

W. HOOPES & N. A. ROBERTSON.  
PROCESS OF MAKING ELECTRIC CONDUCTORS.  
APPLICATION FILED JAN. 16, 1905.

FIG. 1.

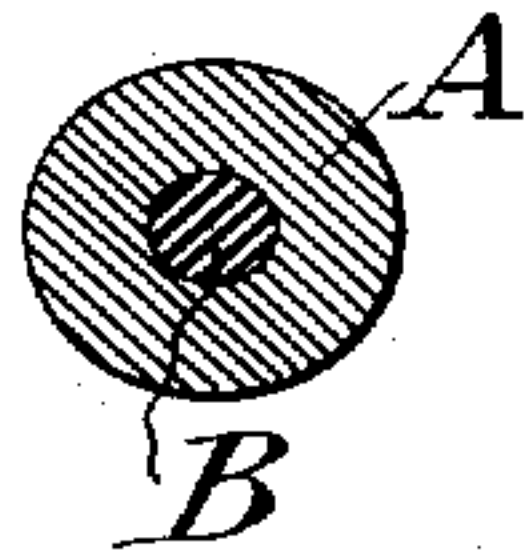


FIG. 2.

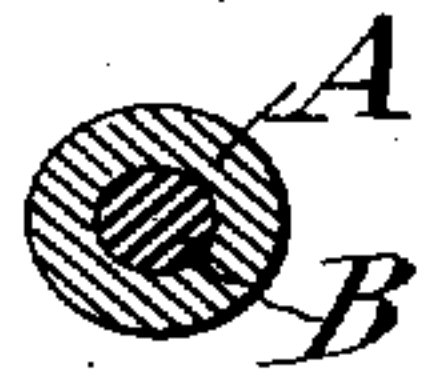


FIG. 3.

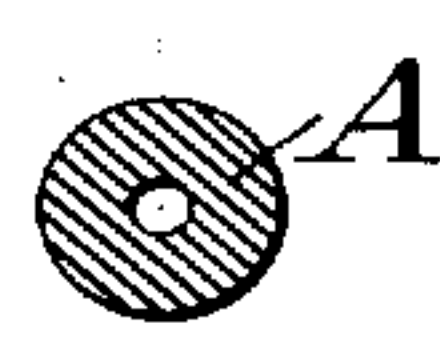


FIG. 4.

