Feb. 20, 1940. W. COOK 2,190,824

ALUMINUM TO COPPER CONNECTOR

Filed Feb. 9, 1938

Fig. 1.

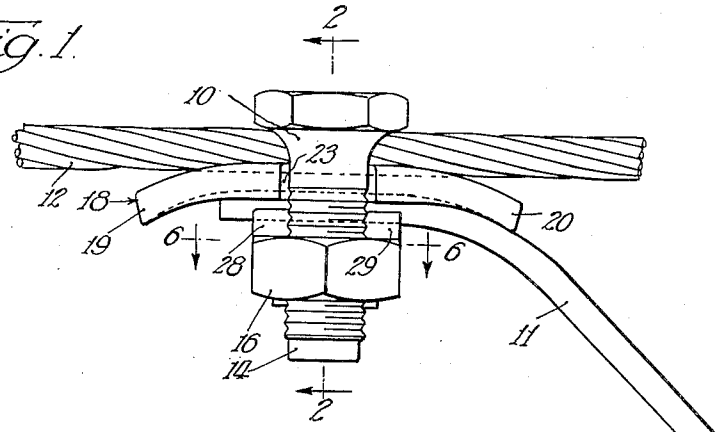


Fig. 2.

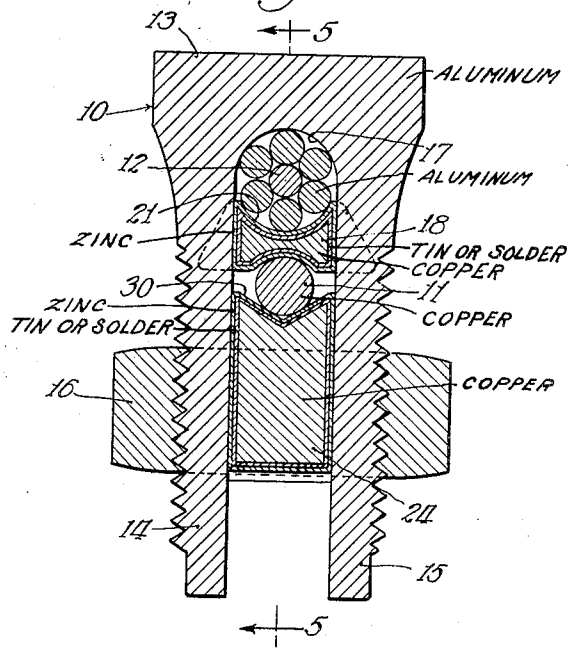


Fig. 3.

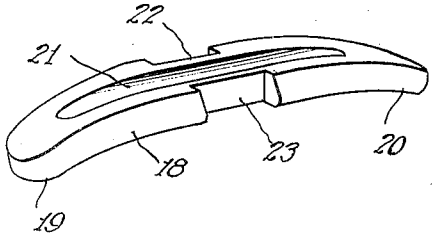


Fig. 4.

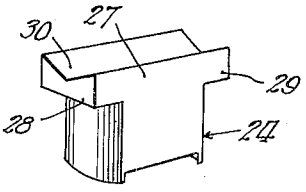


Fig. 5.

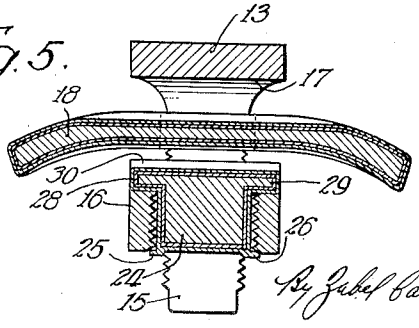
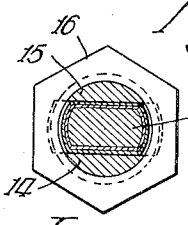


Fig. 6.



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UNITED STATES PATENT OFFICE

2,190,824

ALUMINUM TO COPPER CONNECTOR

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Application February 9, 1938, Serial No. 189,531

4 Claims. (Cl. 174—94)

The present invention relates to electric connectors for connecting aluminum conductors to copper tap wires. The invention is particularly directed to the provision of a solderless connector which is capable of producing enough compression upon the relatively hard copper to make a good electric connection and one which is capable of practically avoiding the galvanic action which tends to take place between the aluminum and copper with resultant destruction of the aluminum conductor.

The aluminum conductors which are used by the utilities are very often what is known as aluminum cable, steel reinforced. This means that the conductor is a cable composed of several aluminum wires with a steel wire in the center to give the cable the necessary tensile strength. Such a conductor has relatively low conductivity as compared with the same area of copper. Therefore, the largest copper tap wire that would normally be used with the cable would be much smaller in cross-section than the cable. The aluminum of the cable is only about ⅓ as hard as copper. In order to obtain a satisfactory solderless connection on copper it is necessary to have compression which approaches the yield or cold flow point of the copper. The present invention contemplates the provision of a solderless connector of the split bolt type wherein the parts clamping the aluminum cable engage an area much larger than the area of copper wire engaged so as to produce a sufficient compression on the copper.

