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W. E. OAKLEY.

METHOD OF MAKING RAIL BONDS.

APPLICATION FILED MAY 13, 1903.

Fig. 1.

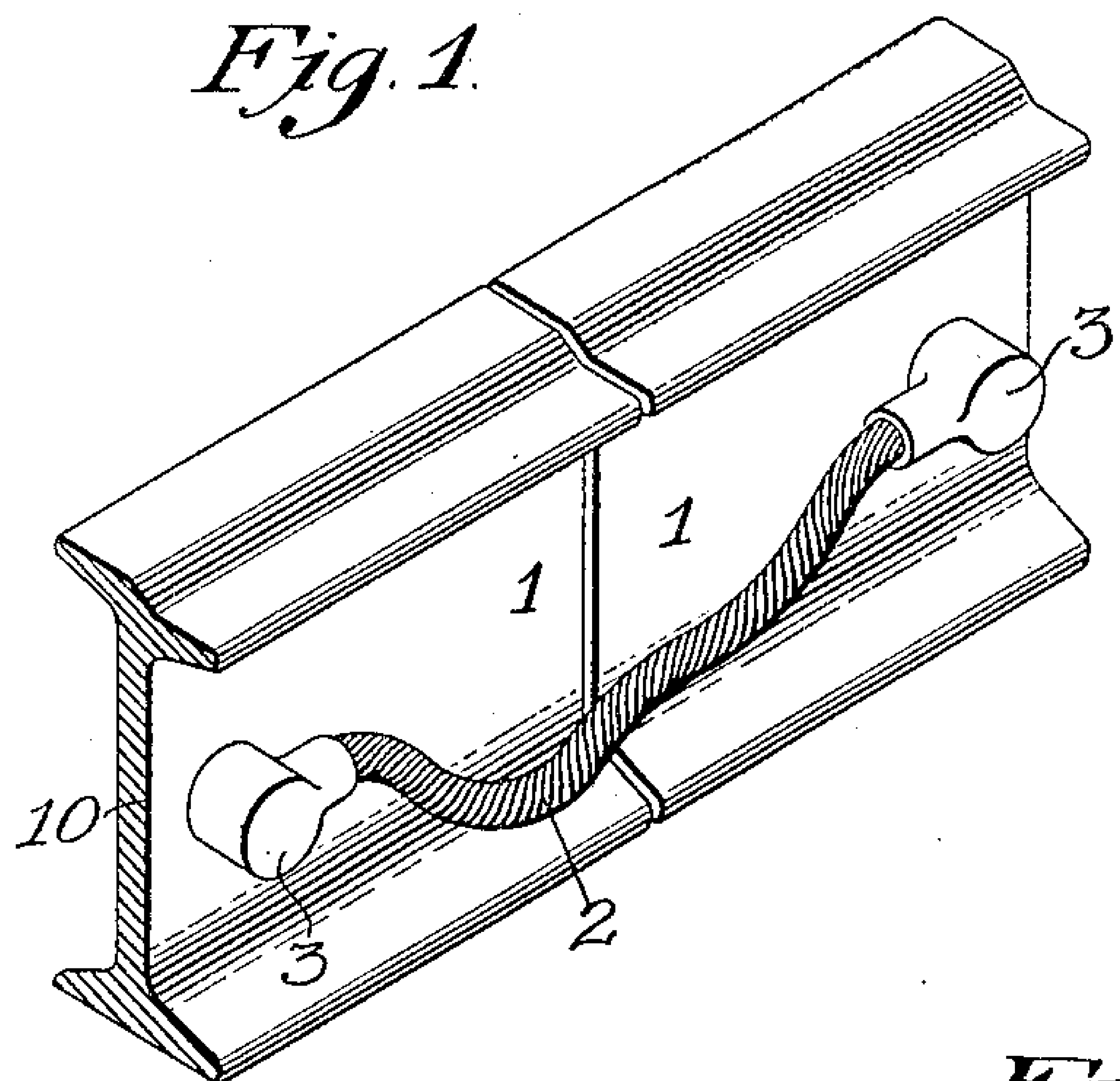


Fig. 2.