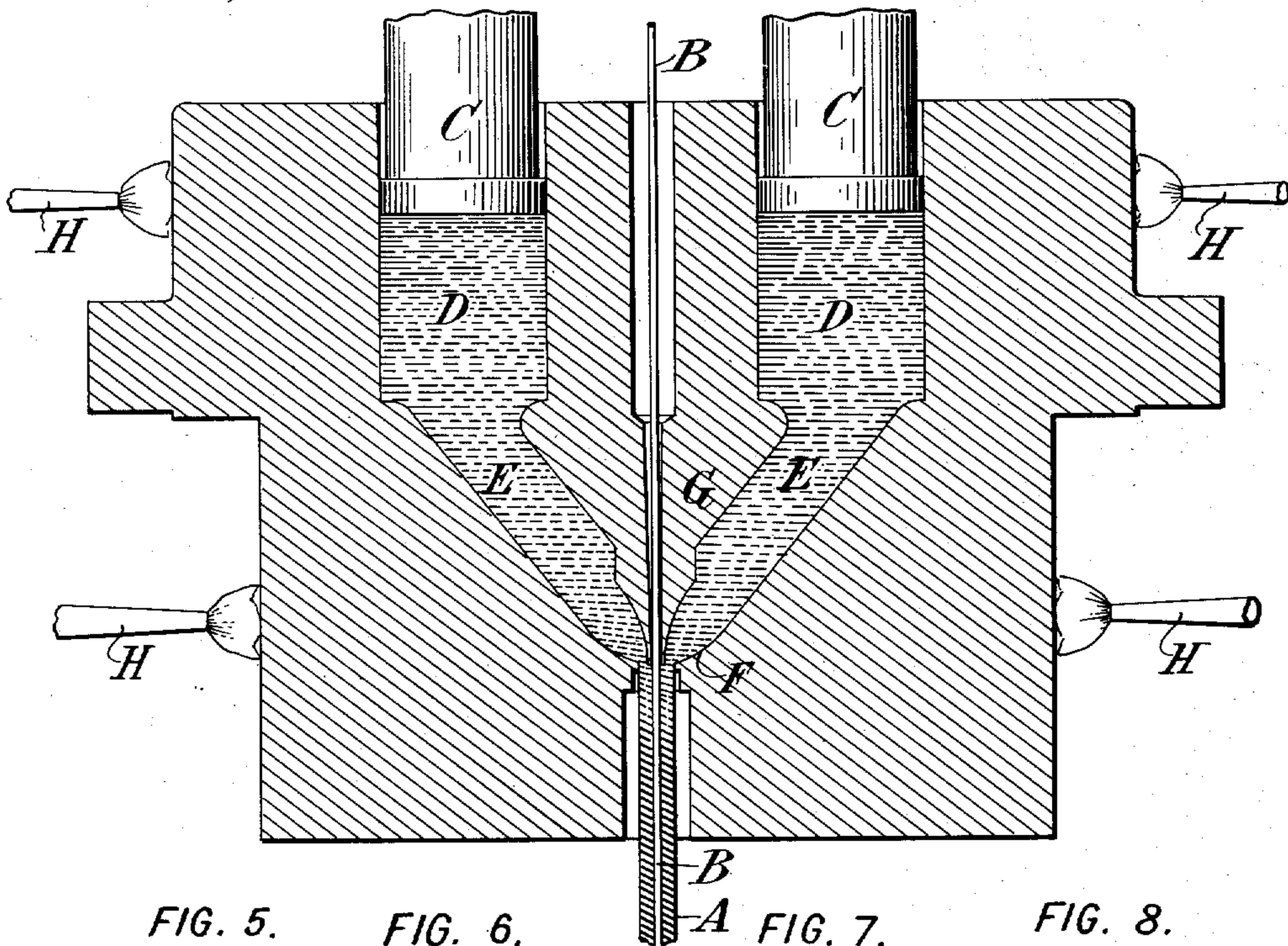


FIG. 5.

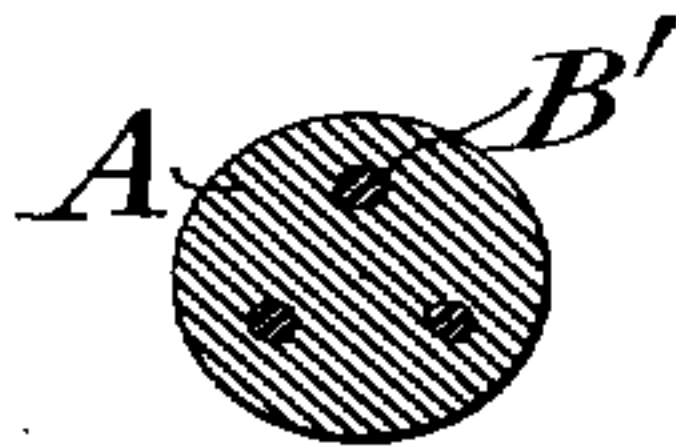


FIG. 6.



FIG. 7.

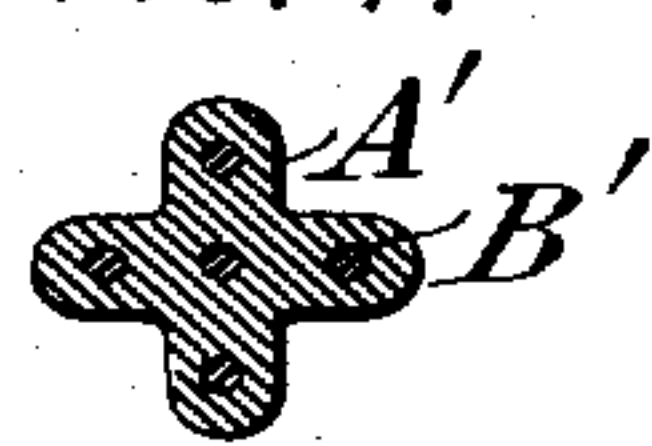
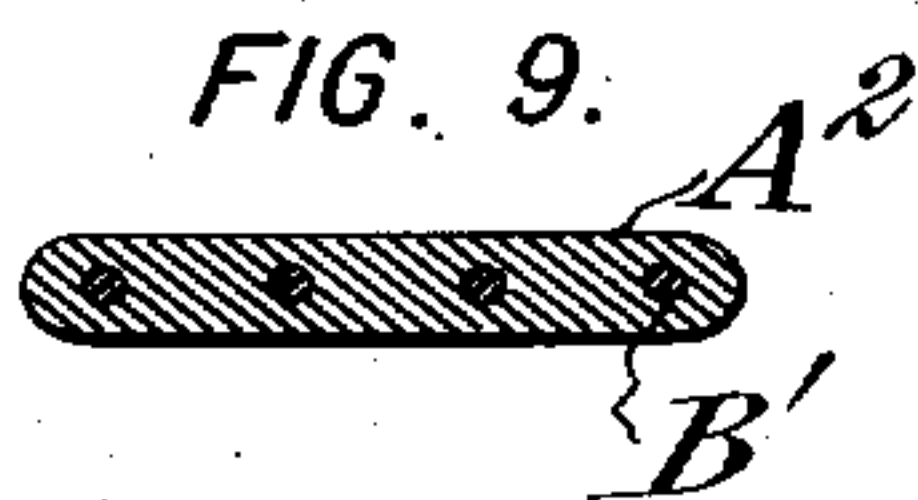


