March 1, 1966 J. C. LANIUS, JR 3,238,495

ELECTRICAL CONNECTOR

Filed April 17, 1964

PRIOR ART

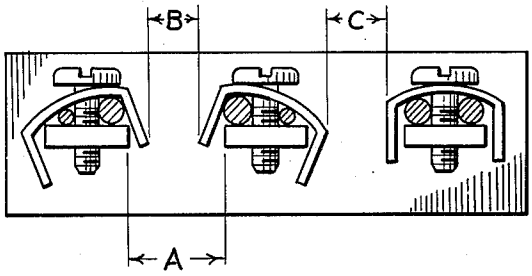


Fig. 1

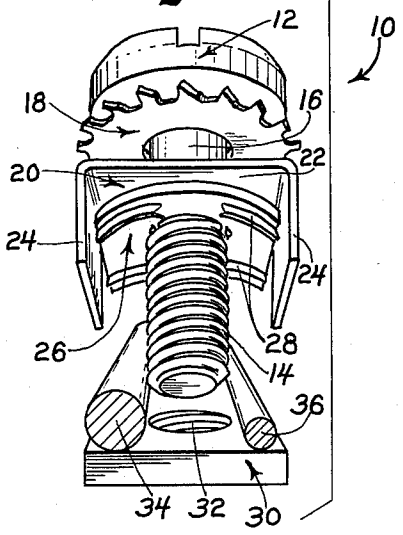


Fig. 2

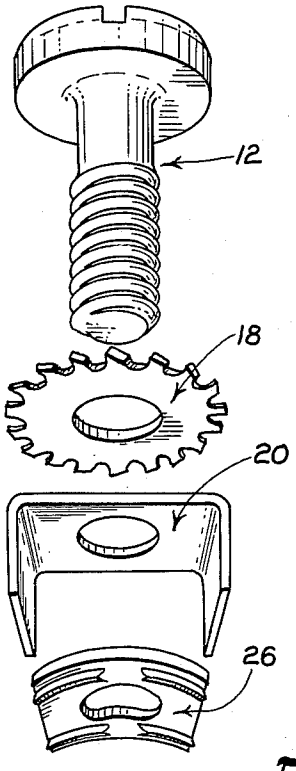


Fig. 3

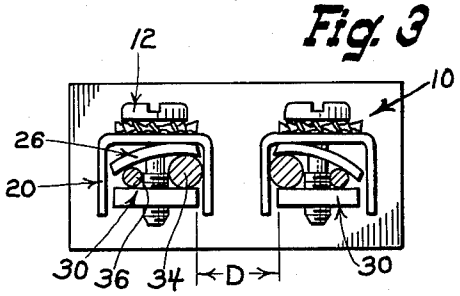


Fig. 4

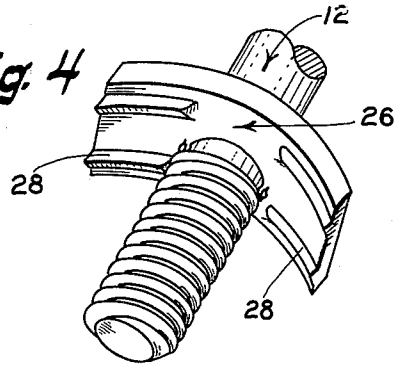
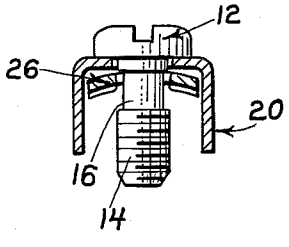


Fig. 5



INVENTOR.
James C. Lanius, Jr.
BY Robert W. Beart
His Att'y

United States Patent Office 3,238,495 Patented Mar. 1, 1966

3,238,495

ELECTRICAL CONNECTOR

James C. Lanius, Jr., Elgin, Ill., assignor to Illinois Tool Works Inc., Chicago, Ill., a corporation of Delaware

Filed Apr. 17, 1964, Ser. No. 360,550
10 Claims. (Cl. 339—246)

This invention relates to an electrical connector or terminal clamp for removably securing the end of a conductor to a workpiece, and more specifically, it relates to those types of connectors or clamps which are adapted to be utilized with terminal blocks as they are called in the trade, bus bars, circuit breakers, and the like.

