Nov. 20, 1956 O. A. VORDTRIEDE 2,771,591

ELECTRICAL DRAWBOLT TYPE CONNECTOR WITH CONSTANT LOAD WASHER

Filed May 25, 1953

FIG. 1.

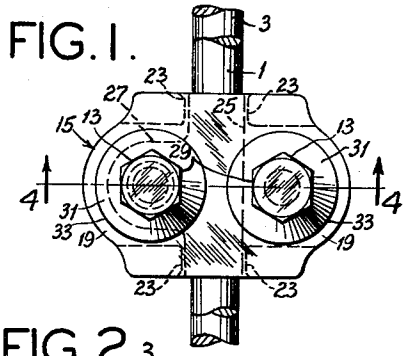


FIG. 2.

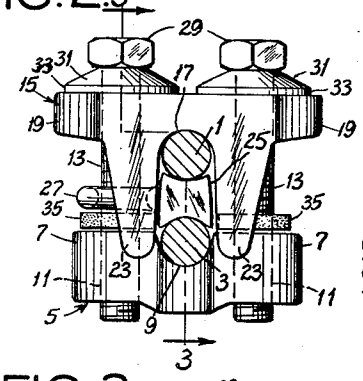


FIG. 3.

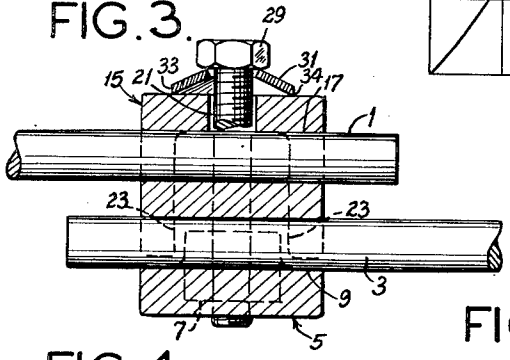


FIG. 4.

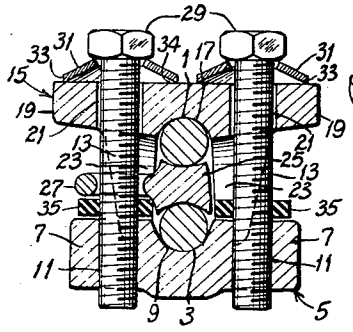


FIG. 5.

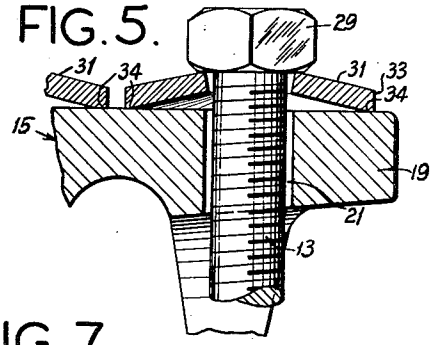


FIG. 7.

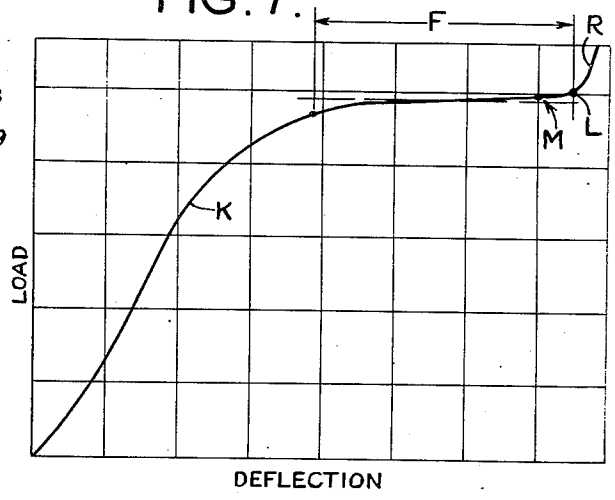


FIG. 6.

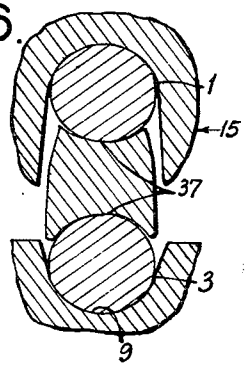
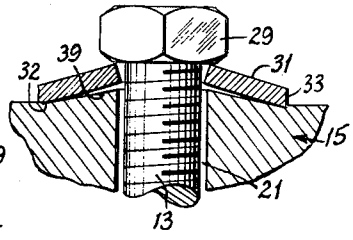


FIG. 8.



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United States Patent Office 2,771,591 Patented Nov. 20, 1956

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ELECTRICAL DRAWBOLT TYPE CONNECTOR WITH CONSTANT LOAD WASHER

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Application May 25, 1953, Serial No. 357,323

3 Claims. (Cl. 339—263)

This invention relates to connectors, and more particularly to aluminum connectors for aluminum conductor wires and the like.