FIG. 8.



FIG. 9.



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*Fred White*  
*Rene Duine*

INVENTORS:  
*William Hoopes and*  
*Norman A. Robertson,*  
By Attorneys,  
*Arthur C. Fraser & Co.*



# UNITED STATES PATENT OFFICE.

WILLIAM HOOPES, OF PITTSBURG, PENNSYLVANIA, AND NORMAN A. ROBERTSON, OF NEW YORK, N. Y.

## PROCESS OF MAKING ELECTRIC CONDUCTORS.

No. 867,658.

Specification of Letters Patent.

Patented Oct. 8, 1907.

Application filed January 16, 1905. Serial No. 241,199.

*To all whom it may concern:*

Be it known that we, WILLIAM HOOPES, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, and NORMAN A. ROBERTSON, residing in the borough of Brooklyn, county of Kings, city and State of New York, both citizens of the United States, have invented certain new and useful Improvements in Process for Making Electric Conductors and the Like, of which the following is a specification.

10 This invention provides a mode of making an improved wire rod, bar or the like, for conducting electricity. The product is called a "conductor" herein, though it is understood that it may be applied to other uses.

15 It is well understood that aluminium is a good conductor of electricity. It is, however, subject to flaws which impair its tensile strength, and which, when it is strung in long spans and subjected to the weather conditions affecting aerial wires, result ultimately in transverse fractures; so that this deficiency limits its usefulness for telegraph wires and other purposes. Our invention provides a method of making a conductor of aluminium which is reinforced by a stronger metal; as for example by an embedded wire or core of steel or  
25 other kind of iron. By our process such a conductor can be made commercially in continuous lengths.

The process of this invention consists in the extrusion of aluminium upon a longitudinal core or wire of stronger reinforcing metal, to make a product of high conductivity and great strength.

30 The accompanying drawings illustrate a variety of cross-sections of the improved conductor, and a diametral section of a machine in which the process may be carried out.

35 Figures 1, 2, 3, 5, 7, 8 and 9 are cross-sections of various forms of conductor. Fig. 4 is a central section of the machine. Fig. 6 is a perspective view of the end of another form of conductor.

In Fig. 1 the aluminium constituting the greater portion of the conductor is indicated at A, and the reinforcing consists of a central wire or core of iron B.

40 Fig. 2 shows a conductor of the same materials but of varying proportions of aluminium and iron. The cross-section of the reinforcing core and of the aluminium body will vary in accordance with the strengths of the different materials used, the conductivity required, and the intended use to which the conductor is to be applied as requiring long or short spans.

45 A valuable feature of the invention is that the aluminium is shrunk on the core and fits it very tightly. The reinforcing wire is naked, and the aluminium fits it so closely as to be practically integral therewith, a close examination of the cross-section showing the line between the two materials only by reason of their difference in color. The amount of shrinkage and the conse-

quent intimacy of union is indicated by a comparison of Figs. 2 and 3. Fig. 3 indicates a conductor of aluminium extruded without a core, and therefore allowed to shrink to the full extent. Fig. 2 indicates a wire extruded through the same die as Fig. 3, but with a steel core B which prevents the shrinkage of the aluminium except so far as to tightly embrace the core. 60

By the process of extrusion the conductor can be made in continuous lengths, and can if desired be made hollow so as to increase its stiffness and to adapt it for special uses, thus providing a cheap and efficient substitute for the conductors now in use. 65

