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HEAT TREATMENT OF THE INSULATING COVERINGS
OF ELECTRIC WIRES AND CABLES
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FIG. 1.

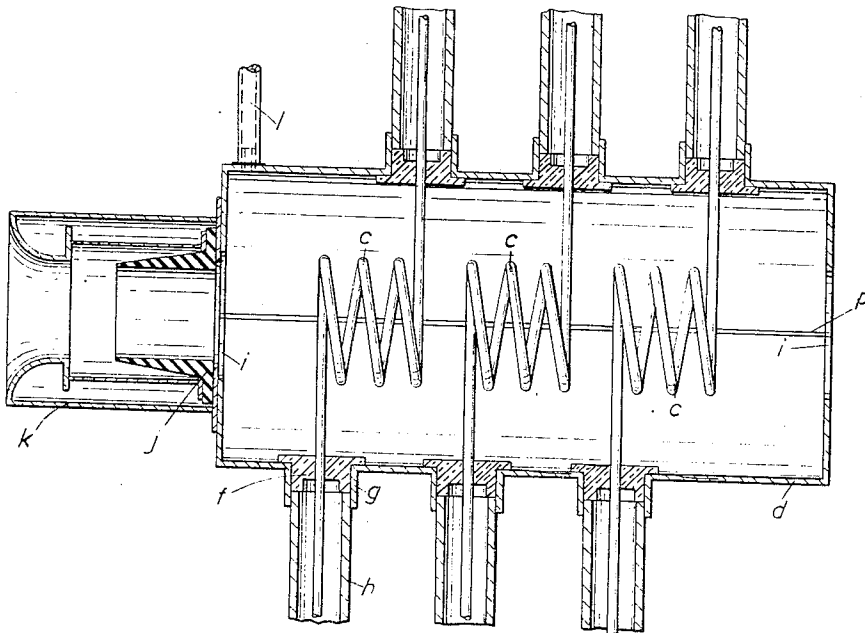
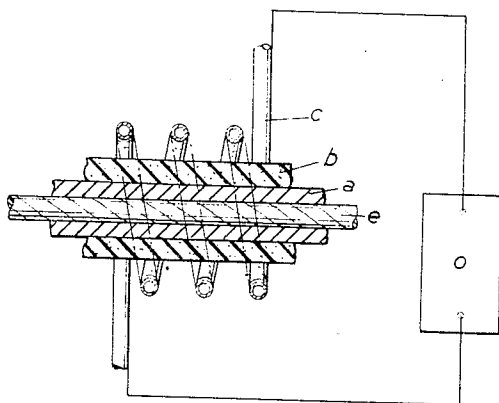


FIG. 2.



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HEAT TREATMENT OF THE INSULATING COVERINGS OF ELECTRIC WIRES AND CABLES

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1 Claim. (Cl. 219—47)

For the heat treatment of the insulating coverings of electric wires and cables, a method has been proposed in which heat is generated within the material by treating it as the dielectric between two electrodes across which a suitable potential difference alternating at a high frequency is maintained. In such an arrangement the dielectric loss in the material causes it to absorb energy from the electric field, resulting in the liberation of heat throughout the part of the material which lies within the electric field.

The present invention provides an alternative method of heating certain kinds of rubber mixes and other material by the use of high frequency electric currents. It is applicable to conductively loaded insulating material, i. e. to material which contains a large quantity of conductive material, in the form of small grains or powder distributed throughout it for the purpose of conferring on it certain properties. An example is provided by the use of powdered carbon black as a reinforcing agent in rubber. The method operates by the production of high frequency electric currents within the mix by the aid of the conductive material distributed therein. The apparatus for carrying out this method may also operate and will generally operate for the generation of heat, to some extent, by the method of the production of dielectric losses.

It has been found that the latter method alone cannot be applied, to practical advantage, to the vulcanising of conductively loaded materials in certain conditions, namely where such material lies in the dielectric field in the form of a layer in series with another layer of comparable thickness and substantially higher dielectric qualities. The conditions arise where the covering of an electric wire or cable comprises an inner layer of good insulating quality (serving as the dielectric layer) and an outer layer (provided for mechanical protection) consisting of rubber loaded with a large quantity of conductive material, for instance, powdered carbon black, to provide a tough sheathing. In such a case the outer layer, in relation to the inner layer behaves as a conductor to a sufficient extent to prevent the establishment across it of a large potential difference. By reason of the great difference in properties of the two layers nearly the whole of the potential difference is absorbed in maintaining the electric field in the inner layer and the presence of the conducting particles suppresses most of the electric field in the outer layer so that the conditions for the generation of heat by losses in electrically stressed rubber cannot be produced there. Ac-

cordingly, in this case the method of heating by dielectric losses cannot be used to practical advantage because the application of the electric field, while producing vulcanisation or other heat treatment of the inner layers, does not vulcanise the sheathing.

The case just mentioned is dealt with satisfactorily by the method in accordance with the present invention.

