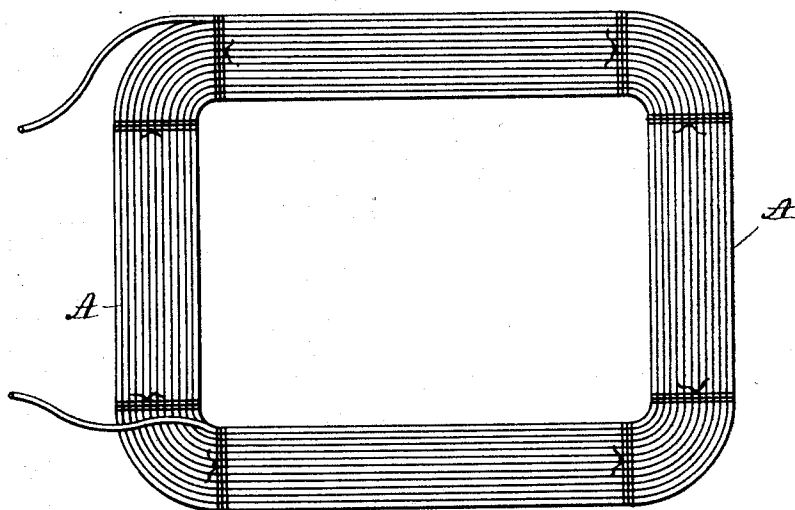
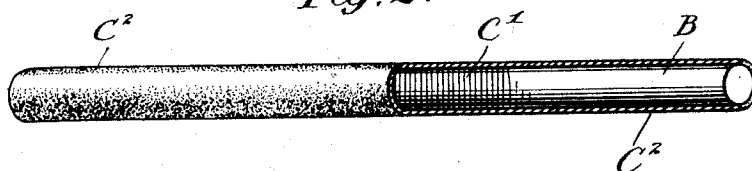


*Fig. 2.*



WITNESSES:

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INVENTOR

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BY

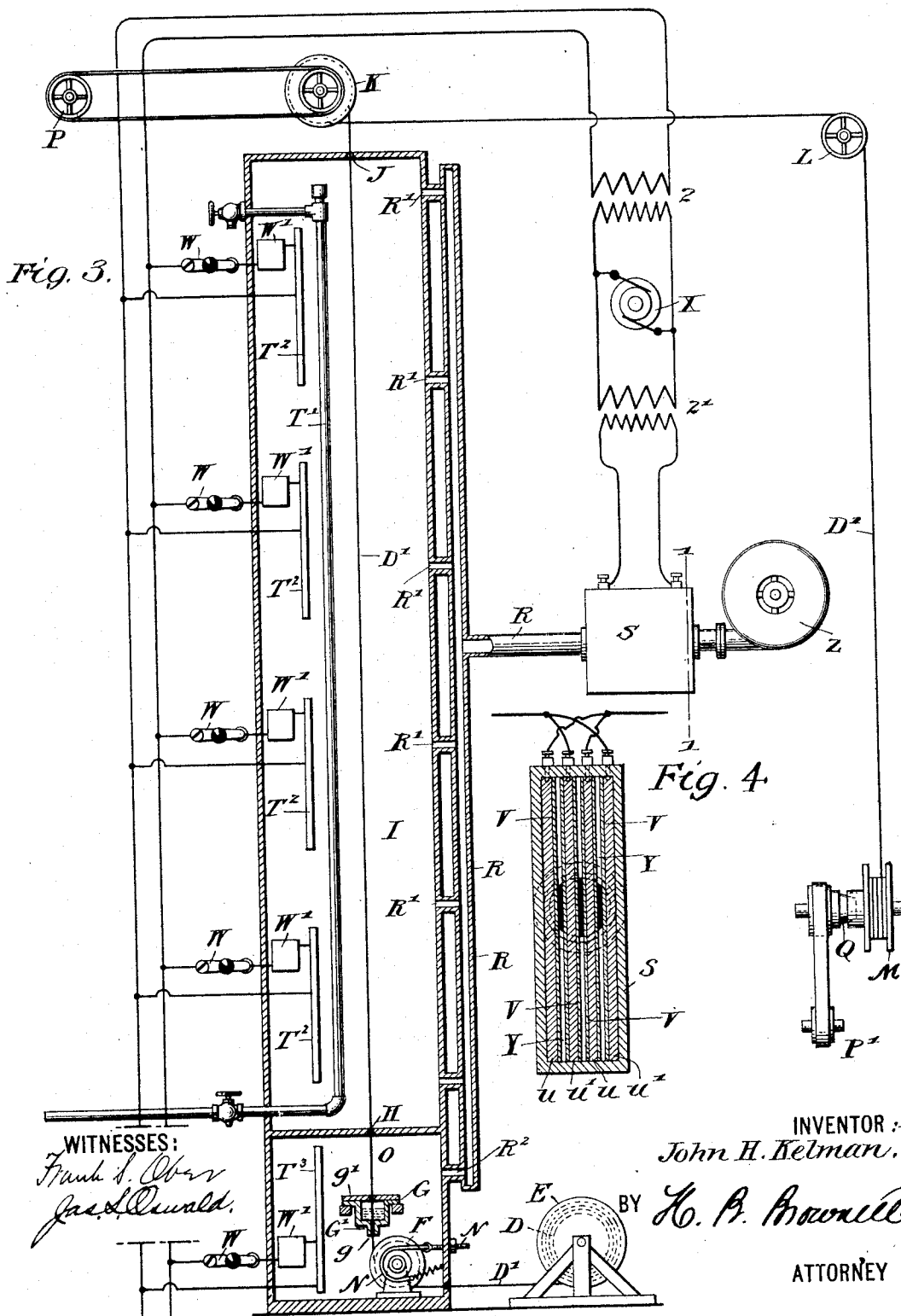
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# UNITED STATES PATENT OFFICE.