In the manufacture of the aluminium conductors described, a very great pressure is required. It is found that if the aluminium be somewhat liquid during the extrusion, it spurts or blows out through the die. As it cools below the point of liquidity it becomes more or less granular or crystalline in consistency, and at this stage also the metal is liable to blow out and emerges in non-coherent condition instead of being squeezed out in a constant stream. This blowing is thought to be due to the gases which as is known aluminium absorbs in large quantities while molten. It is therefore necessary to work the process with the aluminium at a temperature below its crystalline stage when it has become so hard as to firmly imprison the gases and prevent blow outs and yet while it is sufficiently hot to be plastic. To insure this plasticity necessitates maintaining the die and the core of the machine (where such a core is used) at or preferably just below a dull red heat. The stiffness of the aluminium further necessitates an extraordinary pressure, and the machine for extruding the aluminium must be designed to oppose the minimum of resistance to the flow of the aluminium, and to stand a very heavy pressure at a high temperature. 70 75 80 85 90

A diagrammatic view of such a machine is indicated in Fig. 4, in which plungers C C work in vertical cylinders D D which connect by oblique passages E E with the mouth of the die F into which the core G of the machine projects slightly; the reinforcing wire B being carried down through the center. The die and the passages leading thereto (and when necessary the cylinders) are maintained at the desired high temperature by suitable heating means, as by impinging against the exterior the flames from a series of gas blow-pipes H. 95 100

The metal (molten or in the form of slugs or otherwise) is introduced into the cylinders D. If introduced molten, it is allowed to cool to the necessary temperature. If solid, it is heated to that temperature before introduction. The plungers C are then forced into the cylinders, preferably by raising the cylinders by hydraulic pressure against fixed plungers overhead, in the known manner, and the aluminium is forced down through the converging passages E at the junction of which the streams coalesce, and thence out 105 110



through the die F, forming the body portion A of the conductor, and carrying with it the reinforcing wire B. As soon as the aluminium passes out of the constricted portion of the die it commences to cool and shrink:

5 The amount of shrinkage is controlled by the position of the end of the core G in the die.

The reinforce may be much varied in form. By distributing the same amount of reinforcing material at a distance from the center of the conductor, it will produce a stiffer product than where it is all concentrated at the center. Or by dividing the reinforcing material into a plurality of wires and extending them spirally, greater flexibility may be secured. Fig. 5 shows the reinforcing material in the form of three separate wires B' arranged about half way between the center and the circumference of the cross-section. These wires B' may extend straight or spirally. If straight they will stiffen the conductor in the manner of a truss when it is supported at two opposite ends. If spiral, they make a more flexible conductor. Fig. 6 shows the reinforcing wires B<sup>2</sup> twisted together at the center of the conductor so as to extend spirally through it, thus giving approximately the flexibility which a wire rope would have as compared with a rod of the same material and cross-section. The desired variations in the spacing of the separate reinforcing wires may be made by suitable modifications of the core of the machine through which the reinforcing wire or wires pass.

The shape of the conductor as a whole may be modified to suit the uses to which it is to be put, by a suitable modification in the shape of the die. For example in Figs. 7 and 8 cross-shaped forms A' are illustrated, and in Fig. 9 a form A<sup>2</sup> which is oblong in section. The reinforcing metal may be also cross shaped as indicated at B<sup>3</sup> in Fig. 8, or may be of any other shape desired.

The term aluminium is used here in a general sense as applied also to alloys composed so largely of aluminium as to partake largely of its properties. For example an alloy of 90 parts aluminium, 8 parts copper, and 2 parts zinc, may be substituted for pure aluminium. It is also within the invention to include additional elements in connection with the metals described.

The term iron as used here includes all forms of iron or steel. There is a special advantage in the conductor having an iron core, in that the high tensile strength of iron can be utilized while its durability is secure on account of the protection from corrosion. The extruded aluminium covers the iron perfectly and preserves it indefinitely.

Though we have described our invention with great particularity of detail, yet it is not to be understood that the invention is limited to the specific embodiments disclosed. Various modifications thereof may be made by those skilled in the art, without departure from the invention.

What we claim is:—

1. The process of manufacturing a compound conductor of aluminium and a longitudinal reinforcing core of stronger metal, which consists in extruding the aluminium while heated to plasticity upon and enveloping the stronger metal.

2. The process of manufacturing a compound conductor of an envelop of aluminium and a longitudinal reinforcing core of stronger metal, which consists in extruding the aluminium at approximately a dull red heat and also cools it shrinks tightly onto the core.

