No. 772,172. PATENTED OCT. 11, 1904.

W. E. OAKLEY.

RAIL BOND.

APPLICATION FILED JAN 2, 1903.

NO MODEL.

Fig. 1.

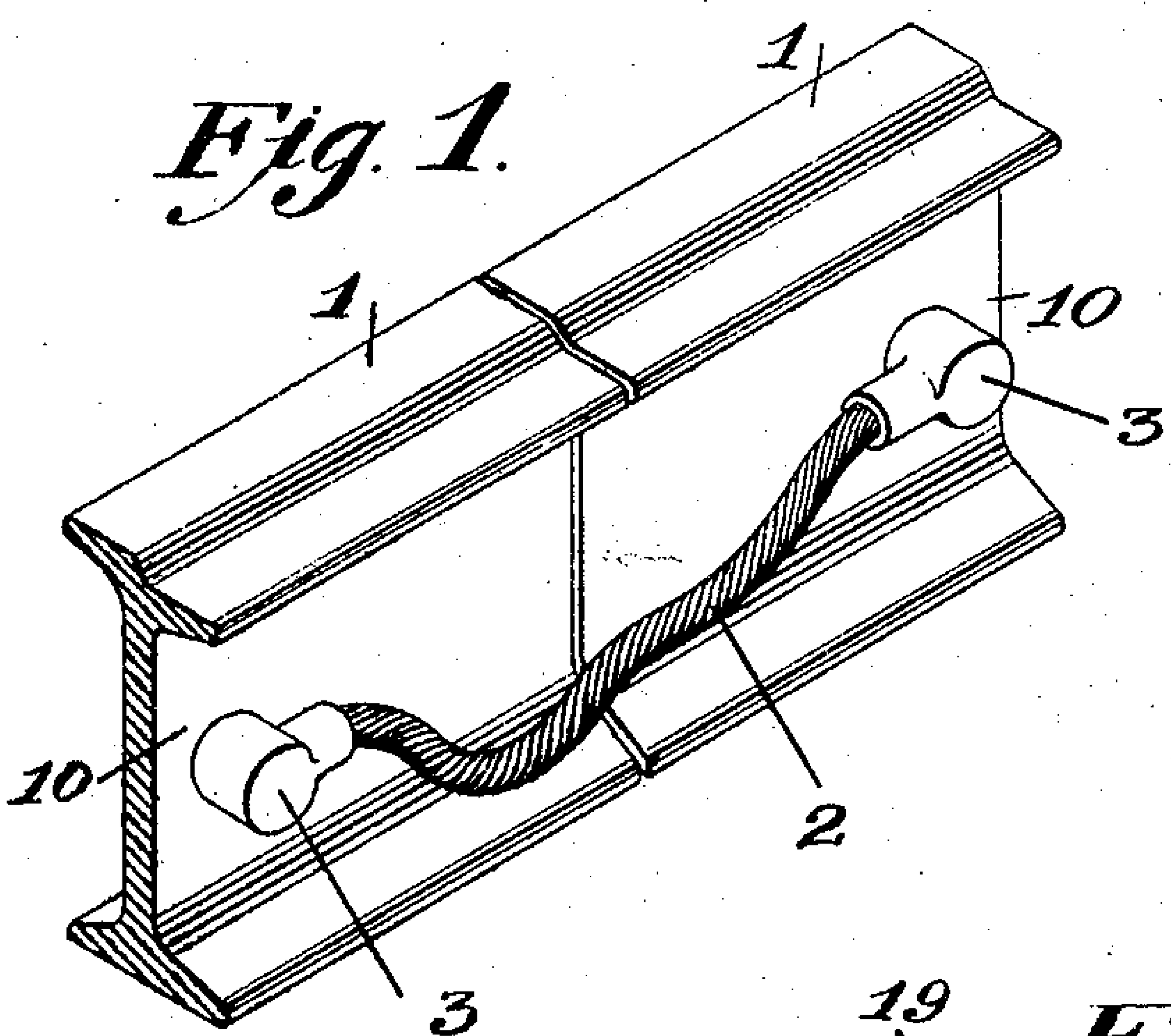


Fig. 2.