JOHN H. KELMAN, OF PITTSFIELD, MASSACHUSETTS.

## FLEXIBLY-INSULATED CONDUCTOR.

SPECIFICATION forming part of Letters Patent No. 586,554, dated July 20, 1897.

Application filed November 27, 1896. Serial No. 613,483. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN H. KELMAN, a citizen of the United States, residing in the city of Pittsfield, in the county of Berkshire and State of Massachusetts, have invented a certain new and useful Flexibly-Insulated Conductor, of which the following is a specification.

My improvement relates to the art of electrical conductors used in systems for the transmission of electrical energy and in apparatus for the generation, transformation, and conversion of such energy.

It has for its object to furnish a safe and reliable insulated conductor on which the insulation is of little bulk, of high ohmic resistance, and of high dielectric strength, and which is particularly useful in the construction of generators, transformers, and motors, and devices generally in which insulated conductors are used in similar relations.

The following is a description of my invention and the means for and method of making the same, reference being had to the accompanying drawings. The means and method do not form a part of this application, as they are described and claimed in a separate application for Letters Patent filed March 29, 1897, Serial No. 629,795.

Heretofore it has been customary to form coils of flexible insulated conductor by weaving upon the conductor a covering of cotton or silk fiber or by applying a covering of paper or other fibrous material, which is sometimes saturated with paint or paraffin or intermingled with rubber, which is subsequently vulcanized. Of these insulated conductors all have their various objectionable features. The insulation upon all of them is bulky and of comparatively low ohmic resistance and dielectric strength, is full of faults which lessen the dielectric strength and permit deterioration, and cannot be advantageously applied to conductors of all shapes; and, furthermore, when cotton or silk is used in direct contact with the wire there is apt to be some salt or acid present, which, when copper is used as the conductor, as is ordinarily the case, attacks the metal, forming salts of copper, which penetrate the covering and reduce its insulating power. It has also been customary to form insulated coils of con-

ductor where the conductor is coiled before it is insulated and then the coil and the parts thereof surrounded by a pyroinsulation, such as vitreous enamel, which surrounds and embeds the conductor, making it an integral and inflexible mass—a coil of inflexibly-insulated conductor and not a coil of flexibly-insulated conductor.

In contradistinction to the coils of insulated conductor referred to above the insulated conductor of my invention has none of the disadvantages referred to, but furnishes a flexible insulation which is uniform and of little bulk and is of high ohmic resistance and dielectric strength, has practically no "faults," and can easily and advantageously be applied to a conductor of any shape, and does not contain substances which attack the conductor or tend to make the insulation itself break down by reason of such action. It rests on the discovery that a thin coating of ordinary boiled linseed-oil or other linseed-oil varnish, such as baking-japan containing linseed-oil, when applied to a copper, German-silver, or other similar wire, such as is used for electrical conductors and hardened by oxidation, possesses sufficient flexibility to permit of coiling the conductor as coated into large helixes, so as to form large coils of flexibly-insulated conductor, and also of coiling or recoiling into small coils for electrical apparatus, such as the coils of generators, transformers, and the like, and forms an insulation having the advantages just enumerated.