The present invention further contemplates the provision of a spacer between the copper wire and the aluminum cable which is made up in such a fashion and of such materials as to practically avoid galvanic action between the aluminum cable and the copper wire.

More particularly, it is the purpose of this invention to provide a split bolt connector for connecting copper tap wires to aluminum cables in which the bolt and nut are combined with a spacer slug and a contactor slug so constructed as to give adequate compression on the copper wire by transmitting the pressure to the copper through a large area of the softer aluminum. The parts are constructed of copper and aluminum, together with interposed layers of zinc and tin, so arranged to prevent galvanic action between the conductors.

The features and advantages of the invention will appear more readily as the description proceeds in conection with the accompanying drawing wherein a prefered form of the invention is shown. It is to be understood, however, that the drawing and description are illustrative only, and should not be considered as limit the invention except insofar as it is limited by the claims.

In the drawing, Fig. 1 is a view in side elevation of a split bolt connector embodying the invention as it is used for connecting a copper tap wire to an aluminum cable.

Fig. 2 is an enlarged cross section taken on the line 2—2 of Fig. 1.

Fig. 3 is a perspective view of the spacer slug.

Fig. 4 is a perspective view of the contactor slug.

Fig. 5 is a cross-sectional view taken on the line 5—5 of Fig. 2 but reduced in size, and

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 1.

Referring now to the drawing, the present invention is embodied in a split bolt connector 10 which is adapted so that it connects a copper tap wire 11 to an aluminum cable 12. The aluminum cable, as hereinbefore stated, is usually of the steel reinforced type, that is it has several strands of aluminum wire about a center strand of steel. The bolt 10 has a head 13 and shanks 14 and 15 which are screw-threaded to receive a nut 16. The slot between the shanks 14 and 15 is rounded where it terminates in the head to give a long bearing surface of substantial area for the aluminum cable 12. In order to provide a large bearing area opposite the surface 17, I use a spacer slug 18 which is shaped as shown in Fig. 3 to fit down between the shanks 14 and 15 and rest upon the cable 12. The spacer slug 18 has its opposite ends curved away from the cable engaging face as shown at 19 and 20. The cable engaging face of the spacer slug is provided with a long groove 21 that is rounded to fit the cable 12. Notches 22 and 23 are formed in the opposite side edges of the slug 18 to guide it on the shanks 14 and 15.

The copper wire 11 is much smaller in diameter than the cable 12. The connector is provided with a contactor slug 24 for clamping the wire 11 against the spacer slug 18. This contactor slug is rotatably secured in the nut 16 by bending over a pair of ears 25 and 26 thereon so that they overlap the nut 16. The contactor slug has the wire engaging end 27 thereof provided with shoulders 28 and 29 which project over the adjacent face of the nut 16. The end 27 is grooved at 30 with a relatively flat V-shaped groove that is adapted to engage the wire 11.

An inspection of the construction illustrated

in the drawing will show that the relative area engaged by the cable 12 and the wire 11 provides at least three times as much surface for the cable 12 to engage as is provided for the wire 11. The large bearing area for the aluminum permits me to obtain enough compression between the spacer slug 18 and the wire 11 on one side and the contactor slug 24 and wire 11 on the opposite side to get a good electric contact. If this relation of large bearing area for the aluminum and small bearing area for the copper is maintained, the connection remains low in resistance and substantially constant in resistance for a long period. The ideal condition is, of course, a relation between the area of copper engaged and the area of aluminum engaged so that the total pressure to cause the copper to yield will cause also the same yield in the aluminum. This would mean, if aluminum is ⅓ as hard as copper, that the aluminum area engaged should be approximately three times the copper area engaged.

The spacer slug 18 is quite thick, particularly at the side edges, in order to provide adequate space between the aluminum cable and the copper wire. In addition, the down-turned ends 19 and 20 hold the wire 11 away from the cable 12 to further insure adequate spacing to avoid direct galvanic action. The relative positions of aluminum and copper, as given in the electro-chemical series by some writers, is minus 1.34 for aluminum and plus .5 for copper. Zinc is in between copper and aluminum at minus .7, and tin is still closer to copper at minus .1. It is well-known that zinc and copper or aluminum and copper make a very good battery. Since the flow of current inside the battery is to the copper, we know that copper which is too closely associated with either zinc or aluminum in an outside wire plant will tend to set up galvanic action and the aluminum or zinc will be gradually sloughed away by this action. This action, which would naturaly be expected in the outside plant, has been observed generally.