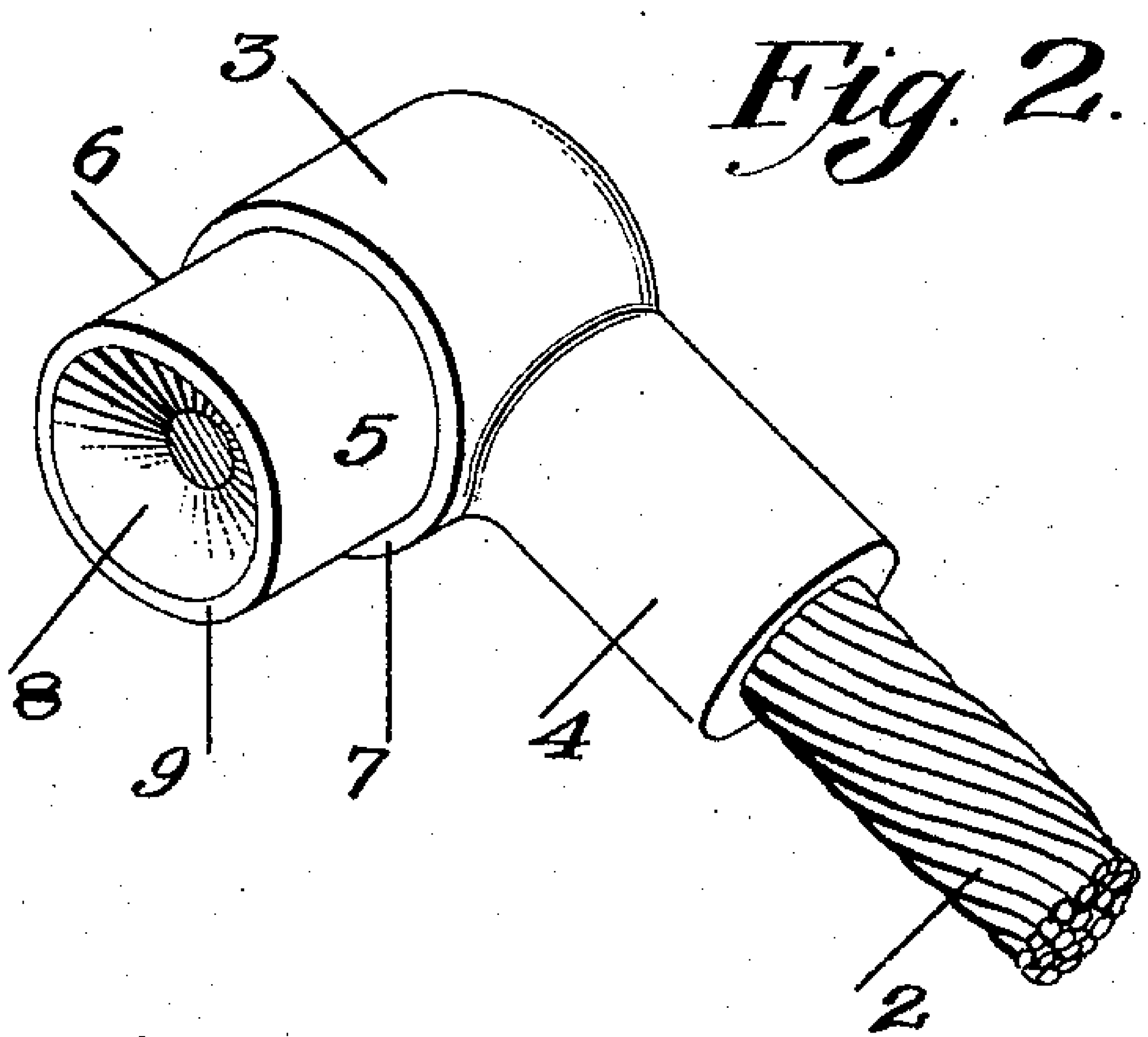


Fig. 3.

