Sept. 1, 1953 R. T. ROTH 2,651,026

S-SHAPED ELECTRICAL CONNECTING AND CLAMPING STRAP

Filed Jan. 24, 1950

FIG. 1.

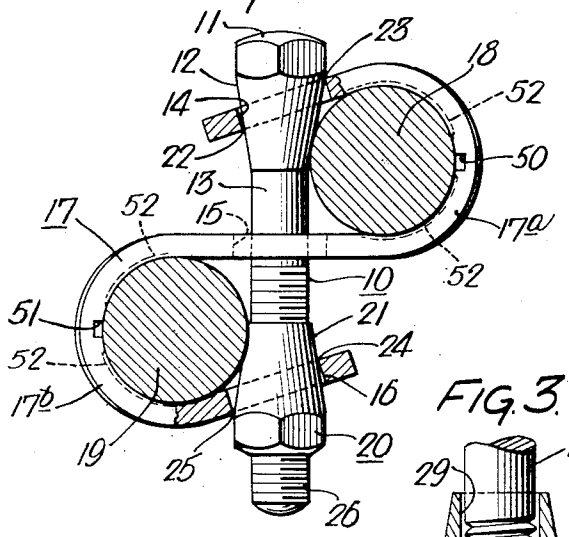


FIG. 2.

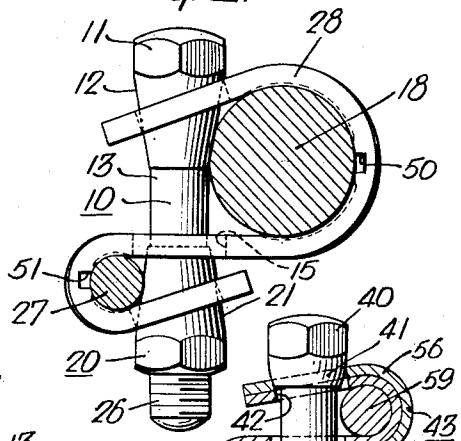


FIG. 3.

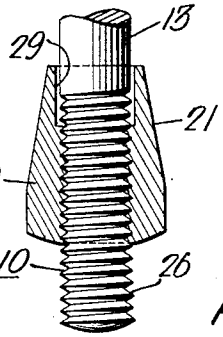


FIG. 5.

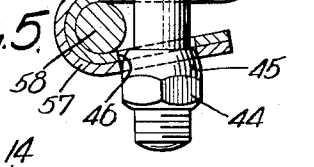


FIG. 4.

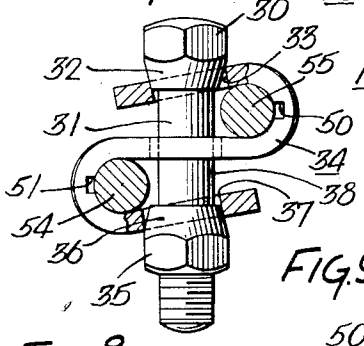


FIG. 6.

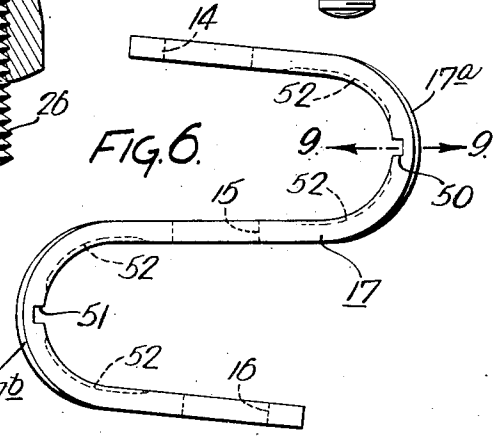


FIG. 9.

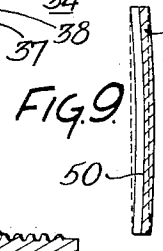


FIG. 8.

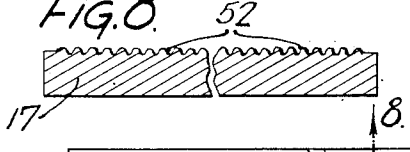
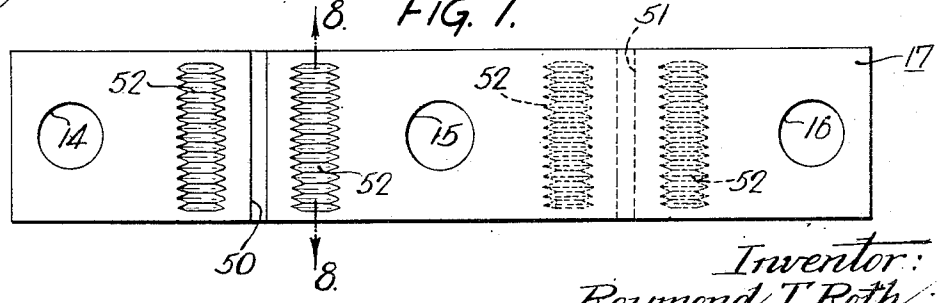


FIG. 7.