Various attempts have been made to avoid injury to the aluminum conductors when associated with copper in outside locations where changing weather conditions may provide the necessary moisture to set up galvanic action. However, such examples as I have seen do not satisfactorily protect the aluminum conductor. I have found that combining elements having a difference of about six points in the electro-chemical scale does not result in any ill effects. For example, tin or solder may be joined with either copper or galvanized iron without any ill effects. The difference between tin and either zinc or copper in the electro-chemical scale is about .6, or in other words, six points. Yet if copper is electro-plated with zinc or cadmium, the copper will "eat up" the coating in anywhere from a few months to a few years, depending upon the weather conditions. Thus elements having six points difference in the electro-chemical series can be satisfactorily used together in the outside plant while those having ten or twelve points or more difference are unsatisfactory.

Now in order to obtain a satisfactory connection between copper and aluminum, in the present connector the split bolt 10 is of aluminum. Therefore direct contact of the aluminum conductor with it will do no harm. The spacer slug 18 must come in contact with the aluminum cable 12, the split bolt 10 and the copper wire 11. In order to have about six points drop between the spacer slug and the aluminum cable 12, and at the same time have a spacer slug that the copper wire can be properly connected to, the spacer slug is made of copper. It is first tin or solder coated and then electro-zinc plated. The contactor slug is also made of copper or bronze and coated first with tin or solder and then electro-zinc plated.

When the connector is used to clamp a copper wire to an aluminum cable as shown in the drawing, the aluminum cable is clamped between the large aluminum surface 17 of the split bolt head and the zinc surface 21 of the spacer slug 18. Since aluminum and zinc are fairly close in the electro-chemical series, (minus 1.34 for aluminum and minus .7 for zinc) they may be placed in direct contact without setting up appreciable galvanic action.

The copper wire 11 is clamped between the spacer slug 18 and the contactor slug 24. The zinc on the adjacent surfaces of both slugs will slough away for a slight area which will do no harm. The copper wire will then have the tin or solder surface next to it and no appreciable galvanic action will take place between the copper wire and the slugs 18 and 24. It is evident that in the completed connection a wide spacing is maintained between aluminum and copper. Furthermore, the spacer slug is so shaped that it is impossible for the lineman to insert the copper wire between the slugs and allow it to remain near the aluminum cable.

The connector just described provides for the transmission of the necessary pressure upon the copper tap for good electrical connection through a large area of the softer aluminum. The shape and thickness of the spacer slug is such that there is no danger of galvanic action between the aluminum conductor and the copper tap wire. Furthermore, the solder and zinc coatings over the slugs gives a zinc surface in contact with the aluminum and an under coating which, when the zinc is sloughed away next to the copper tap, is such that it lives well in the weather with the copper.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A split bolt connector comprising in combination, an aluminum bolt having spaced threaded shanks, an aluminum nut threaded to receive the shanks, a spacer slug fitted beween said shanks, a contactor slug rotatably held by said nut and slidable between the shanks, said slugs having centers principally of copper and being coated with a layer of tin next to the copper and a layer of zinc over the tin.

2. Means for connecting copper conductors to aluminum conductors comprising a metallic clamping device, the material of which occupies a position in the electro-chemical series of metals within about .6 of aluminum, a pair of slugs held by said device in position to separate the copper conductor from the aluminum and from said device, said slugs having an outer metal layer for engagement with the aluminum conductor and the clamping device whose position in the electro-chemical series of metals is within about .6 of aluminum and an inner metal layer whose position in the electro-chemical series of metals is within about .6 of copper and within about .6 of said outer layer.

3. Means for connecting copper conductors to aluminum conductors comprising a metallic clamping device, the material of which occupies

a position in the electro-chemical series of metals within about .6 of aluminum, a pair of slugs held by said device in position to separate the copper conductor from the aluminum and from said device, said slugs having an outer metal layer for engagement with the aluminum conductor and the clamping device whose position in the electro-chemical series of metals is within about .6 of aluminum and an inner metal layer whose position in the electro-chemical series of metals is within about .6 of copper and within about .6 of said outer layer, one of said slugs being held between the conductors by said device and having end portions turned toward one of the conductors whereby to force the conductors apart as they leave the device.

4. Means for connecting copper conductors to aluminum conductors comprising a metallic clamping device, the material of which occupies a position in the electro-chemical series of metals within about .6 of aluminum, a pair of slugs held by said device in position to separate the copper conductor from the aluminum and from said device, said slugs having an outer metal layer for engagement with the aluminum conductor and the clamping device whose position in the electro-chemical series of metals is within about .6 of aluminum and an inner metal layer whose position in the electro-chemical series of metals is within about .6 of copper and within about .6 of said outer layer, the cores of said slugs being composed principally of copper.

WALLACE COOK.