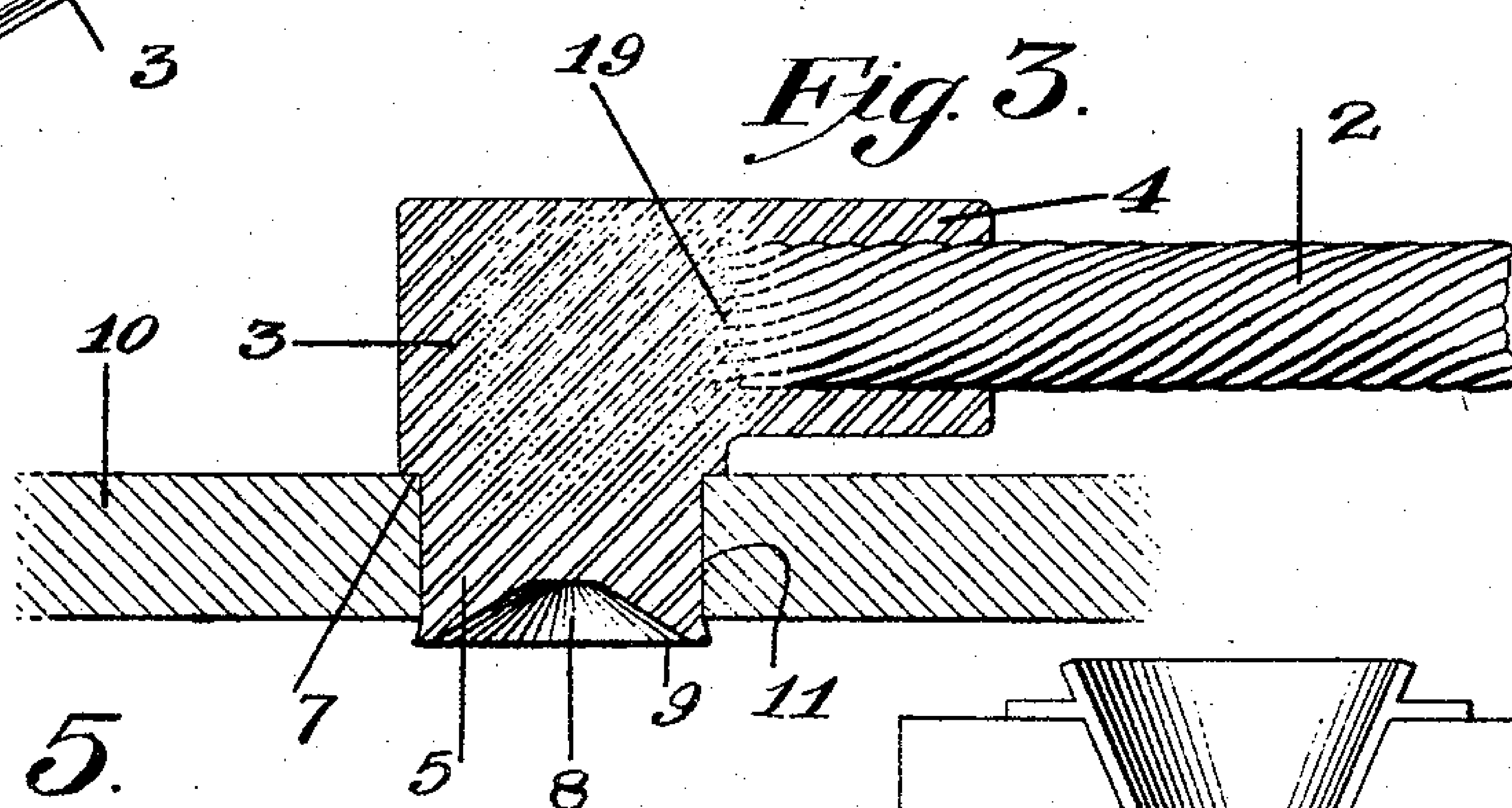


Fig. 5.

