(No Model.)

H. F. CAMPBELL.

ELECTRICAL CONDUCTOR.

No. 369,394. Patented Sept. 6, 1887.

Fig. 1.

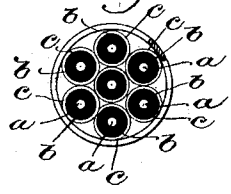
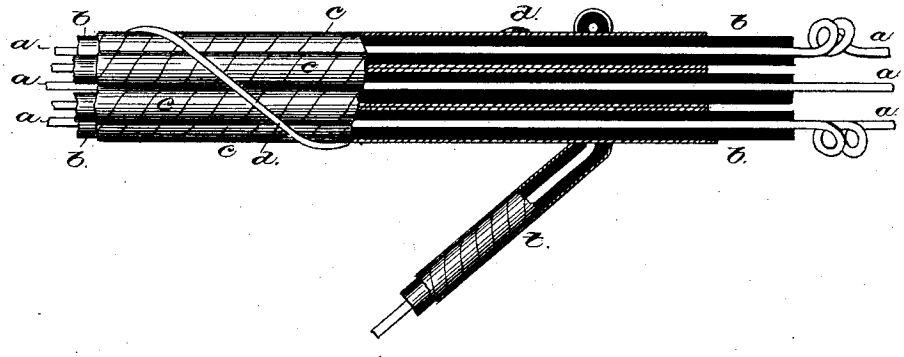


Fig. 2.



Witnesses.
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UNITED STATES PATENT OFFICE.

HENRY F. CAMPBELL, OF CONCORD, NEW HAMPSHIRE, ASSIGNOR TO THE CAMPBELL ELECTRIC COMPANY, OF NEW HAMPSHIRE.

ELECTRICAL CONDUCTOR.

SPECIFICATION forming part of Letters Patent No. 369,394, dated September 6, 1887.

Application filed September 21, 1883. Serial No. 107,011. (No model.)

To all whom it may concern:

Be it known that I, HENRY F. CAMPBELL, of Concord, county of Merrimac, State of New Hampshire, have invented an Improvement in Electrical Conductors, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relating to electric conductors has for its object to prevent disturbances arising from induction from neighboring wires or other disturbing influences.

Electric cables have been made in which each independent conductor, covered with the usual insulating material, is provided with an outer metallic covering, usually composed of a lead or copper tube, or of a covering of tinfoil, it having been supposed that such a covering would prevent the transmission of disturbing currents to the wire. Experiment, however, has shown that such coverings are ineffectual, at least for cutting off such currents as will produce disturbances in the telephonic instruments of the present day.

I have discovered after long investigation that while an ordinary covering composed of the metals usually employed for this purpose—viz., copper, lead, or tin, all good conductors of electricity—are inefficient, there are certain substances which, when employed as a covering or shield for an insulated wire, will greatly diminish or entirely annul the disturbances referred to.

In another application for Letters Patent, No. 97,028, filed June 4, 1883, I have described and claimed a shield composed of paramagnetic and diamagnetic materials, it being many times more effectual than the coverings composed of diamagnetic material alone heretofore employed. While the shield therein described is the best known to me for this purpose, there are other materials besides such a combination of paramagnetic and diamagnetic substances which can be employed, and will give far better results than the materials formerly used.

All my investigations have shown that while the materials known and classed as "diamagnetic" materials, including copper, lead, and tin, which have been most commonly used on account of their abundance, their electrical conductivity, and the ease with which they may be manipulated, are ineffectual. All the paramagnetic elements are found to be effective in a very high degree; and the present invention consists, mainly, in the combination, with an insulated conductor, of a covering or shield composed of one or more paramagnetic materials and with means to connect the said shield in an electric circuit, whereby the current generated in the said shield may be conducted away from it without passing to or affecting the conductor inclosed in the said shield and protected thereby.

Figure 1 shows in transverse section a cable composed of electric conductors embodying my invention, and Fig. 2 a longitudinal section thereof.

As herein shown, a series of independent conductors are united to form a cable, the said conductors *a*, of any usual kind, being each intended to form a portion of the circuit of telephonic or other electrical instruments, and each being provided with a covering, *b*, of any usual and suitable insulating material, to prevent the currents from escaping from it.

Each insulated conductor *a b* is provided with an anti-inductive shield or covering, *c*, which in this instance is composed of paramagnetic material, either a single substance, such as iron, manganese, cobalt, nickel, or a composition of two or more of the said substances. Iron is considered the best paramagnetic when used alone, or as the chief element in quantity when two substances are used, as it stands at the head of the list of materials classed as "paramagnetics." The said covering *c* can be most conveniently made of a strip of iron annealed, or of a soft and flexible nature wound spirally upon the outside of the insulating material *b*, care being taken that each successive turn of the strip is in close contact with or partially overlaps the edge of the one already applied, so as to form a complete uninterrupted covering.

In order to render the shields effective, to prevent the transmission of electric impulses from one to another of the wires inclosed therein, it is essential to provide means for dissipating the currents generated in the shields. This may be accomplished by making the said shields a portion of a complete circuit, as here-

inafter described, and by certain peculiar arrangements of the shielded conductors with relation to one another, which will form the subject of other applications for Letters Patent.

When the shields *c* of the different wires *a* are to form a part of a complete electric circuit, they may be insulated from one another, or, if desired, may be in electrical contact with one another, as shown. In the former case each individual wire will be connected by a terminal, as described in my former application referred to, with the ground or other return circuit for conveying the currents away from the said shields, and thus preventing them from passing upon or affecting the wires *a*, inclosed within them.

When the shields are in contact with one another, as shown, they constitute practically a single conductor, and single terminals, *t*, of a similar nature to those described in my former application, may be employed at each end of the cable to connect the said shields with the ground or with a metallic conductor, forming the return-circuit for the said shields, as described in another application for Letters Patent, filed August 20, 1883, and numbered 104,214.

I consider that the employment of an annealed strip or ribbon of steel, or of homogeneous iron or steel without fiber, or, in fact, any annealed or soft ribbon composed of iron as the base, is within my invention.

I am aware that a wrought-iron pipe or tube has been used with an insulated conductor to increase the tensile strength, and for purposes of defense against abrasion and the action of water, as shown in United States Patents Nos. 91,093 and 201,477.

I claim—

1. An electric conductor having a covering of insulating material, combined with an anti-inductive shield composed of paramagnetic material, substantially as described.

2. An electric conductor consisting of a conducting-core, an insulating covering therefor, and an external shield of iron capable of ready magnetization and demagnetization, as and for the purpose described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY F. CAMPBELL.

Witnesses:

JOS. P. LIVERMORE,

W. H. SIGSTON.