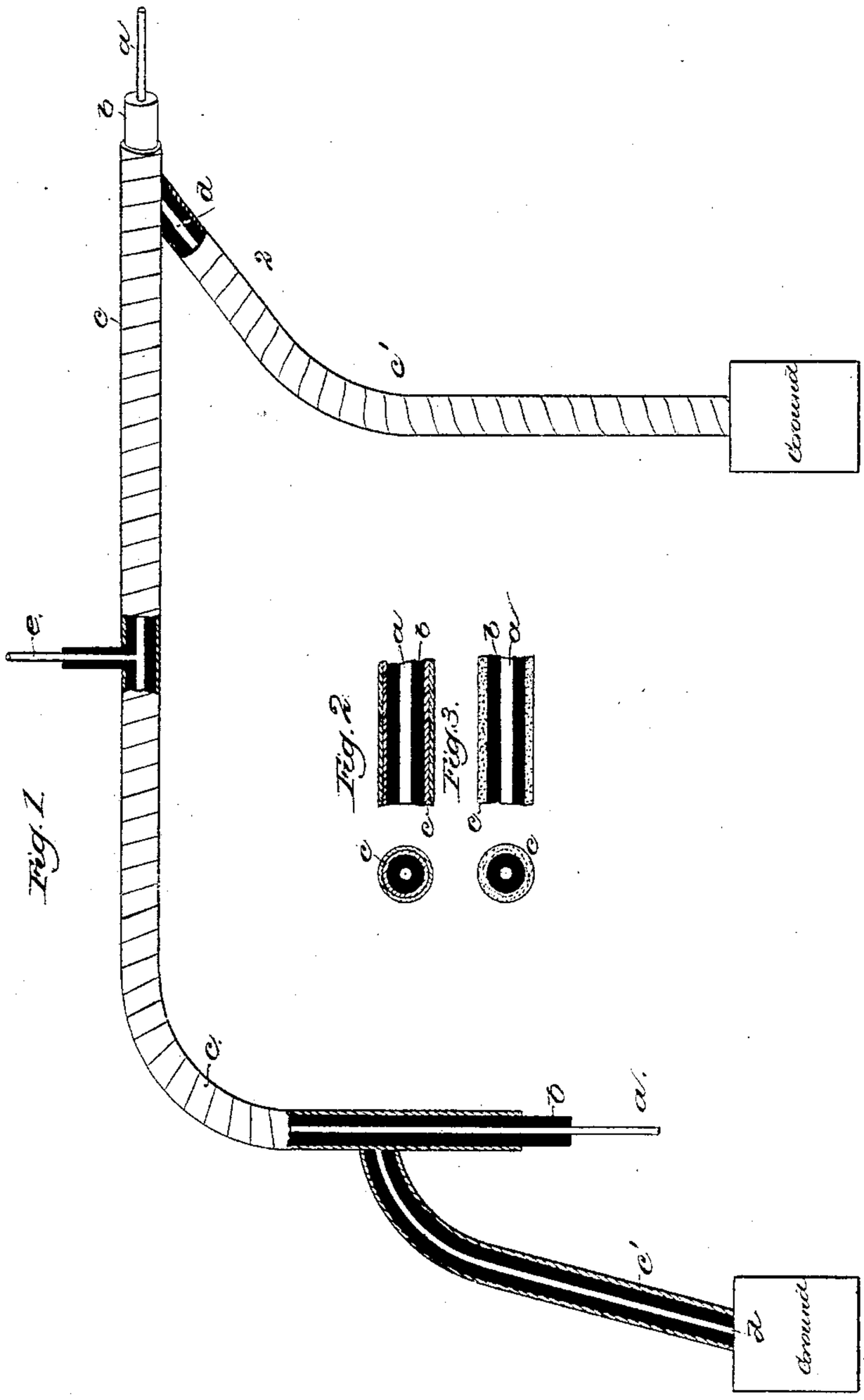
(No Model.)

# H. F. CAMPBELL.

## ELECTRICAL CONDUCTOR.

No. 290,971. Patented Dec. 25, 1883.




Witnesses.
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# UNITED STATES PATENT OFFICE.

HENRY F. CAMPBELL, OF CONCORD, NEW HAMPSHIRE.

## ELECTRICAL CONDUCTOR.

SPECIFICATION forming part of Letters Patent No. 290,971, dated December 25, 1883.

