No. 867,659. PATENTED OCT. 8, 1907.

W. HOOPES & N. A. ROBERTSON.

ELECTRIC CONDUCTOR.

APPLICATION FILED MAY 11, 1906.

FIG. 1.

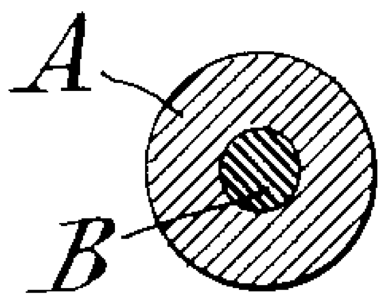


FIG. 2.

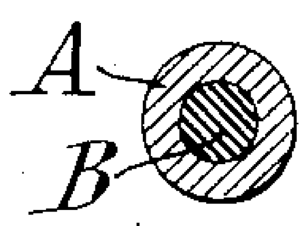


FIG. 3.

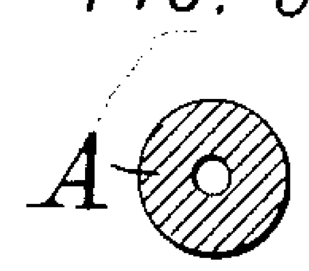


FIG. 4.

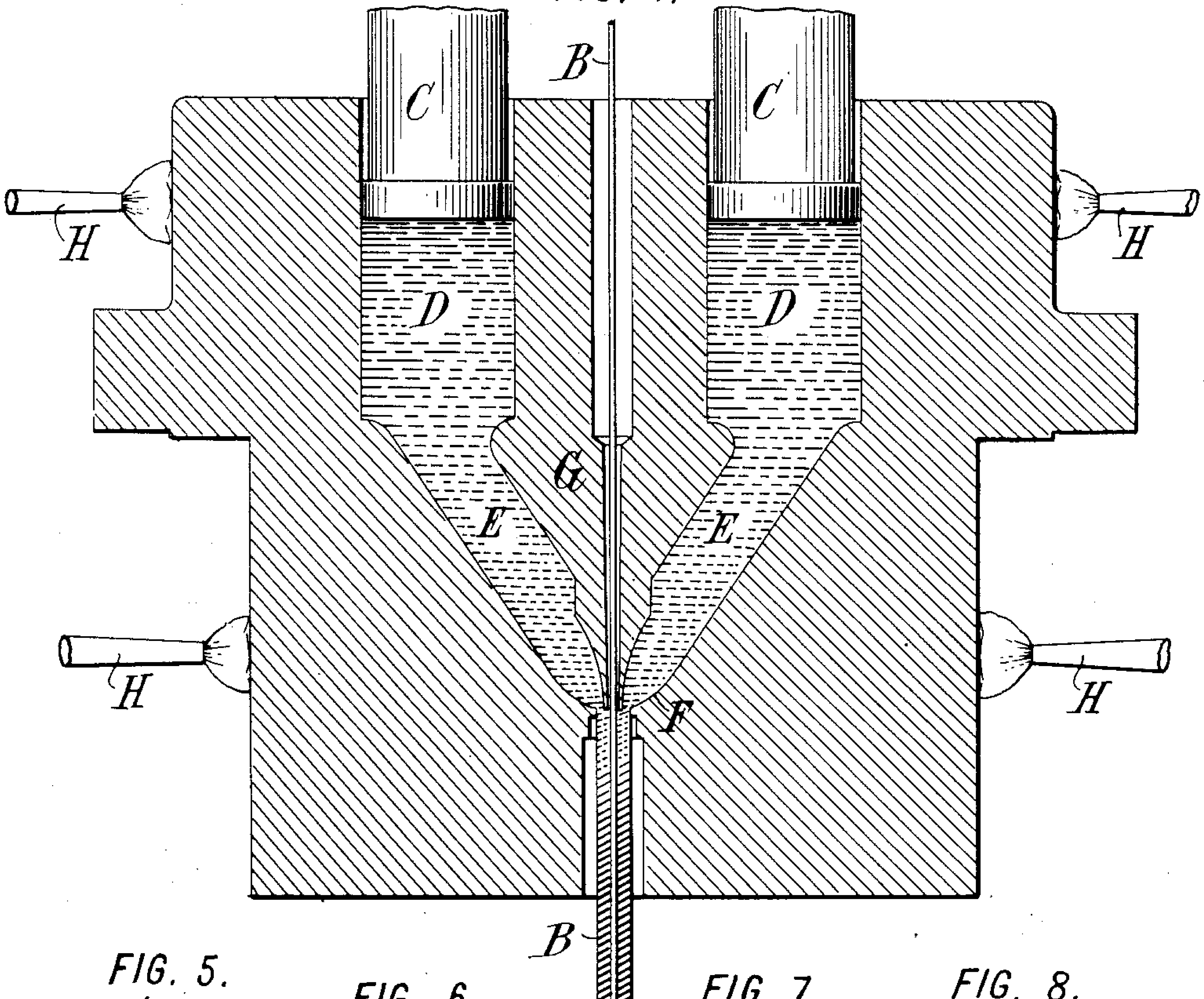


FIG. 5.

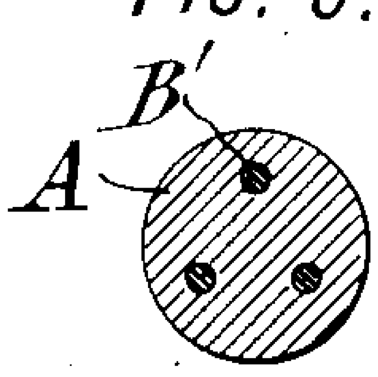