In this method the rubber to be vulcanised or otherwise heat treated is carried through a short cylindrical coil to the terminals of which a high frequency alternating voltage is applied, so that the coil produces within it a high frequency magnetic field. Within this field the conductively loaded rubber provides a closed turn of a transformer, within which heat is generated by the passage of the high frequency currents. In this way heat is generated rapidly in the rubber and vulcanisation is carried out. In speaking of high frequency in connection with the invention it is to be understood that reference is made to the range of frequencies from 20 to 200 million cycles per second. This is the range which is of practical importance for the invention and in most cases it will be preferable to use the upper part of this range, that is frequencies of the order of 100 to 200 million cycles per second. It seems probable that with such frequencies the currents in the conductively loaded material are in part conduction currents through the conductive particles and in part displacement currents through the intervening insulating material.

It will be understood that for the high frequencies in question the effective operation is dependent on the design of the coil. The coil will be made of short length axially, this being, for instance, of the same order as the diameter of the coil. In order to obtain sufficient heating for vulcanisation, while the rubber is travelling at the practically desirable high speed through the coil, it will generally be necessary to arrange several of these coils, one behind the other on the same axis, so that the rubber can pass through them in succession. These several coils can be connected in parallel across high frequency mains, or preferably each provided with a separate oscillator for supplying the high frequency energy.

For the frequencies in question it is practicable to design coils of convenient size which will be approximately at resonance. Due to the large potential drop in the coil there will be a large potential difference between the two ends of the coil so that there will be associated with it a strong electric field, which will extend into any dielec-

tric material which may be associated with the conductively loaded material, and will generate in such dielectric material heat by the dielectric loss method.

The invention will be further described by the aid of the accompanying drawing, in which Figure 1 shows in longitudinal section part of an apparatus embodying the invention and Figure 2 shows one of the coils and the material within it during its operation, also in longitudinal section. The apparatus shown is primarily intended for the continuous vulcanisation of the covering of electric wire *e*, consisting of an inner layer *a* (Figure 2), a dielectric material and an outer layer *b* of insulating material loaded with conductive particles. The layer *a* may be rubber compound of the quality used for providing the insulation of the wire, and the layer *b* may be rubber compound heavily loaded with carbon black so as to produce a tough sheathing. Each coil *c* is formed of a few turns, well spaced apart, of copper tubing.

With the coil arranged as indicated in Figure 2, across the terminals of an oscillator *o*, working at a frequency between 100 and 200 million cycles per second, the coil is in approximate resonance with frequency of the supply and, accordingly, has a large potential difference across it and a large current oscillating within it. This current produces a strong magnetic field, which extends into the layer *b*, and there generates circulating currents, resulting in the production of heat within that layer. Owing to the peculiar form and structure of the layer *b* it does not prevent the establishment of an electric field between the different parts of the coil *c* by way of the layer *a* so that heat may be generated in this layer by the dielectric loss method. As shown in Figure 1, the apparatus comprises a casing *d*, in which are enclosed three similar coils *c*, arranged co-axially and spaced a short distance apart. This casing *d* is preferably made of metal and is of such dimensions and form in relation to the coils that it does not provide in its walls a sufficiently complete conductive path to absorb energy by electro-magnetic induction from the coils to any large extent, nor to absorb any substantial quantity of energy from the electric fields produced by the coils. As shown, the casing is split on the horizontal centre plane and an insulating gasket *p* inserted. This gasket breaks the electric continuity of the wall and assists in making a pressure-tight joint between the two halves of the casing. The ends of the coils are each led out of the casing *d* through an insulating bush *f* which forms a tight joint with the conductor and with the wall of the casing *d*. Each bush

f lies in a flanged aperture *g* to the outer part of which is connected a metal tube *h* forming with the coil conductor a concentric cable suitable for forming a connection between the coil and its oscillator.

At the left-hand end of the casing *d* is an aperture *i*, on the outside of which is arranged a gland *j* of rubber, which, as shown, has a cylindrical bore and a tapering wall surrounding it and a flange adjacent to the aperture *i* by which flange it is clamped in position against the aperture. This gland is enclosed in a short auxiliary casing *k*, with a mouth through which the covered wire can enter. The gland is of such internal diameter that it has a small clearance only over the outer surface of the covering of the wire. There is another aperture *i* at the right-hand end of the casing *d* and a similar arrangement of gland *j* and casing *k* may be provided here. Alternatively, however, a further casing such as *d* may be attached so as to give extended treatment to the covered wire as it passes through, if this is necessary, the number of casings *d* being chosen to give the required duration of treatment. In any case at the right-hand end of the series of casings *d* a gland is provided. A pipe *l* provides gas or vapour under pressure to the interior of the casing, or casings, *d* so as to maintain pressure on the surface of the covering of the wire when this is necessary or advantageous. Gas can be supplied adequately to keep up the pressure within the chamber *d* as leakage takes place at the glands *j*.

It will be seen that this apparatus permits of the continuous passage through it of a covered wire at an appropriate rate and for the heat treatment of it during that passage to the extent required.

What we claim as our invention is:

40 In a method of processing the covering of a conductor having inner and outer layers of electrical insulating material of which only the outer layer is conductively loaded, the steps including
45 passing the conductor axially through an inductor heating coil consisting of a few spaced turns, the coil having a length of substantially the same order as its diameter, and operating approximately in resonance with a source of alternating
50 current of a frequency in the range of 20 million cycles per second and upwards, thereby heating the outer layer by induced current and simultaneously maintaining a voltage across the coil sufficient to heat the inner layer by dielectric
55 loss.

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