In the drawings, Figure 1 represents a coil of flexibly-insulated electrical conductor embodying my invention. Fig. 2 represents a part of a single coil of the same, on an enlarged scale, partly in section. The remaining figures show an apparatus for carrying out the method by which I make coils embodying my invention. Fig. 3 is a section of the apparatus, showing its various parts somewhat diagrammatically. Fig. 4 is a vertical section of the ozone-generator S on the line 1 1, showing its interior plates.

Referring more specifically to the drawings, A represents a coil of flexibly-insulated conductor embodying my invention.

B represents the metallic portion of a part of the same on an enlarged scale. C' represents a coating of tin applied to the copper surface

of the portion B, and C<sup>2</sup> represents the insulated covering upon the same.

In its preferred form the insulated conductor consists of a copper or similar metallic conductor having a tinned surface covered by an ozone-hardened coating of linseed-oil, or other similar linseed-oil varnishes may be used for the coating.

The material I prefer to use for the covering C<sup>2</sup> consists of ordinary boiled linseed-oil. The oil can be thinned by turpentine, if necessary. I have also used a baking-japan having boiled linseed-oil as its base. A formula for making such a japan is as follows: 100 pounds asphaltum gum, 10 gallons boiled linseed-oil, 5 pounds gum-anime, 15 gallons turpentine, and turpentine sufficient to keep it at the necessary thickness for the desired coat. Any commercial linseed-oil baking-japan can be used, the more flexible and tough when hardened the better. Pure-linseed-oil coatings or other baking-linseed-oil varnishes, such as japan, I shall hereinafter refer to as "linseed-oil" varnishes. I apply this covering in the manner and by the apparatus described below.

In the drawings, Fig. 3, D represents a coil of copper wire, preferably tinned, mounted upon a reel E. The wire D' from this coil is passed around a pulley F in a closed chamber O and up through an orifice *g* in a plug or projection G' at the bottom of a vessel G, containing a bath of the material for the insulating-covering and preferably having a cover *g'*. It then passes through the orifice H into a hardening-chamber I. This chamber I is built to retain heat and to keep out as much light, either natural or artificial, as possible, since by my process the best insulation is made when all light is absent from both the hardening-chamber I and the chamber O. In this chamber I, which is a heated ozone-chamber, the wire D', after being coated by passing through the bath in the vessel G, is subjected to the action of ozone and heat, which hardens the material adhering to the wire after its passage through the bath. It then passes out through the orifice J and over the pulley K, after which it passes over the idle-pulley L to the reel M. The pulley F is encircled part way by the wire and has a friction-brake N, which makes the pulley F act as a tension upon as well as a guide for the wire D'. The pulley K is made to revolve at a slow rate of speed by power from some convenient source, as P, and draws the wire D' upward through the chamber I. The reel M is made to revolve sufficiently fast to take up the wire as it comes to it, being driven from some convenient source of power, as P', by a friction connection Q, which permits it to adjust its rotation to the speed of the wire.

Directly below the chamber I is the closed chamber O, which preferably should be of size large enough to permit a man to enter. Within this chamber is the vessel G, containing the bath, a suitable composition for which

has been above described. If necessary, by the addition of turpentine or other similar fluid it can be kept at the proper degree of fluidity when heated to result in a smooth coat. The orifice *g* through the small plug or projection G' is of a size to just permit the free passage of the wire D'. In order to maintain the bath in proper condition, I maintain the temperature of the contents of this vessel at about 200° Fahrenheit, preferably by an electrical heating device T<sup>3</sup>, which also heats the conductor D' from the coil D somewhat before it reaches the bath.