FIG. 6.

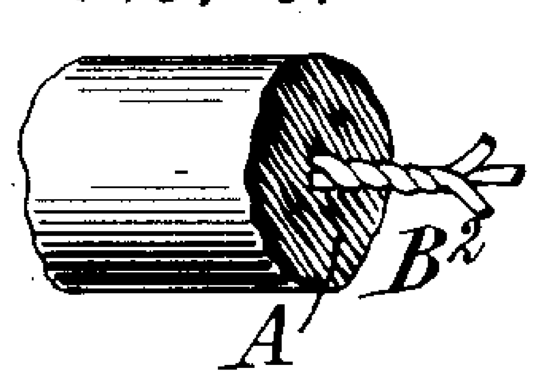


FIG. 7.

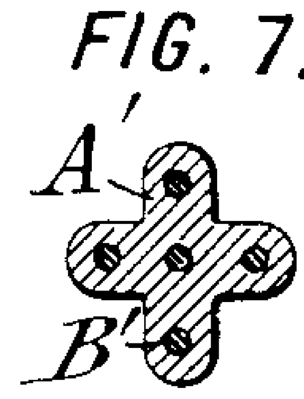


FIG. 8.

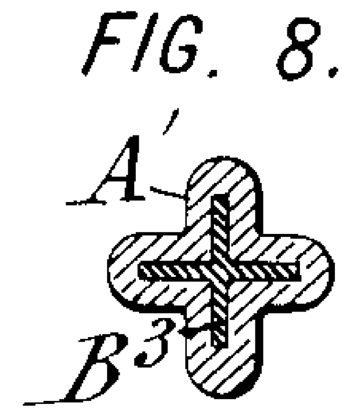
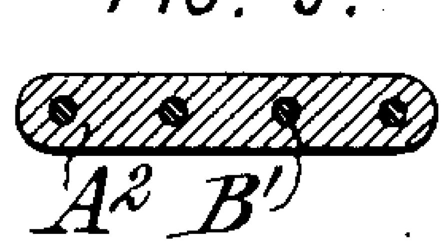


FIG. 9.



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UNITED STATES PATENT OFFICE.

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ELECTRIC CONDUCTOR.