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2,651,026

S-SHAPED ELECTRICAL CONNECTING AND CLAMPING STRAP

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Application January 24, 1950, Serial No. 140,275

6 Claims. (Cl. 339—246)

1

This invention relates to clamps for connecting two objects to each other by means of pressure applied through a bolt and nut. A clamp or connector constructed in accordance therewith is especially adapted for use between electrical cables or conductors and is an improvement in the connector described in my copending application Serial No. 735,624, filed March 19, 1947, now abandoned.

A primary object of the present invention is to provide an improved nut and bolt construction for a clamp assembly.

A further object of the invention is to provide an improved electrical connector adapted particularly to join two electrical conductors of different diameters.

A further object of the invention is to provide an electrical connector of the class described, having one or more parts which may be used to interchangeably connect conductors of widely different sizes.

A further object of the invention is to provide an electrical connector of the class described, which has improved gripping features between the clamp and the conductors.

A further object of the invention is to provide in an electrical conductor of the class described, a clamp having increased electrical contact surface between the clamp and the conductors.

A still further object of the invention is to provide a clamp of the class described which may be more readily installed and in which the torque necessary to provide suitable electrical contact is controlled within desired limits.

A still further object of the invention is to provide an electrical connector of the class described, having an improved construction for the nut and bolt head.

A still further object of the invention is to provide a clamp between electrical conductors of different metals in which any electrolytic action between the clamp and the conductors is reduced to a minimum or eliminated.

Further objects will be apparent from the specification and drawings in which:

Fig. 1 is a side view showing one form of my improved clamp connector used between conductors of substantially the same diameter;

Fig. 2 is a view similar to Fig. 1, but showing a modified connector suitable for use between conductors of considerably different diameters;

Fig. 3 is a transverse section of the nut shown in Figs. 1 and 2;

Fig. 4 shows a clamp similar to Fig. 1 used between two conductors of substantially equal but

2

smaller diameters, and employing a modified nut and bolt head;

Fig. 5 is a view similar to Fig. 4, showing a bi-metallic strap for the clamp;

Fig. 6 is a side view of the strap shown in Fig. 1 before installation on the conductors;

Fig. 7 is a developed view or flat plan of the strap shown in Fig. 6;

Fig. 8 is a transverse section as seen at 8—8 of Fig. 7; and

Fig. 9 is a transverse section as seen at 9—9 of Fig. 6.

The invention comprises essentially the provision of an S-shaped strap or band having an aperture or hole at either end and a central aperture which, when the strap is formed into the desired S-shape, is substantially in alignment with the holes in the ends of the strap. For an electrical connector, the strap is made of an electrically conductive material such as copper, which may be provided with suitable serrations for improved electrical contact between the strap and one or both electrical conductors. Also, I prefer to form the strap so that it is outwardly convex both transversely and longitudinally at the apex of each bend. A transverse slot may be milled or otherwise provided on the inside or concave portion of the bend to assist in the tightening of the strap and to insure ample electrical contact. The strap, if desired, may be of a bonded bi-metallic construction of metals such as copper and aluminum, in order to inhibit any electrolytic action therebetween. It is desirable that the diameter of the center strap hole be large enough to clear at least one-half of the tapered face of the nut. Also, the nut as well as the bolt head may be provided with a relatively short conical or semi-spherical face to prevent bottoming on the threads and also to permit the use of a partially smooth shank on the bolt.

The connector or clamp assembly described herein incorporates several innovations which are directed to the problem of securing proper and adequate pressure between the objects that are clamped together. While my clamp is primarily intended for use between electrical conductors, it will be understood that it may also be utilized to join bars, tubes, or rods for any purpose whatsoever.