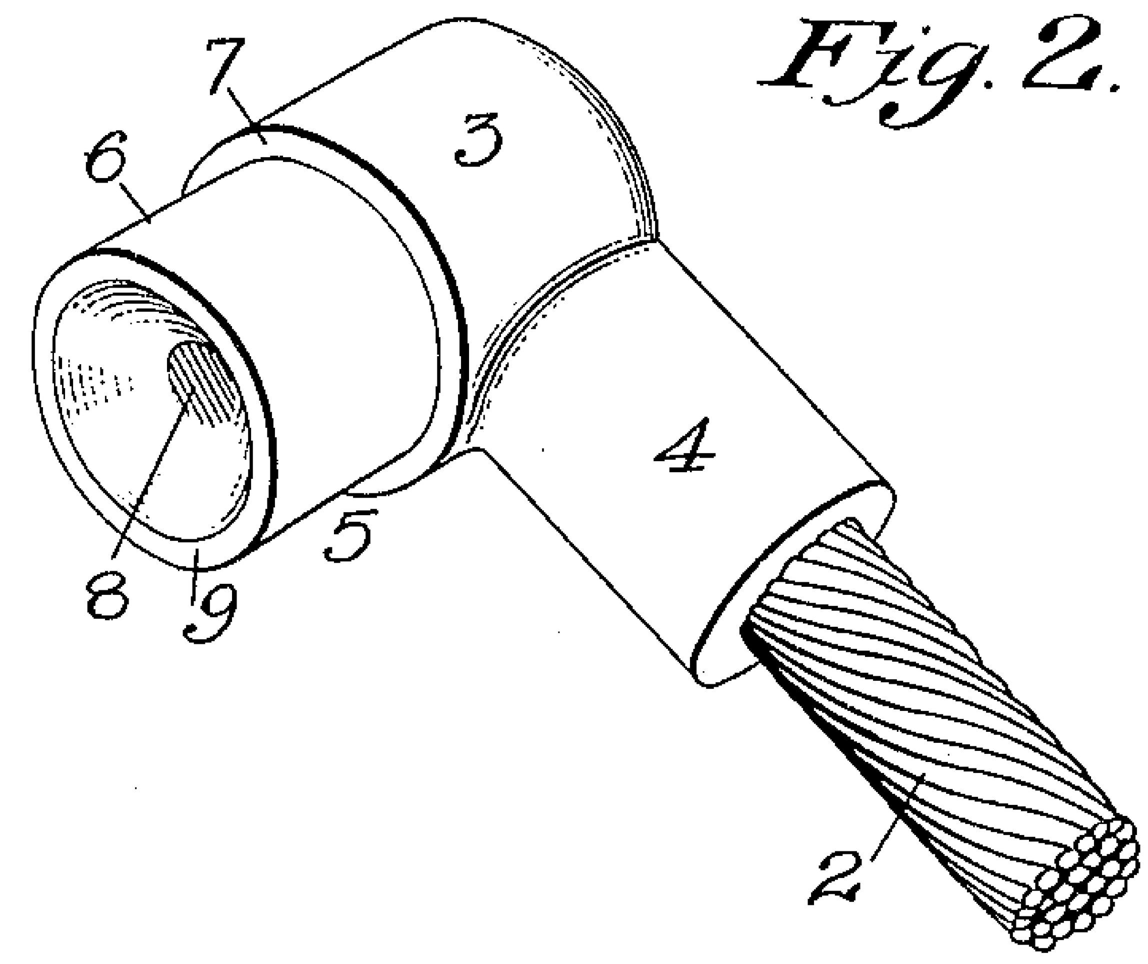


Fig. 3.