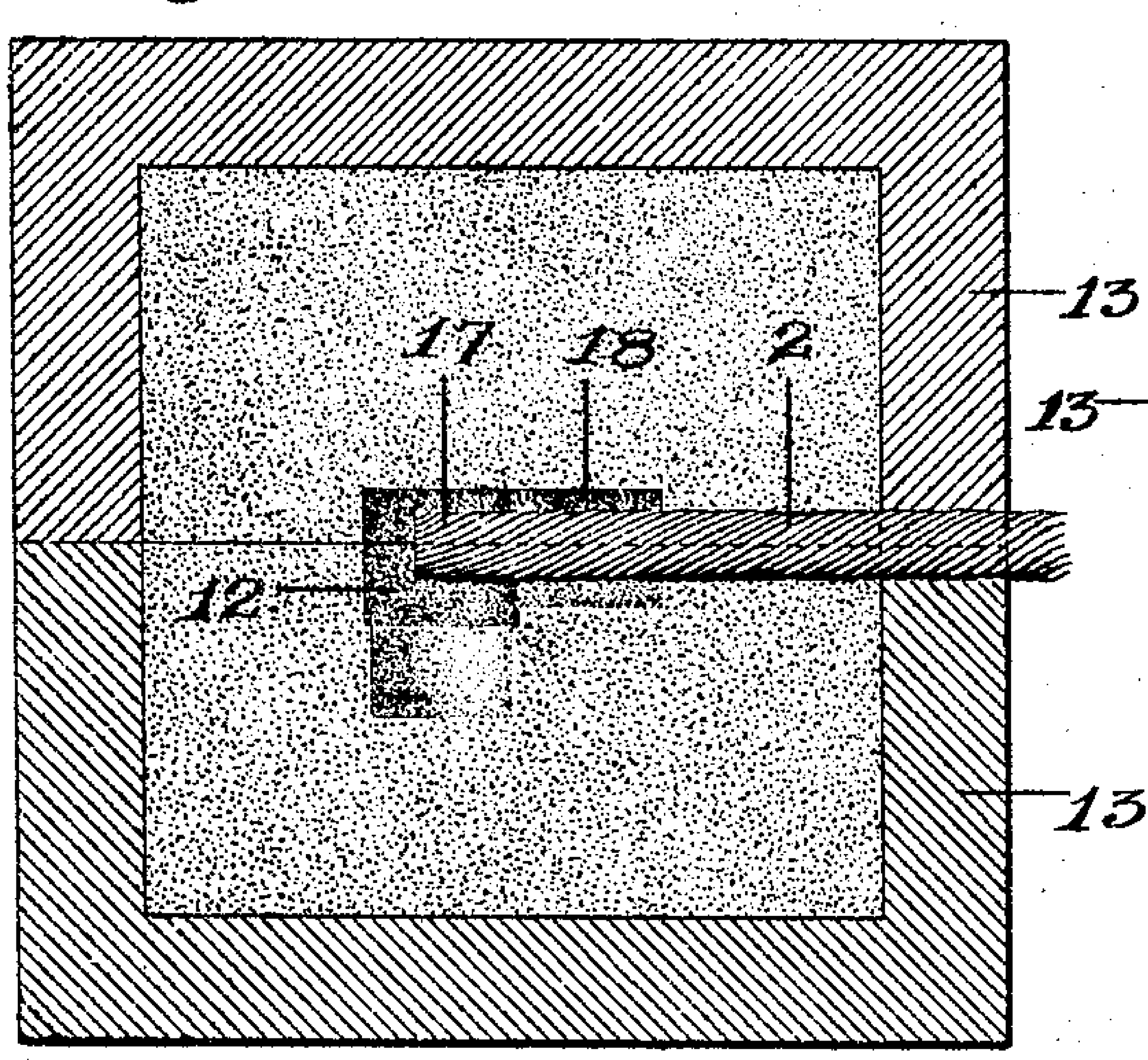