Referring now more particularly to the drawings, a clamp constructed in accordance with the present invention comprises a bolt 10 having a hexagonal head 11 and a tapered frusto-conical surface 12 between the bolt head 11 and the bolt shank 13. The bolt 10 is inserted through holes

14, 15 and 16 in an S-shaped strap 17 to connect, for example, a pair of electrical conductors 18 and 19 which are enclosed by the bends 17a and 17b of strap 17. A nut 20 having an elongated frusto-conical face 21 is drawn up on bolt 10 so that a wedging action takes place between face 21 of nut 20 and conductor 19, as well as between face 12 of bolt head 11 and conductor 18. The diameter of holes 14 and 16 is such that the face 12 of bolt head 11 and the face 21 of nut 20, extend substantially halfway into these holes. Consequently, as the ends of strap 17 are drawn around conductors 18 and 19, face 12 bears on opposite edges 22 and 23 of hole 14, and face 21 bears on opposite edges 24 and 25 of hole 16 so that there is a continuous and ample contact area between the strap 17 and both the bolt head and the nut, regardless of the amount that the nut may be run onto the threads 26 of the bolt.

The strap 17 shown in Figs. 1, 6 and 7, may be used to clamp objects having somewhat different diameters. However, in the event that it is desired to connect objects of widely different diameters, it will be desirable to relocate one or more of the holes in the strap, as shown in Fig. 2. In this event, the nut 20 will of course, run onto threads 26 a greater distance than shown in Fig. 1, to obtain the desired tight wedging action between the small object or conductor 27 and the nut 20. In order to reduce the number of different parts that may be required to connect objects of different diameters, I have provided the nut 20 with a counterbore 29 (Fig. 3) so that it may be turned well onto the bolt 10 before bottoming on the unthreaded shank 13. The cost of providing threads on shank 13 of the bolt substantially all the way up to the tapered face 12, has been found to be prohibitive either with a rolled or with a cut thread, so that threads 26 terminate a substantial distance short of the face 12. This improved construction of the nut provides an ample tapered surface for wedging the conductor over a wide variety of conductor sizes, and also permits a substantial reduction in cost to be achieved by eliminating expensive and unnecessary threading on the bolt shank. Furthermore, the unthreaded portion of the nut serves as a guide that enables the nut to be readily started on the bolt threads with a minimum of effort and lost time due to dropping. Due to the fact that linemen ordinarily wear cumbersome rubber gloves, this thread-starting feature of the nut is quite beneficial.

In addition to the counterbore referred to above, a center strap hole 15 is of sufficient diameter to permit the minimum diameter of the leading edge of nut 20, to enter the center hole in the event that the nut must be turned on the bolt unusually far in order to securely clamp one of the conductors.

Figs. 4 and 5 illustrate a slightly modified nut and bolt construction which may be employed with objects of relatively small diameter. Referring to Fig. 4, head 30 of bolt 31 has a frusto-conical face 32 similar to the face 12 of bolt head 11 but which is relatively shorter and which does not extend so far through the end strap hole 33 of strap 34. Likewise, the nut 35 used in conjunction with bolt 31 has a relatively short frusto-conical face 36 which seats in the end strap hole 37. In both cases, the minimum diameter of the tapered faces is only slightly less than the diameters of the holes 33 and 37 so that the faces at most extend only slightly through the holes. Nut 35 may also, if desired, be counterbored in the same manner as shown in conjunction with nut 20 so that the nut may be partially run over the unthreaded shank 38 of bolt 30.

Fig. 5 shows another modified bolt and nut configuration. In this case, the bolt head 40 has a semi-spherical face 41 which seats completely in the end strap hole 42 of strap 43. Nut 44 likewise has a semi-spherical face 45 which seats in the end strap hole 46. As in the case of Fig. 4, the minimum diameter of faces 41 and 45 is only slightly less than the diameter of holes 42 and 46. This insures that full contact between the strap and the bolt head, and between the strap and the nut, takes place at all times. It will be apparent that the size of the end strap holes, as well as the length and slope of the faces on the nuts and bolt heads, all cooperate to produce the desired result. The combined proportions however, should be such that the bolt head and nut when tight float in the strap, thus providing excellent electrical and/or mechanical contact with the clamped objects either with or without the wedging action.

Particularly in the case of an electrical connector, I provide the straps 17 and 28 with transverse slots or grooves 50 and 51 on the inside of the bends. These slots are preferably narrower than the diameter of a single strand of the cable to be used for any of the conductors 18, 19, 27, 54 or 55. The depth of either slot 50 or 51 may be as great as one-half the thickness of the strap since it is only necessary that one-half the current flow past the slot, the other half being transferred from the cable to the strap in the cable area between the slot and aperture 15. Since the cross-sectional area of the strap has been substantially reduced at slots 50 and 51, the torque required to tighten the nut is correspondingly reduced. Thus, with a given amount of torque, greater wedging action and a better electrical connection are achieved.