The chamber I is kept saturated, or almost so, with ozone supplied by ducts R' R' from the ozone-generator S. This chamber is kept heated so that at the bottom the temperature is about 250° Fahrenheit and at the top 350°. The chamber O is also preferably supplied with ozone by the duct R<sup>2</sup>, so that the coating is acted on somewhat before it reaches the higher temperature of the chamber I. The heating I prefer to accomplish by the joint action of steam-heaters T' T' and electrical heaters T<sup>2</sup> T<sup>2</sup>, which latter, as well as T<sup>3</sup>, are controlled by switches, preferably by manual switches W and also by automatic thermostatic switches W', so as to automatically regulate the temperature. The length of the chamber I is governed by the length of conductor to be coated that can be drawn by the pulley K from the reel E without stretching, a greater length of chamber permitting greater speed of the conductor without shortening the time during which it is subjected to the action of the ozone and heat.

The ozone-generator I have used generates a sufficient quantity of ozone and consists of a chamber Y, containing two sets of opposing conducting-plates *u u'*, separated by thin coatings of a dielectric V, such as a coating of enamel or japan on their opposing surfaces. The alternate plates are connected, respectively, to the terminals of a circuit of high alternating potential. A fan Z or other similar means is provided for drawing or forcing a current of air between the plates *u u'* and into the ozone-chamber I. The air as it passes between the plates *u u'* is acted upon by the electric discharge and part of it converted into ozone. This ozonized air then passes into the chambers I and O and escapes at openings therein. As shown, the generator X, through the transformers Q Q', supplies electricity to the ozone-generator S and the heaters T<sup>2</sup> T<sup>2</sup> and T<sup>3</sup>.

The action upon the covering on the wire in the heated ozone-chamber is as follows: The heat soon volatilizes any volatile parts of the coating, while at the same time the ozone rendered more active by the heat oxidizes the linseed-oil contained therein in the absence of any light. This process of oxidation being of a different nature from evaporation leaves no pores in the covering, but on the contrary makes a covering without pores and of a tough, flexible, and semielastic char-

acter. As any portion of the now covered wire reached the upper portion of the hardening-chamber I it is subjected to an increased temperature, which tends to still further harden the covering. The higher degree of heat at the upper part of the chamber tends to decompose the ozone, but the circulation in the chamber being upward keeps the upper part supplied with ozone.

If it is desired that the covering be subjected to the action of heat and ozone for a longer period, the conductor may be made to traverse the hardening-chamber for a second time. The flexibly-insulated conductor after the coating is sufficiently hardened is reeled, making the completed coil, the coating of the several turns being separate at the points of contact. Should it be desired to make the insulation thicker than can be done by passing the conductor through the bath and chamber but a single time, the first operation can be repeated upon the flexibly-insulated conductor until the several coats make the desired thickness.

When a copper conductor is used, it should preferably be tinned before it is coated. This assists very materially in obtaining a smooth and even coat, as the insulating material adheres more readily to the tinned surface than it does to the copper surface. The apparatus above described, to obtain the best results, should be run continuously twenty-four hours a day, new reels being supplied and joints soldered while in operation. The speed at which the wire moves should be such that the coating will be well hardened before it leaves the ozone-chamber.

The drawings show but one wire passing through the chamber I. In practice, however, as large a number of wires are run through as can be without interference, to do which the number of reels, pulleys, baths, &c., is increased accordingly.

The metallic portions of the conductor may be of almost any shape.

My invention is of peculiar advantage when embodied in flexibly-insulated conductors in which the metallic portion is in the form of a flat strip, since conductors of that form cannot be advantageously insulated at all by some of the methods hitherto used for insulating other forms of conductors.

What I claim is—

1. A flexibly-insulated conductor for electrical purposes, consisting of an extended length of electric conductor and a coating thereon of oxidized-oil varnish such as linseed-oil varnish, substantially as described.

2. A flexibly-insulated conductor for electrical purposes consisting of an extended length of tinned copper conductor, and a coating thereon of linseed-oil varnish, substantially as described.

3. A coil of flexibly-insulated conductor for electrical purposes consisting of a coiled copper wire and a flexible and uniform coating of hardened-linseed-oil varnish adhering thereto, the coatings of the several turns being separate at the points of contact, substantially as described.

4. A coil of flexibly-insulated conductor for electrical purposes consisting of an electrical conductor and a coating of ozone-hardened-linseed-oil varnish, substantially as described.

5. A coil of flexibly-insulated conductor for electrical purposes consisting of a coiled copper conductor having a tinned surface, and a coating of ozone-hardened linseed-oil, substantially as described.

In testimony whereof I have hereunto set my hand.

JOHN H. KELMAN.

Witnesses:

H. M. SKINNER,

H. B. BROWNELL.