3. The process of manufacturing a compound conductor of an envelop of aluminium and a longitudinal reinforcing core of stronger metal, which consists in maintaining the aluminium at a temperature slightly below its solidifying point and extruding it upon such core.

4. The process of manufacturing a compound conductor of an envelop of aluminium and a longitudinal reinforcing core of stronger metal, which consists in extruding the aluminium upon such core through a die while maintaining the aluminium at approximately a dull red heat and also heating the die during the period of extrusion.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

WILLIAM HOOPES.

Witnesses:

THOMAS W. BAKWELL,  
ALLAN C. BAKWELL, JR.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

NORMAN A. ROBERTSON.

Witnesses:

DOMINGO A. USINA,  
FRED WHITE.

Correction in Letters Patent No. 867,658.

It is hereby certified that in Letters Patent No. 867,658, granted October 8, 1907, upon the application of William Hoopes, of Pittsburg, Pennsylvania, and Norman A. Robertson, of New York, N. Y., for an improvement in "Processes of Making Electric Conductors," an error appears in the printed specification requiring correction, as follows: Line 65, page 2, should be stricken out and the following words inserted instead: *aluminum hot and fitting the core closely so that as it*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 17th day of November, A. D., 1908.

[SEAL.]

C. C. BILLINGS,  
Acting Commissioner of Patents.



through the die F, forming the body portion A of the conductor, and carrying with it the reinforcing wire B. As soon as the aluminium passes out of the constricted portion of the die it commences to cool and shrink:

- 5 The amount of shrinkage is controlled by the position of the end of the core G in the die.

- The reinforce may be much varied in form. By distributing the same amount of reinforcing material at a distance from the center of the conductor, it will produce a stiffer product than where it is all concentrated at the center. Or by dividing the reinforcing material into a plurality of wires and extending them spirally, greater flexibility may be secured. Fig. 5 shows the reinforcing material in the form of three separate wires B' arranged about half way between the center and the circumference of the cross-section. These wires B' may extend straight or spirally. If straight they will stiffen the conductor in the manner of a truss when it is supported at two opposite ends. If spiral, they make a more flexible conductor. Fig. 6 shows the reinforcing wires B<sup>2</sup> twisted together at the center of the conductor so as to extend spirally through it, thus giving approximately the flexibility which a wire rope would have as compared with a rod of the same material and cross-section. The desired variations in the spacing of the separate reinforcing wires may be made by suitable modifications of the core of the machine through which the reinforcing wire or wires pass.

- The shape of the conductor as a whole may be modified to suit the uses to which it is to be put, by a suitable modification in the shape of the die. For example in Figs. 7 and 8 cross-shaped forms A' are illustrated, and in Fig. 9 a form A<sup>2</sup> which is oblong in section. The reinforcing metal may be also cross shaped as indicated at B<sup>3</sup> in Fig. 8, or may be of any other shape desired.

- The term aluminium is used here in a general sense as applied also to alloys composed so largely of aluminium as to partake largely of its properties. For example an alloy of 90 parts aluminium, 8 parts copper, and 2 parts zinc, may be substituted for pure aluminium. It is also within the invention to include additional elements in connection with the metals described.

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Though we have described our invention with great particularity of detail, yet it is not to be understood that the invention is limited to the specific embodiments disclosed. Various modifications thereof may be made by those skilled in the art, without departure from the invention.

What we claim is:—

1. The process of manufacturing a compound conductor of aluminium and a longitudinal reinforcing core of stronger metal, which consists in extruding the aluminium while heated to plasticity upon and enveloping the stronger metal.
2. The process of manufacturing a compound conductor of an envelop of aluminium and a longitudinal reinforcing core of stronger metal, which consists in extruding the aluminium at approximately a dull red heat and also cooling it shrinks tightly onto the core.
3. The process of manufacturing a compound conductor of an envelop of aluminium and a longitudinal reinforcing core of stronger metal, which consists in maintaining the aluminium at a temperature slightly below its solidifying point and extruding it upon such core.
4. The process of manufacturing a compound conductor of an envelop of aluminium and a longitudinal reinforcing core of stronger metal, which consists in extruding the aluminium upon such core through a die while maintaining the aluminium at approximately a dull red heat and also heating the die during the period of extrusion.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

WILLIAM HOOPES.

Witnesses:

THOMAS W. BAKWELL,  
ALLAN C. BAKWELL, JR.

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C. C. BILLINGS,  
*Acting Commissioner of Patents.*