Among the several objects of the invention may be noted the provision of an aluminum connector for use in connecting aluminum line wires which will minimize electrolytic corrosive action on, and which will have substantially the same coefficient of expansion as, such wires; the provision of a connector of the class described which is adapted to minimize loss of contact pressure due to the relatively large creep factor of such wires; and the provision of a connector of the class described which is economical to produce and foolproof in operation. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, the invention comprises a connector having jaws or clamps for receiving wires to be connected. These are forced together by draw members in the form of threaded bolts. Under the compressing portion or head of each bolt is located a so-called Belleville-spring tensioning washer. This, unlike an ordinary spring or spring washer, does not follow Hooke's straight-line law of load-deflection relationship. In the case of an ordinary tensioning device, deflection is proportional to load. Therefore, if a contact pressure being held by such an ordinary device should relax, the follow-up pressure is rapidly reduced as the device expands. The result, in the case of a wire connector employing bolts and ordinary spring washers or tensioning devices, is a loss of all or considerable contact pressure, particularly in cases of wire having a high creep factor, such as aluminum wire. The difficulty is aggravated if no springs at all are used in connection with the bolt or bolts used for tightening purposes.

The Belleville-spring washers used according to the present invention have a load-deflection curve in which the load-deflection relationship does not follow Hooke's law and wherein beyond a certain rising knee portion the load does not substantially change with deflection over a desired range. Beyond this range the curve generally again rises steeply. The washers are arranged so that, when deflecting a substantial amount, their load-deflection condition corresponds to a point beyond said knee portion and on the more or less (not necessarily exactly) flat portion of the load-deflection curve. Preferably a suitable stop is provided which limits washer deflection, such that its load-deflection condition remains on said substantially flat portion of the curve, i. e., is not on said steeply rising portion. Then the force on the draw member may be reduced a predetermined amount so that the condition still corresponds to a point on the substantially flat portion of the curve (beyond the knee) while allowing washer movements in response to wire and connector size variations caused by temperature changes or the like.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

Fig. 1 is a plan view of the invention as preliminarily applied to a pair of solid aluminum wires;

Fig. 2 is a front elevation of Fig. 1;

Fig. 3 is a vertical section taken on line 3—3 of Fig. 2;

Fig. 4 is a vertical section taken on line 4—4 of Fig. 1;

Fig. 5 is an enlarged cross section of a fragment of Fig. 4, illustrating the final position of a Belleville-spring washer employed according to the invention;

Fig. 6 is a fragmentary view showing a tendency of connected wires to deform at their regions of contact;

Fig. 7 is a theoretical load-deflection chart illustrative of certain features of the invention; and,

Fig. 8 is a fragmentary view similar to Fig. 5, showing an alternative form of the invention.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings. It will be understood that the drawings are in part diagrammatic so far as are concerned showings of threads, washer thicknesses and cross hatching. The wires, although being shown as solid in cross section (and such may be used), may each also be of the strand type, including, if desired, one or more steel strands in addition to the aluminum strands (sometimes referred to in the art as an "aluminum-cable steel-reinforced" wire).

Referring now more particularly to the drawings, there are shown at numerals 1 and 3 a pair of solid aluminum wires to be connected. At numeral 5 is an aluminum jaw of cruciform shape in plan, having sideward lugs 7 and a central cradle portion 9 for one of the wires 3. The lugs 7 contain threaded openings 11 for the reception of threaded bolts 13 composed, for example, of stainless steel or cadmium plated steel.

A second jaw of the connector is shown at 15. It also has a cradle portion 17 and sideward lugs 19, the latter containing unthreaded openings 21, each sized for the fairly loose passage of one of the bolts 13. Extending from the lugs 19 are guide fingers 23. These fingers 23 engage opposite sides of the lugs 7 and cradle 9 to maintain alignment. Between the jaws is located a pressure bar 25, having an eye 27 loosely surrounding one of the bolts 13, but it will be understood that, if desired, another duplicate eye (not shown) and like 27 may be provided on the opposite side of the pressure bar 25, surrounding the opposite bolt 13.

Each bolt 13 has a head 29 beneath which is located a special frusto-conical Belleville-spring washer 31. The frusto-apex of each washer 31 is contacted by the lower surface of the respective head 29. The lower skirt portion of each washer preferably has cylindric sides, as indicated at 33. The lower edge of the skirt preferably has a slight flat, forming a seating portion 34. The threaded shank of each bolt loosely fits within the hole of its respective washer. Surrounding each bolt 13 (between members 5 and 15) is a tightly fitting rubber washer 35 which acts to hold captive the respective bolt 13 and washer 31 with the jaw 15 when the bolts are unthreaded from the jaw 5. The washer 35 on the bolt 13 that passes through eye 27 also holds captive with this assembly the pressure bar 25.