When straps are pressed by the forming dies into the shape shown in Fig. 6, they may also be provided with serrations or grooves 52, 52 which tend to bite into the conductors and therefore to improve the electrical connection between the conductors and the strap. In addition, the bends of the straps may be transversely and outwardly convex (as shown in Figs. 1, 2, 4, 6 and 9) so that there is no tendency for the strap to bow outwardly at or near grooves 50, 51 when the nut is tightened. This convexity enhances the electrical connection between the conductors and the strap because otherwise the lateral edges of the strap tend to pull away from the conductors as the nut is drawn up. In other words, the strap and the conductor have their maximum areas under pressure contact.

The present clamp construction also lends itself remarkably well to the elimination of undesired electrolytic action when the clamp is used to connect electric conductors of different metals. When the connector is installed outdoors or where moisture is prevalent and therefore conducive to electrolysis, I have found that a special bi-metallic strap 43 for my clamp enables an especially beneficial result to be realized. In this form for example, a layer 56 of copper and a layer 57 of aluminum may be employed. It will be noted that the copper portion 56 of the strap is in contact with one conductor 58 and with bolt head 40 (as shown in Fig. 5). Similarly, the aluminum layer 57 of the strap is in contact with the other conductor 59 and with the nut 44. For optimum results of course,

the strap layer and the conductor with which it is in contact, should be of the same metal, so that in Fig. 5 conductor **59** is aluminum and conductor **58** is copper. These two metals are cited by way of example only, since other materials may be used with comparable results. It will thus be understood that all flow of electrical energy from one metal to a different metal takes place in the strap itself and the straps may be satisfactorily bonded in manufacture to reduce or avoid electrolysis. "Alcuplate," a product of the General Plate Division of Metals & Controls Corporation, is an example of such a bi-metallic bonded material.

It will therefore be understood that I have provided an extremely satisfactory clamp for tightly clamping objects such as conductors. The clamp is relatively inexpensive to manufacture, is adapted to be utilized for a wide range of diameters, and the torque necessary to insure a suitably strong connection is relatively small, so that it is well within the Underwriters' Laboratory requirements for clamp connectors. The shape of the strap enhances the ability to obtain full contact between the bends of the strap and the conductors. Also, the use of a bonded bimetallic strap which has an "S" configuration, is ideal for electrically uniting conductors of different materials. The construction of the bolt and nut is so designed that excellent contact under clamping conditions with a minimum of torque is provided even though the shank of the bolt is not completely threaded and also in the event that the nut must be turned relatively far onto the threaded portion.

Having thus described my invention, I claim:

1. A clamp assembly for joining a pair of electrical conductors and the like, comprising an S-shaped metal strap to extend about and embrace the conductors, said strap having an aperture in each end portion and an aperture in its central portion, the aperture in each end portion being defined by a circular wall extending perpendicularly to the faces of the strap, a bolt for insertion through said apertures having a threaded shank freely insertable through the apertures and a tapered portion engageable with the wall defining one of the end apertures, and a nut threadedly engageable with said shank and having a tapered portion engageable with the wall defining the other end aperture, whereby tightening of the bolt and nut causes oblique positioning of the end portions of the strap relative to the axes of said tapered portions and effects biting line contact of each tapered portion with the associated wall completely about the tapered portion.

2. A clamp assembly according to claim 1, wherein each of the oppositely-facing bends of the S-shaped strap is provided on its inside with a transverse groove to increase the flexibility of each bend and thus enable easier tightening of the bolt and nut.

3. A clamp assembly according to claim 1, wherein each of the oppositely-facing bends of the S-shaped strap is outwardly convex transversely of the strap to effect better contact of the strap with each of said conductors.

4. A clamp assembly according to claim 1, wherein each of the oppositely-facing bends of the S-shaped strap is provided on its inside with serrations which bite into the associated conductor and thus effect better contact therewith.

5. A clamp assembly according to claim 1, wherein said nut has an unthreaded bore extending inwardly from the smaller end of the tapered portion of the nut, said bore being of larger diameter than the threaded shank of the bolt, whereby the tapered portion of the nut may be projected inwardly beyond the thread on the bolt shank.

6. A clamp assembly according to claim 1, wherein said strap is composed of two different metals to prevent electrolytic action.

RAYMOND T. ROTH.

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