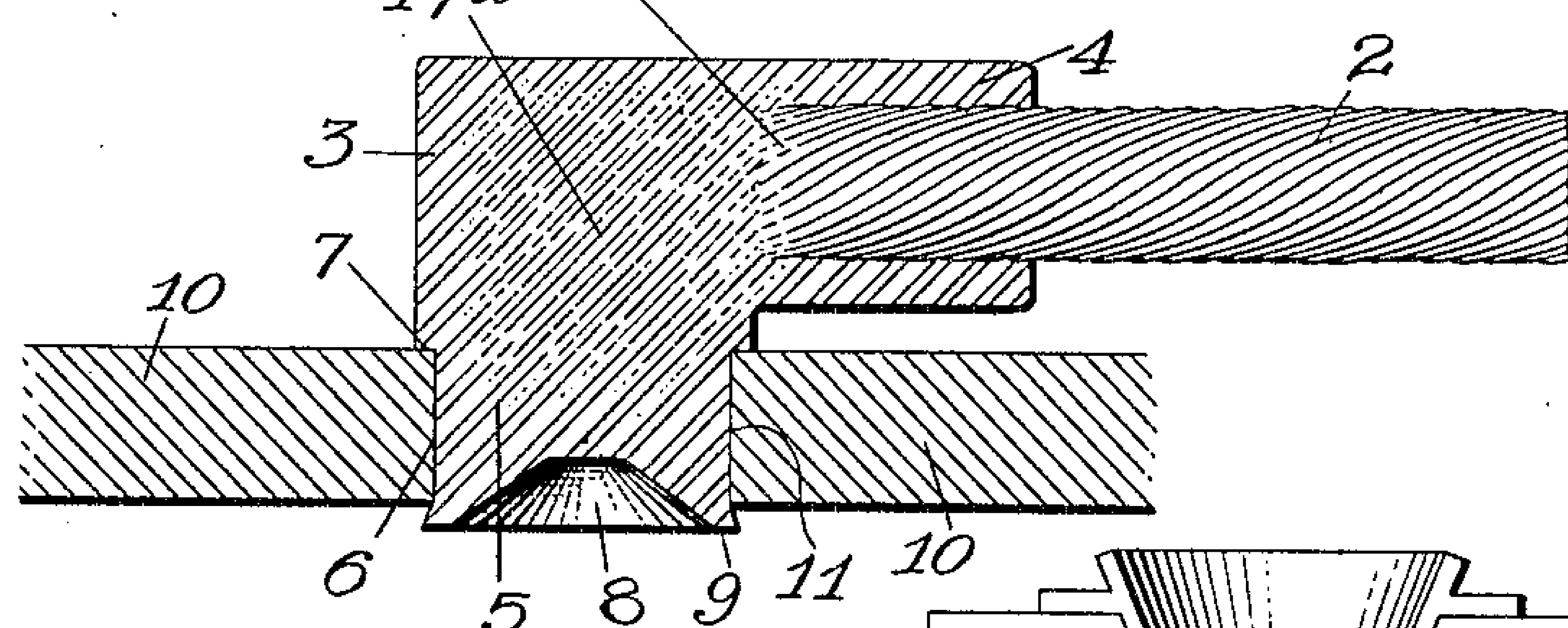


Fig. 4.