Application filed June 4, 1883. (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 has for its object to prevent disturbance arising from induction in electrical conductors, especially in those employed for telephonic purposes. There exist in nature two classes of substances or elements distinguished by certain electrical phenomena, and known as "diamagnetic" and "paramagnetic." I have discovered that an effectual shield may be produced against the effects of induction by the employment of these two classes of elements in conjunction, and especially in certain proper proportions and arrangements, substantially as hereinafter described.

By a large number of experiments I have found that a shield composed of essentially pure paramagnetic and diamagnetic elements, in which the former predominates, produces a very effectual shield, the quantity of the combined elements and their thickness depending upon the strength of the induced current to be overcome.

Iron, nickel, cobalt, manganese, platinum, and osmium may be mentioned as the best among the class of paramagnetic substances, and bismuth, antimony, zinc, cadmium, sodium, mercury, lead, silver, copper, sulphuric, muriatic, and nitric acids, and sulphur in its various combinations, may be mentioned as among the best of the diamagnetic substances, and various methods of conjoining one or more elements of the one class with one or more elements of the other class will readily suggest themselves to those familiar with chemical and metallurgical operations.

When metallic substances are chosen, one or more from each class, they have been found to produce excellent results when applied in any of the following methods, namely: As a tube or envelope of the distinctive metals, one surrounding the other, and both applied as continuous, unbroken coverings upon the outside of any usual insulating covering of the wire or conductor to be protected; or one or more metals of the one class may be deposited upon the surface of an enveloping tube composed of one or more metals of the other class by chemical or other process—as, for example, by electroplating a diamagnetic element—such as bismuth, antimony, or copper—upon a paramagnetic element—such as iron or manganese—or a combination thereof outside of an insulating covering, thus forming a shield or envelope. The thickness of the shield should be proportioned to the work to be done, or, in other words, to the strength of the electric currents from which protection is desired. In some instances the shield or envelope may be applied in the form of a paint or flux composed of some suitable vehicle containing elements of the two classes in the proper proportions in a finely-divided state, or pulverized, or the diamagnetic elements in form of powder may be applied to a paramagnetic shield or envelope; but a continuous metallic covering generally produces better results.

An anti-induction shield or envelope embodying this invention, and one which is readily available, both on account of the abundance and cheapness of the materials and their adaptability because of their mechanical properties to the use in question, consists of sheet-iron coated with tin or zinc, or both, by the ordinary process of dipping or galvanizing.

A ribbon of iron of from eighteen to twenty gage, coated by dipping and wrapped spirally around the insulated wire, is generally sufficient for ordinary telephonic purposes; but when several wires are to be used in a cable, as each wire has its own covering, so that two coverings or shields are interposed between each two wires, a thinner shield may be employed.

Figure 1 shows a portion of a wire provided with an anti-induction shield or envelope in accordance with my invention, and Figs. 2 and 3 show each in longitudinal and cross section modifications in the construction of the shield.

*a* represents the wire; *b*, the usual covering of insulating material—such as cotton, rubber, paraffine, or substances generally known and classed as "dielectrics" or "insulators"—which should be sufficiently flexible to admit of the

conductor being wound upon a shield and bent; and *c* the coating or envelope composed of paramagnetic and diamagnetic material, as hereinbefore described.

As shown in Fig. 1, the envelope *c* is made from a strip or ribbon of the proper materials—such as iron coated or plated with tin, zinc, or copper, or any one or more diamagnetic metals—the said ribbon being preferably connected and wound spirally around the insulated wire or conductor, care being taken that each successive turn of the spiral overlaps the one already laid upon the wire, so that no space is left between the successive turns when in position for use. A shield constructed in this manner is very flexible, and a conductor provided with it may be bent almost as easily as the ordinary insulated conductors having no external metallic covering.

As shown in Fig. 2, the shield consists of continuous concentric tubes of the distinctive elements or substances, this construction affording somewhat less flexibility than that illustrated in Fig. 1, but the protected conductor still being sufficiently flexible for most purposes. When the shield is in the form of a continuous tube, as illustrated in Fig. 2, and it is desired to bend the conductor at a sharp angle, the shield may be made at the corner or bend of a spiral ribbon, as shown in Fig. 1, the ends of the ribbon being soldered to the tubular portion of the shield at either side of the angle.