A Belleville-spring washer such as 31, as is known in the art, may be designed to approximate a characteristic load-deflection curve as exemplified in Fig. 7, having a relatively steeply rising knee portion K from the origin, and then a relatively (although not necessarily exactly) flat portion F, with finally the rise as shown at R. Thus when such a washer is in the undeflected shape, such as shown in Figs. 1–4 (bolts 13 not tightened) conditions are as indicated at the origin of the curve in Fig. 7., i. e., there is no load and no deflection on the respective washer 31. Then as each bolt is tightened, the washer deflects (flattens) until an intermediate position such

as shown in Fig. 5 is reached. This corresponds to a location on the load-deflection curve such as shown, for example, at L. This condition results in tightening the wire contact, as indicated at **37** in Fig. 6. Then if relaxation should occur in the material of the wires **1** and **3**, there will be a follow-up pressure, for as the deflection in each washer **31** decreases, the load is fairly well maintained, instead of falling off, as would be the case if no washers were used under the bolt heads **29**, or if ordinary loading springs or spring lock washers were used, or none at all.

The conditions such as shown in Fig. 5 and indicated by the load and deflection at L in Fig. 7 may be ascertained by employing a suitably calibrated torque-indicating wrench on the heads **29**. However, in order to avoid the necessity for such a wrench, the arrangement shown in Fig. 8 may be employed, wherein the surface of the jaw **15** under the washers **31** may be provided with a conical backstop **39**. This allows an operator to use an ordinary wrench and turn down upon a bolt head **29** with enough force to bring the respective washer against the stop **39** without forcing the load-deflection point beyond L on the load-deflection curve and without exceeding the elastic limit of the washer. Then each bolt may be backed off a predetermined amount such as a half-turn to obtain the clearance as shown in Fig. 8, which allows the washer to function as stated. After backing off, the conditions on the curve of Fig. 7 may be as shown at M. This backing off allows slight washer deflection toward the stop in response to such pull on its draw bolt **13** as may be caused by heating and expansion of the wires or connector parts while in use. Such action tends to shift M towards L in Fig. 7. It will be understood that, although the stop such as shown at **39** in Fig. 8 is of conical form, it may also be constituted by a simple rim around the upper end of the opening **21**.

In some cases Belleville-spring washers may be designed not to exceed the elastic limit when flattened or almost flattened and at the same time to arrive at a point such as indicated at L on the load-deflection curve (Fig. 7). In such cases the stop such as shown at **39** in Fig. 8 is unnecessary under a washer and the flat or substantially flat surface shown in Fig. 5 may be employed.

Most Belleville-spring washers may be designed to function as above stated without the necessity for confining their peripheries, the peripheries providing self-confinement. In the case of those requiring such confinement, it may be provided for by eliminating the flat **34** and allowing the resulting knife edge to press into the aluminum base of the jaw **15**. Or a small pre-machined groove may be employed for receiving the lower edge of the washer. This is shown by way of example at **32** in Fig. 8.

It will be understood that the washers **31** must be composed of a suitable spring material such as spring steel, Phosphor bronze, beryllium copper or the like, having a high elastic limit, since the internal stresses set up in washers of this type are considerable. It will also be understood that the inside diameters of the washers, being such that the bodies of the bolts **13** pass freely through them, allow free flattening movements without interference between the insides of the washers and the threaded bolt shanks.

The connector members **5**, **15** and **25** are preferably composed of cast aluminum being designed with sufficiently large sections so as to have little creep. Thus, corrosion from electrolytic action between them and the aluminum wires is avoided. However, they may also be composed of other materials such as steel, copper, bronze, et cetera, if corrosive conditions are nil, or to match like materials of which the wires may be made.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A wire connector assembly comprising two clamp means adapted to receive between them wire to be connected, at least one drawbolt means, said drawbolt means including a compressing portion adapted upon rotation of an element thereof to force said clamp means together upon the wire, a concave frusto-conical spring washer located around the draw-bolt means and also between said compressing portion and one of the clamp means, said washer being characterized in that it has a load-deflection curve including a substantially flat portion over which the load does not substantially change for a substantial range of deflection of the spring washer, whereby the washer may be forced by said compressing portion to a deflection under which relaxing wire movement may occur under a substantially constant pressure on the wire.

2. A wire connector made according to claim 1, including stop means under the concave portion of the washer adapted to limit its deflection to a point short of flattening, such that when the washer is deformed against said stop means load and deflection values are positively limited so as not to exceed the maximum of said values as indicated on said substantially flat portion of said curve.

3. A wire connector made according to claim 1, wherein the clamp means engaged by the washer is provided with a recess for receiving the washer and in response to deflection of the washer radially confining the outer marginal portion thereof.

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