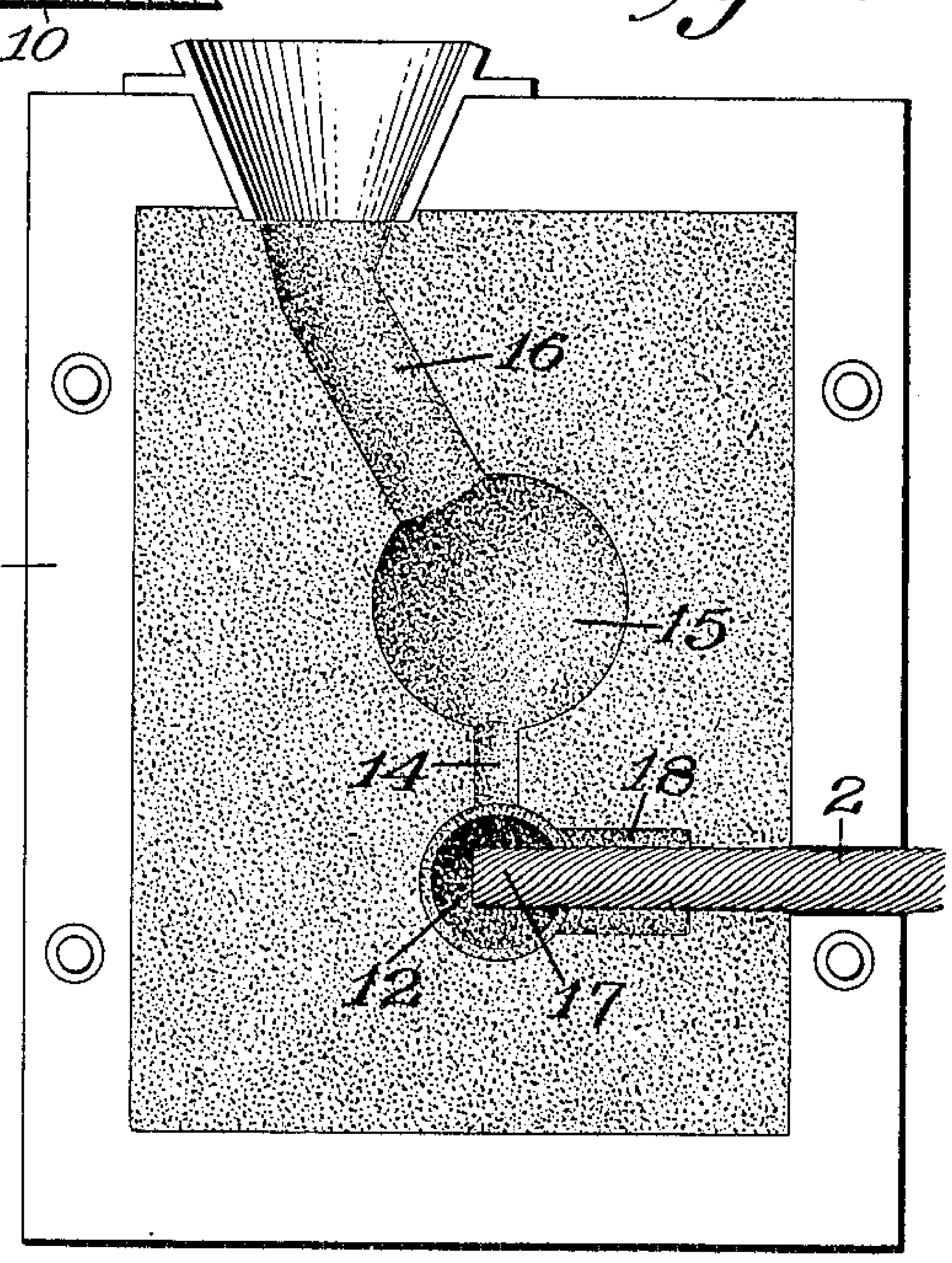
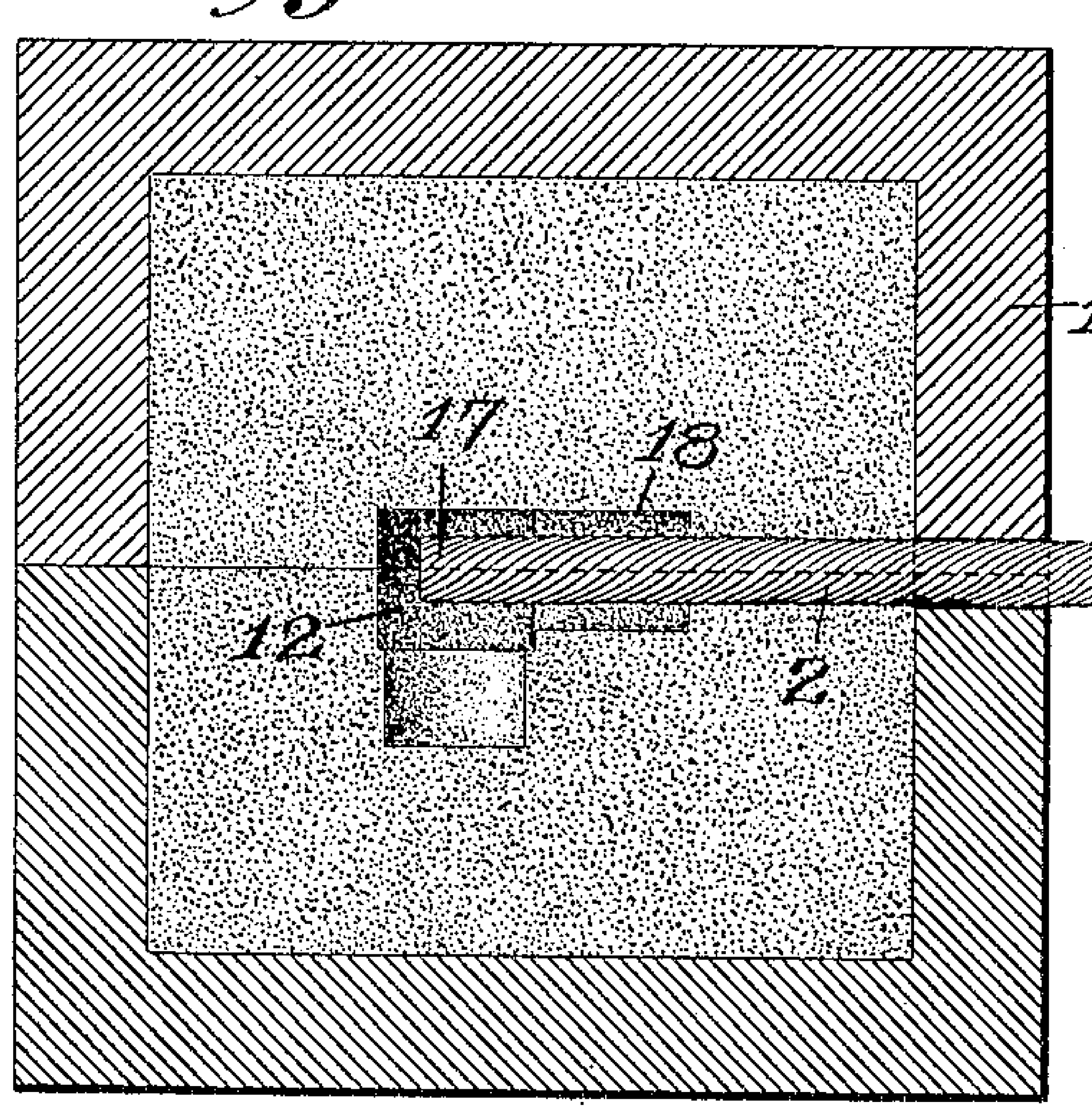


