No. 663,490. Patented Dec. 11, 1900.

W. B. CLEVELAND.

METHOD OF FORMING ELECTRICAL CONNECTIONS.

(Application filed July 12, 1900.)

(No Model.) 2 Sheets—Sheet 1.

FIG. I.

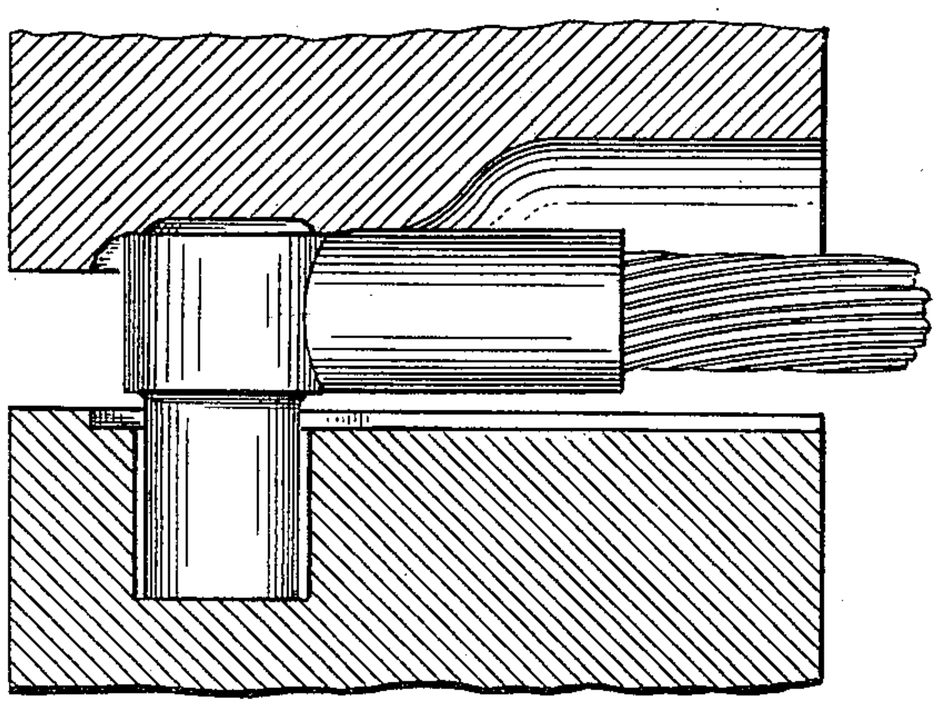

FIG. II.