No. 867,659. Specification of Letters Patent. Patented Oct. 8, 1907.

Original application filed January 16, 1905, Serial No. 241,199. Divided and this application filed May 11, 1906. Serial No. 316,279.

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, in the county of Kings, city and State of New York, both citizens of the United States, have jointly invented certain new and useful Improvements in Electric Conductors, of which the following is a specification.

This invention provides 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.

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.

The present invention provides a conductor of aluminium reinforced by a stronger metal, as for example by an embedded wire or core of steel or other kind of iron. It has been proposed to form a conductor with a core of copper and a shell of aluminium by casting aluminium around the heated copper core to form a compound ingot from which the wire would be drawn down; but in practice it has been found impossible to produce such a conductor with either a copper or steel core, because the aluminium and the harder metal will not elongate equally in the process of reducing the ingot to wire by the use either of dies or rolls, so that the result of an attempt to produce the compound wire or conductor is invariably to rupture one or other of the components thereof. The present invention provides a new and different product, in that the aluminium exists in the form produced by the process of extrusion through a die under heat and pressure, whereby it has properties which are readily recognizable and which distinguish it from aluminium which is elongated or reduced by rolling down or wire drawing. Extruded aluminium is characterized by homogeneity, pliability, and freedom from cracks, fissures or ruptures; and in the case of a compound conductor having an inclosed core of stronger metal, it is further characterized by the extreme tightness with which the aluminium embraces the core by reason of its shrinkage thereupon in cooling. As compared with cast aluminium,—which breaks with a fibrous coarsely-crystalline and uncertain fracture, and has an elongation of barely 5 per cent,—extruded aluminium is denser, breaks with a much finer crystalline fracture, and has an elongation of about 25 per cent. Cast aluminium which has been modified by rolling or drawing, cuts in the lathe with difficulty, dragging over the tool, and forming granular chips and leaving a rough surface behind the tool; whereas extruded aluminium turns easily, forming a smooth cut, the chip coming off as a smooth uniform shaving.

The process of producing this conductor of extruded aluminium with an inclosed core or reinforce, is set forth and claimed in our application filed January 16, 1905, Serial No. 241,199 of which the present application is a division.

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

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 reinforce consists of a central wire or core of iron B. 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.

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. Thus the two metals are in metallic and conductive contact, so that the electric current may flow unrestrictedly from one to the other. The amount of shrinkage and the consequent 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 involved in its cooling. 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. 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.

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 blows out 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. This temperature 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. 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.

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 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. 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 flexibilty 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^2 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 advantage of using a plurality of wires of the stronger metal may be secured as well with a conductor of other materials as with the conductor of aluminium described.

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^2 which is oblong in section. The reinforcing metal may be also cross shaped as indicated at B^3 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 here used 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 secured 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. A continuous conductor of extruded aluminium reinforced by a longitudinal core of stronger metal.

2. A conductor of extruded aluminium reinforced by a longitudinal core of stronger metal, the aluminium tightly embracing the core.

3. A conductor of aluminium reinforced by a plurality of longitudinal wires of stronger metal.

4. A conductor of extruded metal reinforced by a plurality of longitudinal wires of stronger metal spaced apart from each other.

5. A conductor of extruded metal reinforced by a plurality of longitudinal wires of stronger metal extended spirally.

6. A continuous conductor of extruded aluminium reinforced by a core of iron surrounded and protected by the aluminium.

7. A continuous conductor consisting of a core of naked iron wire and a tubular envelop of extruded aluminium inclosing said core in metallic contact therewith.

8. A continuous conductor consisting of a core of iron wire and a tubular envelop of extruded aluminium inclosing and tightly embracing said core in close, conductive metallic contact therewith.

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

WILLIAM HOOPES.

Witnesses:
R. T. DANFORTH,
B. E. WITHERS, Jr.

NORMAN A. ROBERTSON.

Witnesses:
DOMINGO A. USINA,
FRED WHITE.