Fig. 5.



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METHOD OF MAKING RAIL-BONDS.

No. 829,931. Specification of Letters Patent. Patented Aug. 28, 1906.

Original application filed January 2, 1903, Serial No. 137,479. Divided and this application filed May 13, 1903. Serial No. 156,874.

To all whom it may concern:

Be it known that I, WILLIAM EDWARD OAKLEY, a citizen of the United States, residing at Millbury, in the county of Worcester and Commonwealth of Massachusetts, have invented a new and useful Improvement in Methods of Making Rail-Bonds for Electric Railways, of which the following is a specification, accompanied by drawings forming a part of the same, and constituting a divisional application of my pending application, Serial No. 137,479.

In the accompanying drawings, Figure 1 is a perspective view of the adjoining ends of two rails of an electric railway connected by a rail-bond embodying my invention. Fig. 2 is a perspective view of one of the terminals of my improved rail-bond. Fig. 3 represents one of the terminals of my improved bond applied to the rail and shown in sectional view through the center of the terminal. Fig. 4 is a plan view of the lower portion of a founder's flask, showing one-half of the matrix for casting the terminal with the end of the flexible connection placed in position to be embedded therein; and Fig. 5 represents a founder's flask containing a matrix for a rail-bond terminal and shown in sectional view.

Similar figures of reference refer to similar parts in the different figures.

My present invention relates to a rail-bond for electrically connecting the adjoining ends of rails in an electric railway, by which the rails are made to form a return-circuit for the electric current which has been supplied from a separate conductor to the electric motor of a car; and the objects of my improvements are to simplify the construction and reduce the cost of the rail-bond, to increase the electric conductivity of the bond, and to prevent or retard its deterioration, whereby the rail resistance is decreased and the serviceable life of the bond is lengthened.

My improved rail-bond belongs to that class of bonds which comprise a flexible connector joined at its opposite ends to terminals which are inserted in the adjacent ends of a pair of rails. The flexible connectors in bonds of this class usually consist of a copper wire or an assemblage of copper wires, either flat or round and wound into a cable, and the terminals consist of cast or forged pieces of copper or other metal joined to the ends of the connectors and provided with cylindrical extensions adapted to be inserted in circular holes in the web of a steel rail and expanded or riveted therein or otherwise held from displacement. In case the terminals are made of copper a resistance loss is incurred due to the difference in expansion between the copper terminal and the steel rail, the longitudinal expansion of the copper terminal under a rise in temperature producing a permanent set in the copper and preventing it from filling the hole in the rail under a lower temperature. In addition a compression of that portion of the terminal which is inserted in the rail is liable to occur from the vibration incident to the passage of cars over the rail. Any failure of a perfect contact between the terminal and the rail admits moisture, which deteriorates the electrical conductivity of the joint by electrolytic action and the formation of oxid of high resistance between the opposing surfaces lessens the electrical efficiency of the bond.