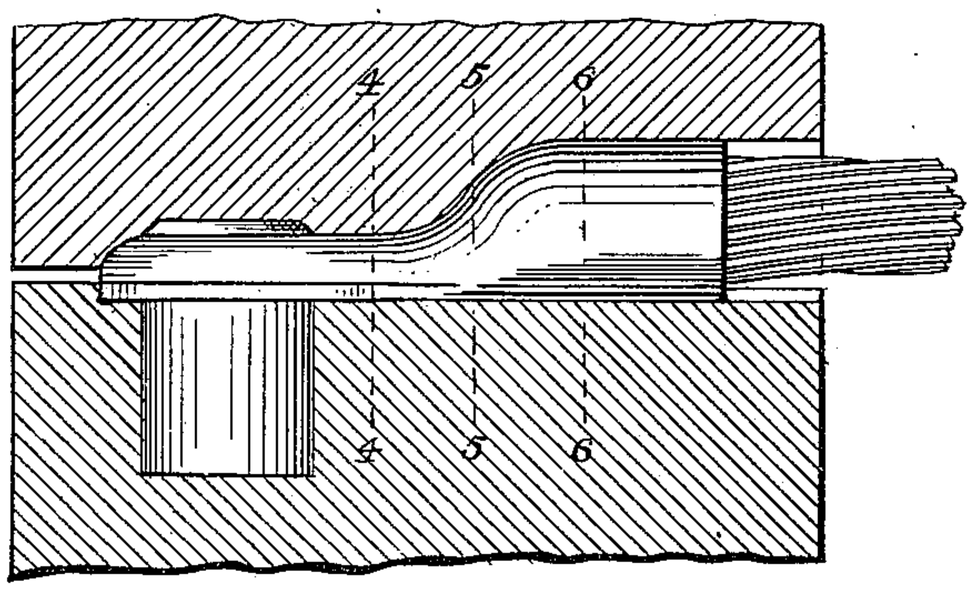

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FIG. III

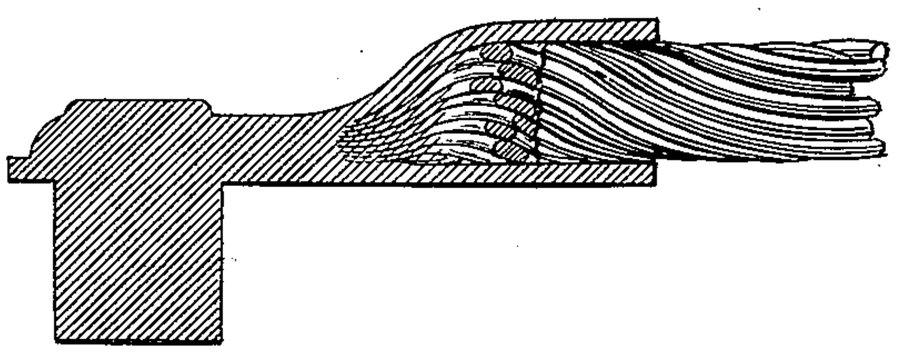


FIG. VI

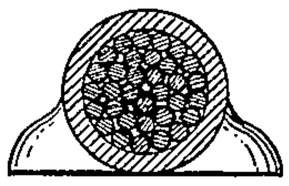
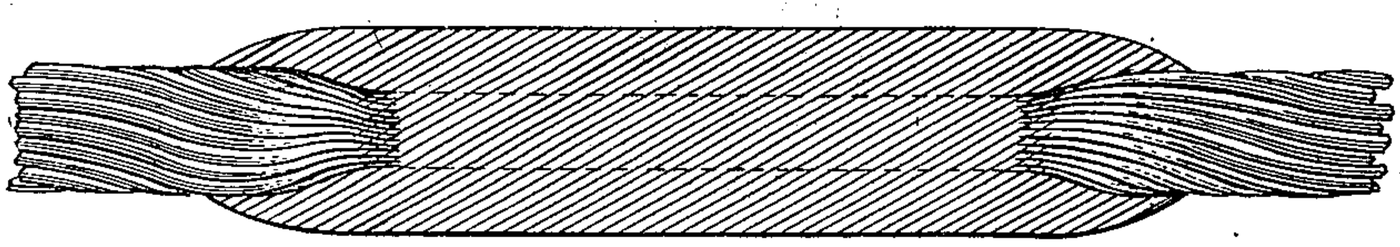


FIG. V

FIG. IV

FIG. VII



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METHOD OF FORMING ELECTRICAL CONNECTIONS.

SPECIFICATION forming part of Letters Patent No. 663,490, dated December 11, 1900.

Application filed July 12, 1900. Serial No. 23,400. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM B. CLEVELAND, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Methods of Forming Electrical Connections, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

My invention has for its object the union of two electrical conductors in a manner such that the resulting connection will embody electrical and physical characteristics such as are necessitated by the requirements of greatest possible economy.

Said invention consists of a method of forming such connection hereinafter fully described, such process being applicable with particular advantages to the union of a terminal and a cable connection of a plurality of strands.

The annexed drawings and the following description set forth in detail one mode of carrying out the invention, such disclosed mode constituting but one of various ways in which the principle of the invention may be used.

In the annexed drawings, Figure I represents a cable and surrounding terminal in front elevation located in a die and illustrating the form of such terminal and cable prior to the application of pressure which I utilize in my improved process. Fig. II represents a side elevation of such connection located in said dies and illustrating the position of the latter and the form of the connection after the application of pressure. Fig. III represents a longitudinal section of such connection. Figs. IV, V, and VI represent transverse sections taken upon the plane represented by the lines 4 4, 5 5, and 6 6, respectively, Fig. II; and Fig. VII represents a cable-splice formed in accordance with my invention, showing the sleeve in longitudinal section.

In carrying out my said process as applied to a cable and a terminal the latter is first caused to surround that portion of the cable to which it is desired to attach such terminal. This may be done by placing the cable portion in a suitable mold and then casting the metal of the terminal upon it, or the terminal may be first cast or otherwise formed and provided with an opening formed during or subsequently to the casting operation for the reception of such cable portion and the latter inserted after such terminal has been formed. A third method may be employed consisting of placing a ferrule of the terminal metal upon the required portion of the cable and subsequently casting the remainder of the terminal upon such ferrule and cable. The cable or inner member and the terminal or outer inclosing member having been so prepared, that portion of the members that is to be operated upon is preferably first heated to about a red heat and then placed in a die or dies and submitted to pressure. Such pressure is applied in degrees varying in substantially regular variation from a maximum at one extremity of a given area to a minimum at the other extremity of such area, thereby producing a portion of the connection having cross-sectional areas varying from a minimum in the plane or planes of maximum pressure to a maximum at the plane or planes of minimum pressure. Such result is accomplished by the use of dies formed with intaglios whose combined cross-sectional areas at one plane at the extremity of a given portion of such intaglios is a minimum and varies to a maximum at the other extremity of such portion. Such maximum cross-sectional area is caused to be substantially equal to the cross-sectional area of the cable and ferrule portion of the terminal prior to compression—that is, substantially equal to the normal sectional area of the connection. The metal is hence compressed while confined in the dies through varying distances, such variation being from a maximum to a minimum, the minimum being substantially zero and the maximum a finite quantity. Such finite quantity is made sufficiently large to cause the cable and terminal to unite in intimate contact to form a coherent homogeneous structure of least possible electrical resistance at such point of greatest compression or of least cross-sectional area. The union hence varies from a