In a typical terminal block assembly, there is provided a plurality of elongated terminal blocks at predetermined distances from one another, each being adapted to receive at least one conductor element which is connected thereto by a terminal clamp or electrical connector. If a predetermined distance between terminal blocks is not maintained, the air gap between adjacent terminals, under certain conditions, may readily carry a current, and thus cause an undesirable electrical arc between the terminals.

This problem becomes further complicated by the fact that it is sometimes necessary to clamp two different sized conductors to a terminal block at the same time. In such an instance, the terminal clamp or electrical connector must be able to accommodate and efficiently clamp different sized conductors without requiring greater separating distances between adjacent terminal blocks. There are, of course, various types of rocking terminal clamps or electrical connectors which will accommodate a plurality of conductors of different size, while also maintaining a predetermined distance between terminal blocks, but these types of terminal clamps do not longitudinally and transversely restrain the conductors in an effective manner.

One type of electrical connector with a rocking feature which will clamp different sized conductors, while also effectively restraining movement away from the terminal blocks, is well known in the art. These types of terminal clamps have a U-shaped clip which rocks about the axis of its associated fastener for efficiently clamping different sized conductors at the same time. One major difficulty with these rocking U-shaped clips is that they require the terminal blocks to be spaced apart a greater distance than that necessary for those varieties of rocking clamps, referred to above, which are not always able to effectively clamp the conductors to the terminal blocks. This is due to the fact that the legs of the U-shaped clip have a tendency to close the distance between the terminal blocks during their rocking movement, and thus increase the likelihood that an electrical arc will be established. The present invention overcomes these above noted difficulties since it will not only assure the maintenance of a minimum distance between the terminal blocks, but will also make certain that the same or different size conductors will be efficiently clamped to each terminal block.

Accordingly, it is an object of the present invention to provide a new and improved terminal clamp or electrical connector for efficient pressure clamping of at least one electrical conductor to a terminal block, bus bar, or the like, and thereby insure a good electrical connection.

Another object of the present invention is to provide a terminal clamp or electrical connector for accommodating and clamping the same or different sized conductors while preventing longitudinal and transverse movement thereof.

A still further object of the present invention is the provision of a terminal clamp or electrical connector which in addition to the aforementioned objects, permits adjacent terminal blocks to be maintained at predetermined minimum distances to one another without the need to compensate for the structure and operation of the connecting or clamping device.

Another object of the present invention is to provide a terminal clamp which will assure that an electrical connection is established with metal conductors even though they may be insulated.

Still a further object of the present invention is the provision of a terminal clamp which is simple in construction, made of a minimum number of parts, and which may be readily assembled and disassembled from its associated terminal block.

Other objects and advantages will become apparent from the following description when taken in conjunction with the accompanying drawings wherein:

The figure designated "Prior Art" is a front elevational view, partly in section, of a plurality of well known terminal clamps or electrical connectors as associated with their respective terminal blocks;

FIG. 1 of the drawings is a perspective view, partially in section, of the terminal clamp or electrical connector constructed in accordance with the principles of the present invention prior to assembly with a plurality of conductors mounted atop a terminal block;

FIG. 2 is an exploded perspective view of the terminal clamp or electrical connector shown in FIG. 1;

FIG. 3 is a front elevational view, partly in section, of the terminal clamp or electrical connector of the present invention as mounted on a typical terminal block assembly;

FIG. 4 is an enlarged fragmentary perspective view showing the undersurface of the clamping plate of the electrical connector as associated with the rotary threaded fastener thereof; and

FIG. 5 is a front elevational view, partly in section, of a modified form of terminal clamp or electrical connector.

Referring now to the drawings, it will be noted that the figure of the drawings designated "Prior Art" illustrates the assembly of a well known terminal clamp or electrical connector to a typical terminal block assembly for releasably securing conductors thereto. Each terminal clamp comprises a rotary threaded fastener, such as a screw or the like, upon which is mounted a U-shaped clip which clamps the end of a plurality of conductors to its respective terminal block. The U-shaped clip is adapted to teeter or tilt about the axis of the screw since the opening formed in the bight end portion thereof is slightly larger than the major diameter of the threaded shank. This type of construction permits the U-shaped clip to accommodate conductors of different size while effectively securing the conductors to the terminal block.