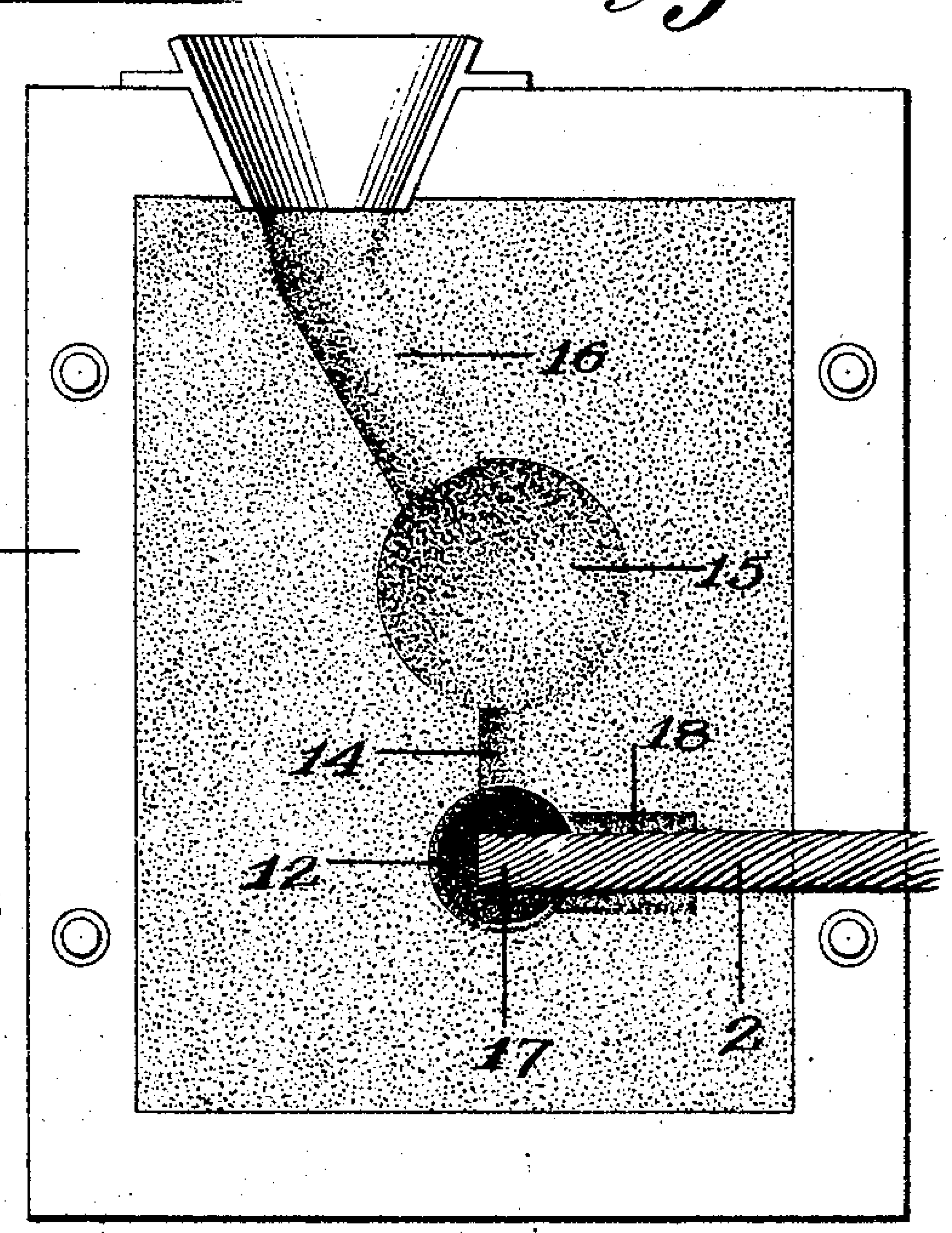


Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM E. OAKLEY, OF MILLBURY, MASSACHUSETTS.

RAIL-BOND.

SPECIFICATION forming part of Letters Patent No. 772,172, dated October 11, 1904.

Application filed January 2, 1903. Serial No. 137,479. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. 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 Rail-Bonds, of which the following is a specification, accompanied by drawings forming a part of the same, in which—

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 numerals 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.

So much of the method of making my improved rail-bond as is herein described forms no part of my present invention, as the same has been claimed in my copending divisional application, Serial No. 156,784.

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 are 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 founders' 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 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 rail-bond 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 close joint which is not liable to 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 terminal, and the bond is then completed by turning or milling the exterior surface 6 of the extension.

I have herein described a process of constructing a rail-bond in which the temperature coefficient of the terminals is substantially that of the rail, while the resistance is slightly more, if any, than that of the connector by which the terminals are joined. The theory by which the result accomplished may be explained is not clear to my mind, and I therefore do not wish to advance any theoretical ideas concerning it. I have assumed that the low resistance of the bond constructed as herein described was due, in part at least, to an increase in the area of contact between the metal of low resistance forming the connector and the metal of higher resistance constituting the terminal. It may, however, be due, in part at least, to the distribution throughout the mass of the terminal of particles of metal having a lower resistance than that of the metal of the terminal. The physical change in the structure of the bond over those now in use, so far as I am aware, consists, broadly, in mixing the metal of the terminal having a relatively high resistance and a temperature coefficient substantially that of the rail with another metal, such as that of the connector having a relatively lower resistance, and making such a terminal integral with the end of the connector.

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

1. A rail-bond comprising a copper connector and a head or terminal therefor composed of steel and copper intimately mixed or commingled through the mass of the head, or terminal, and integral with the connector.

2. A rail-bond comprising a connector and a head or terminal therefor composed of metals of different electrical conductivities and having a portion of the metal of the connector distributed through the mass of the head or terminal.

3. A rail-bond for electric railways, consisting of a pair of terminals of one metal and an electrical connecting wire or cable of another metal, and having portions of the metal of the connecting wire or cable distributed through the mass of the terminals.

4. A rail-bond comprising a head or terminal, and a connector of different metals, the portion of the head at the end of the connector composed of the two metals intermixed through the mass of the head.

5. As an improved article of manufacture, a rail-bond for electric railways, consisting of metal terminals having a temperature coefficient substantially the same as that of the rail, a metallic wire or cable forming an electrical connection between said terminals and having a lower resistance than the terminals, with the metal of the connector intermingled or mixed through the mass of the terminals.

6. A rail-bond for electric railways comprising a pair of metallic terminals and a metallic connecting wire or cable of a different metal, having different electrical conductivities, with the ends of the connector entering the terminals and having the metal of the connector coalescing with the metal of the terminal through the mass of the latter.

7. As an article of manufacture, a rail-bond for electric railways, comprising a pair of metal terminals and a metallic electrical connector between said terminals, with the metal of the connector mixed or commingled through the mass of the terminals, said terminals having a sleeve integral therewith and inclosing the connector adjacent to the terminal.

8. As an article of manufacture, a rail-bond for electric railways, comprising a metallic connector and a metallic terminal on the end of the connector and fusible at a higher temperature than the connector, with the metal of the connector mixed or commingled through the mass of the terminal, said terminal having a sleeve integral therewith and inclosing the connector adjacent to the terminal.

Dated this 31st day of December, 1902.

WILLIAM E. OAKLEY.

Witnesses:

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PENELOPE COMBERBACH.