maximum or perfect intimacy of contact to a minimum or normal superficial contact. The intimacy of contact being perfect at the plane or planes of maximum compression, the cable is compacted and the internal voids which existed prior to the compression between the strands of the cable and between the strands and the terminal are entirely eliminated. Such elimination varies from the direction of the plane or planes of least compression, at which plane or planes such elimination is substantially zero, toward the plane or planes of greatest compression. The resulting connection is such that the terminal may be secured to a stationary object and the conductor embedded and secured to it may be subjected to vibratory movements with a resulting greater length of life and integrity of structure at the plane of maximum bending strain—that is, at the extremity of the ferrule or outer inclosing member—than has heretofore, in so far as I am aware, been attained. Such increased length of life is a result of the normal cross-sectional area at the point of entrance into the terminal—that is, at the plane of maximum bending—the conductor in such condition being in the best condition and form for resisting the strain produced by such bending in any direction. The change of form of the conductor or cable by reason of the compression to which it has been subjected, which decreases the resisting qualities thereof in the direction of decreased dimension of the cross-sectional area, is by the above method caused to take place gradually and to cause the amount of bending to vary inversely as the said decreased dimension, thus presenting the greatest possible economical characteristics.

In splicing an electric cable the two ends are placed adjacent to each other and surrounded by a ductile-metal sleeve A, which is subjected to pressure by suitable dies or other tools to form two connections, each connection having the characteristics previously described.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the steps herein disclosed, provided the method covered by any one of the following claims be employed.

I therefore particularly point out and distinctly claim as my invention—

1. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other and uniting the two in varying degrees of intimacy by pressure, such pressure being in substantially regular variation and sufficient to cause a portion only of the inclosing conductor to form a homogeneous structure with the inclosed conductor.

2. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other and uniting the same by the application of varying pressure so as to cause a part only of the union to form a coherent homogeneous structure.

3. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other and applying a pressure to a given area, said pressure varying from a maximum at one extremity of such area to a minimum at the other extremity thereof, such maximum pressure being sufficient to cause only a part of that portion of the conductor which is inclosed to form a coherent homogeneous structure with the inclosing conductor.

4. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other and compressing a given volume through regularly-varying distances and so as to cause only a part of the inclosed portion of the inclosed conductor to form a coherent homogeneous structure.

5. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other and compressing a given volume of said inclosed portion through distances varying from a maximum at one extremity to a minimum at the other and so as to cause only a part of the inclosed portion of the inner conductor to form a coherent homogeneous structure with the outer conductor.

6. The method of forming an electrical connection between two conductors which consists in surrounding one with the other and uniting said inclosed portion of said two conductors by the application of a pressure varying from zero or a low pressure to a comparatively high pressure, whereby only a part of said inclosed portion of the inclosed conductor is caused to form a coherent homogeneous structure with the outer conductor.

7. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other and compressing said conductors through distances varying from substantially zero to a finite quantity sufficiently large to cause that part of the inclosed portion of the inner conductor to which it is applied to form a coherent homogeneous structure with the outer conductor.

8. The method of forming an electrical connection between two conductors which consists in surrounding the one with the other to form a normal cross-section and applying pressure so as to form the inner or inclosed portion of the connection of progressively decreasing cross-section, the two conductors forming a coherent homogeneous structure at the plane of cross-section of least area of the inner conductor and free from homogeneity at the plane of the cross-section of greatest area of said inclosed portion.

9. The method of forming electrical connection between two conducting members which consists in inserting the end of one

within the other and then swaging a portion of said outer member into such intimate contact with the inner member as to cause said outer and inner members to form a coherent homogeneous structure, the free end of the outer member being subjected to a diminishing pressure whereby the inner member as it emerges from the outer member is substantially normal in cross-section.

10. The method of forming electrical connection between two conducting members which consists in inserting the end of one within the other and subjecting part of the inclosed portion of the inner member to pressure, said pressure increasing from a point at or near the end of said outer member, at which end the inner conductor is substantially normal in cross-section, to a point where the pressure is so great as to cause said conductors to form a coherent homogeneous structure.

11. The method of splicing electrical cables which consists in inclosing their ends in a ductile-metal sleeve, and then swaging a portion of said sleeve into such intimate contact with said ends as to cause said portion of said sleeve and ends to form a coherent homogeneous structure, the outer portion of said sleeve being subjected to a diminishing pressure whereby said cables as they emerge from said sleeve are substantially normal in cross-section.

12. The method of splicing electrical cables which consists in inclosing their ends in a ductile-metal sleeve and subjecting a portion of said sleeve and cable ends to pressure, said pressure increasing from a point at or near the respective ends of said sleeve, at which respective ends the inclosed cables are substantially normal in cross-section, to a point where the pressure is so great as to form the ends of said cables into a coherent homogeneous structure with said sleeve.

Signed by me this 16th day of June, 1900.

WILLIAM B. CLEVELAND.

Attest:

D. T. DAVIES,

A. E. MERKEL.