It has been proposed to employ iron or steel terminals either cast or forged in separate pieces and electrically welded to the ends of a copper bar or rod in order to secure a terminal of the same temperature coefficient as the rail, and thereby avoid one of the disadvantages incident to the use of a copper terminal. The employment of iron or steel, however, as proposed, is attended with other and more serious disadvantages arising from the greater electrical resistance of iron over copper from the difficulty of securing a perfect joint between the terminal and the copper rod and the difficulty of expanding the hard-steel terminal in the hole in the rail. The latter has been attempted by forming an internal screw-thread in a terminal having a slit or slot which would allow the terminal to be expanded by a bolt slightly larger than the screw-threaded hole in the terminal; but a joint so made is expensive and admits moisture to the slit and soon becomes defective by the loosening of the bolt. The method of joining a terminal to the ends of a flexible connector, as is sometimes practiced with copper terminals, fails to secure the desired intimate contact between the terminal and the connector. It is attempted to remedy this defect by casting a copper terminal around the end of the connector and afterward subjecting the terminal inclosing the end of the connector to great pressure to secure a close contact of the two. This method of compressing the terminal does not prove effective in the case of an iron or steel terminal, which requires a more perfect union with the connector than copper, as the resistance of iron or steel is relatively much greater. This increased resistance is in part compensated for between a copper terminal and the rail by increasing the diameter of the terminal in order to secure a larger surface in contact with the rail; but this expedient cannot be employed between the terminal and a connector of uniform diameter throughout.

By my improvement I secure a rail-bond with a copper connector and having terminals of steel of the same temperature coefficient as the rail and of sufficient hardness to withstand the jar or concussion of passing cars and without substantial impairment of the electrical conductivity of the joint. I also provide means for producing an effective electrical joint between the terminal and the rail without requiring the expansion of the terminal into contact with the surface of the hole. I also unite the terminal to the connector during the single process of casting the terminal and I avoid the injurious effect upon the wires of the connector by the high temperature incident to the application to the wires of fused iron or steel. I also increase the ductility of the terminal to enable it to be headed or riveted into the hole in the rail by a succession of light riveting blows.

Referring to the accompanying drawings, 1 1 denote portions of two adjacent rails of an electric railway.

2 is a flexible connector, and 3 3 the terminals of a rail-bond uniting the rails 1 1 and embodying my invention. The connector 2 in the present instance consists of a series of copper wires twisted together in the form of a cable. Each of the terminals 3 3 is of steel cast in a fused state around the ends of the connector, as hereinafter described, whereby a perfect union of the two metals is accomplished. The terminal 3 is provided with a sleeve 4, inclosing a portion of the connector adjacent to the terminal, for the purpose hereinafter set forth, and on one side with a cylindrical extension 5, having its outer surface 6 slightly tapered from a shoulder 7 toward its end. The end of the extension 5 is provided with a shallow recess 8, preferably with tapering sides, making the recess in the form of the frustum of a cone, surrounded with a narrow annular rim 9, arranged to project slightly through the web 10 of a rail. The taper of the surface 6 is preferably about one-sixtieth of an inch and the terminal is applied to the rail by forming a round hole 11 in the web 10 of the rail, substantially of the same diameter as the diameter of the smaller end of the extension 5. The extension 5 is then driven or pressed into the hole 11, forming a tight fit, and by holding a heavy piece of metal against the terminal the recessed end is upset by a series of blows applied to the annular rim 9, thereby expanding the end and securely holding the terminal in place.