Fig. 3 is intended to illustrate a shield composed of the elements in a pulverized condition applied to the insulating covering by means of a suitable flux or fluid vehicle after the manner of a paint. The shield *c* should be in electrical connection with the ground, and the terminals or ground connections of the said shield should themselves be protected from the main wire *a* by the anti-inductive shield. To effect this the terminal wire *d*, connecting the shield *c* of the main wire *a* with the ground, may itself be provided with a shield, *c'*, of the same nature as that of the main wire *a*, and in order to more effectually exclude the possibility of the current passing from the terminal wire *d* to the unprotected portion of the wire *a* beyond the end of the shield *c*, the said terminal wire may be turned backward along the tread of the main wire, as shown at 2, Fig. 1, in which case the shield *c'* may, if desired, be omitted. The wire *a* is adapted to have telephonic or other instruments connected with its ends, and, if desired to connect an instrument at an intermediate point or points, suitable branch wires *e* may be connected directly with the wire *a*, as shown in Fig. 1, care being taken that the said branch wire is properly insulated from the shield *c* at the point where it passes through the said shield. The application to the insulating medium of the branch wire *e* of an anti-inductive shield will be necessary only when placed near other wires, and is useful in case of unusual electrical disturbance of the atmosphere. The paramagnetic elements being stronger must have relatively a thicker body in the shield than the diamagnetic elements, the proportions of the elements depending upon the materials used—as for instance, a smaller amount of zinc is required than of tin or lead.

In practice I have obtained the best results with paramagnetic and diamagnetic substances in proportions of about seven or eight tenths of the former to from two to three tenths of the latter. Observing this the elements may be increased to the utter extinction of sound; but if the proper proportions have been reached, it does not seem to help by adding the one element if the corresponding increase of the other is omitted, and especially is this true if the paramagnetic is not increased. The same may be said of many repeated experiments with various combinations of paramagnetic and diamagnetic elements.

The diamagnetic and paramagnetic classes include a large number of substances widely varying in their electrical conductivity, some being generally classed as insulators, and others as conductors, and I have found in my experiments that the best results are produced by using a shield, the paramagnetic and diamagnetic elements of which are both good conductors. An element of either class, when used alone, as heretofore practiced, or even in conjunction with another of the same class, is inadequate; but when any member of one of the two great classes is added to one of the other class, the desired result is attained.

I have herein shown and described certain combinations of elements which are not claimed in the present application, and I desire it to be understood that all new features that are not herein claimed will form the subject of other applications for Letters Patent, and especially I shall claim, broadly, in another application a shield composed of paramagnetic material; and I shall also claim, broadly, an insulated conductor covered with an annealed or soft and flexible metallic strip composed of one or more paramagnetic substances, with or without diamagnetic substances, the said strip being wound closely about the said insulating material, so as to form a complete uninterrupted shield.

I claim—

1. An electrical conductor provided with a covering of insulating material, and having an inclosing anti-inductive envelope composed of paramagnetic and diamagnetic substances upon the said covering, the said shield having terminals connected with the ground, substantially as described.

2. The combination, with an electrical conductor having an anti-inductive shield or envelope composed of paramagnetic and diamagnetic elements, as described, of terminals reflexed or bent backward along the trend of the wire, the shield thus being interposed between the operative wire and the terminals, substantially as described.

3. The combination, with an electrical conductor having a shield or envelope, of a grounded terminal to the said envelope, and a similar shield or envelope inclosing the said terminal, substantially as described.

4. An electrical conductor having a covering of insulating material, and an anti-inductive shield thereon, composed of paramagnetic and diamagnetic substances, the said conductor with its insulating covering and shield being flexible, substantially as described.

5. An electrical conductor and insulating covering therefor, combined with an anti-inductive shield composed of paramagnetic and diamagnetic substances in themselves good conductors of electricity, substantially as described.

6. An insulated electrical conductor provided with an inclosing anti-inductive shield composed of paramagnetic and diamagnetic substances, the amount of the former being in excess of the amount of the latter, substantially as described.

7. The combination, with an electrical conductor having an anti-induction shield, of terminals reflexed or bent back, substantially as described.

8. An electrical conductor having a flexible insulating covering, combined with an anti-inductive shield composed of a strip or band of paramagnetic and diamagnetic substances wrapped spirally around the said insulating covering, substantially as described.

9. An electrical conductor having a flexible covering of insulating material, combined with an anti-induction shield composed of iron coated with zinc, tin, or other diamagnetic metal, substantially as described.

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

HENRY F. CAMPBELL.

Witnesses:
G. W. GREGORY,
JOS. P. LIVERMORE.