The terminal 3 is cast in a suitably-shaped matrix 12, conveniently formed in founder's sand in a flask 13, with a suitable gate-channel for the admission of molten steel and comprising a restricted passage 14 communicating with the matrix, a spherical chamber 15, and a large channel 16, into which the molten steel is poured. The connector 2, consisting of a copper cable, is inserted in the flask with its end 17 directly beneath the passage 14 and concentrically with the matrix to make an annular space 18 to form the sleeve extension 4. Molten steel is then poured in the gate-channel 16, filling the chamber 15 and flowing in a continuous and restricted stream through the passage 14 directly upon the end 17 of the copper cable until the matrix is filled. The flow of molten steel at its high temperature of fusion impinging in a restricted stream upon the ends of the copper wires 17 fuses them before the matrix becomes filled, and by the mechanical agitation of the stream the fused copper is commingled with the molten steel, forming an alloy of steel and copper, the center of the terminal being largely of copper, with the relative proportion of copper gradually decreasing toward the outside of the terminal, as indicated by the cross-shading at 17^a in the sectional view in Fig. 3. The molten steel flows into the annular space 18 and becoming partially cooled by its contact with the cable and the wall of the matrix serves to protect the wires of the cable adjacent to the terminal and also to anneal the inclosed wires, and thereby increase their strength and perfect the union of the cable and terminal, which might otherwise become weakened by the effect of the high temperature upon the sections of the wires immediately adjacent their fused ends.

The alloy of copper in the terminal renders it more ductile and facilitates both the compression of the tapered extension 5, as it is driven into a hole 11 of slightly less diameter, and also the upsetting of the annular rim 9. In order to promote the more intimate commingling of the copper and steel, I apply to the end 17 of the cable a flux, preferably pulverized boracic acid.

The terminals of my improved rail-bond are preferably made of steel; but my invention is not confined to that material. I employ a terminal the temperature coefficient of which is nearer that of the rail than copper and which fuses at a sufficiently high temperature to cause the fusion of the copper wires of a connecting-cable in the operation of casting the terminal when applied in a current impinging against the cable, serving to not only fuse the copper, but to mix it with the inflowing metal.

The alloy of copper and steel in the center of the terminal has an unbroken metallic connection at 19 with the ends of the unfused wires of the cable and serves to increase the area of contact between the copper and the steel by an expansion of the mass of copper inclosed in the terminal, thereby compensating in part at least for the resistance occasioned by the non-conductivity of the steel.

By my improved method I largely increase the electrical efficiency of the joint between the cable and the terminal, making it substantially equal to the conductivity of the joint between the terminal and the rail when a copper terminal is used, so that the electrical tests of my improved bond have proven it equal to those constructed wholly of copper, while the steel terminal, with its tapered extension, when driven into the rail forms a perfect joint, which does not deteriorate under changes in temperature and the concussion of passing cars. I further avoid the cost of compressing the terminal and cable for the purpose of perfecting the contact of one with the other, as now practiced in the case of copper terminals with uncertain results. The operation of casting the terminal by the fusion of the cable and mechanical agitation of the fused metal completes the electrical union between the cable and the terminal, and the bond is then completed by turning or milling the exterior surface 6 of the extension.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The herein-described method of making rail-bonds for electric railways, consisting in first inclosing an end of the connector in a matrix, then casting a terminal of metal upon said end of the connector of metal fusible at a higher temperature than that of the connector, directing the stream of molten metal against said end of the connector thereby melting the end of the connector and causing an intermixture of the metal of the terminal and the connector.

2. The herein-described method of making a rail-bond for electric railways consisting in placing an end of the connector in a matrix having a diameter of a size appreciably greater than that of the connector, then pouring a metal in a molten state and fusible at a higher temperature than the connector into the cavity in the mold with the molten stream directly against the end of the connector thereby molding the latter and causing the two metals to mix and form an alloy of the two in the completed terminal.

3. The method of making a rail-bond for electric railways which consists in placing an end of the connecting wire or cable within a mold having a cavity therein, fusing the ends of the connecting wire or cable by pouring a molten metal therein, the pouring of the molten metal not only fusing the ends of the wire or cable but also causing the intermixing thereof with the mass of the molten metal during the operation of casting the terminal whereby the mixture of the metals comprising the terminal of the wire or cable is effected.

4. The herein-described method of making a rail-bond for electric railways consisting in inserting the end of the wire or cable through the sleeve-section of a matrix into the center of the head or body section thereof, and then casting a terminal thereon from a molten metal having a higher melting-point than the wire or cable whereby the area of contact is increased by the fusion of the end of the wire or cable thereby intermixing the two metals.

5. The process of making a rail-bond for electric railroads which consists in pouring molten steel into a mold in contact with the end of a copper connector inserted therein, in such manner and under such conditions as will cause the copper to be melted, and the two metals to become mixed during the pouring and casting operation.

Dated this 24th day of March, 1903.

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Witnesses:

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