As has been noted above, the major difficulty with this prior art construction is primarily due to the fact that the legs of adjacently positioned U-shaped clips have a tendency to move toward one another, and thus increase the possibility of electrical arcing under certain conditions. As a result, even though the terminal blocks themselves are maintained a predetermined distance apart, the legs of such U-shaped clips will close the gap or spacing between such blocks. To illustrate this, the terminal blocks shown in the well known construction have been placed apart a minimum distance from each other, and this has been designated by the letter "A." When the terminal clamps are positioned into engagement with conductors of different size, the U-shaped clip thereof will reduce this distance "A," and establish a minimum separating distance which has been designated by the letter "B." It is also to be observed that the gap between adjacent terminal blocks will be reduced even though only one of the U-shaped clips has teetered about the axis of

its fastener, and this is designated by the letter "C." The disadvantage of this prior art device has become especially acute in view of present day demands for miniaturized and compact terminal block assemblies.

The present invention overcomes the difficulties encountered with these heretofore existing prior art devices while maintaining the principle advantages thereof. The terminal clamp or electrical connector shown in FIG. 1 of the drawings and designated by the numeral **10** generally comprises a rotary threaded fastener **12**, such as a bolt or screw, having a head, a threaded shank **14**, and a smooth unthreaded portion therebetween, the latter having mounted thereon a toothed lock washer **18**, a U-shaped clip **20**, and a clamping plate **26**. It is preferable, though not necessary, that the lock washer **18**, the U-shaped clip **20** and the clamping plate **26** are preassembled to the rotary threaded fastener. This is generally accomplished by inserting each of these designated parts in successive fashion upon a fastener after the formation of threads thereon and thereafter deforming the aperture of the clamping plate to retain the parts on the fastener. Each of the parts have an opening initially greater than the maximum diameter of the threads formed on the fastener, but after the parts have been assembled on the fastener, the aperture of the clamping plate **26** is deformed to provide at least one transverse dimension which is less than the maximum diameter of the threads on the fastener. The alignment of the parts prior to insertion on the fastener **12** is shown in FIG. 2 of the drawings; FIG. 4 illustrating the manner in which the aperture of the clamping plate is deformed to retain the various parts on the fastener.

This preassembly technique is well known in the art, and further explanation is thus unnecessary. It is to be understood that while this preassembly technique is the preferred form of securing the above designated parts of the electrical connector to the rotary fastener, there are other well known preassembly techniques for accomplishing the same purpose. For example, it may also be possible to roll threads in the fastener having a maximum diameter greater than the clamping plate aperture after the parts have been assembled thereon, but this requires the U-shaped clip **20** to be initially flat, and bent into its final shape only when the thread forming operation has been completed.

The U-shaped clip, as is usual with this type of construction, has a bight end portion **22** and a pair of downturned oppositely disposed flanges or legs **24**. The length and spacing of the legs or flanges **24** is such as to permit accommodation of its associated terminal block therewithin. If the spacing between the legs is only slightly greater than the width of the terminal block, then tilting movement of the U-shaped clip will be hindered to a great degree since the legs will engage the sides of the terminal block.

An aperture is formed in the bight end portion **22** of the clip **20** for accepting the rotary fastener **12** and is preferably centrally located between the downturned flanges **24**. The clamping plate **26** is nestably received between the downturned flanges **24** of the U-shaped clip **20** and is provided with a centrally located aperture which is preferably deformed in the manner shown in FIG. 4 of the drawings for retaining the clamping plate, U-shaped clip, and toothed lock washer on the fastener as has previously been discussed.

It is also desirable that the aperture formed in the clamping plate **26** is of a size which permits the clamping plate to slide upon the smooth unthreaded portion **16** of the fastener and teeter or rock about the axis thereof, even though a portion of the clamping plate aperture has been reduced in size. Conductors **34**, **36** of different size can thus be simultaneously clamped to the terminal block **30** without movement of the U-shaped clip **20**. This will be evident from an inspection of FIG. 3 where it is shown that conductors **34**, **36** of differing diameters will nevertheless be securely retained to the terminal block **30** by the clamping plate **26** via the force applied through the bight end portion of the U-shaped clip **20** and the fastener **12**. The result of this is that the terminal blocks may be maintained at a predetermined minimum dimension without any concern over the possibility that the electrical connectors themselves will reduce the spacing between the blocks. Terminal blocks **30** can thus be positioned at distances closer to one another than the distances which were required when "Prior Art" devices were used as indicated by letter "D" in FIG. 3, to thereby provide a compact terminal block assembly.

It will be observed in FIGS. 3–4 that the clamping plate **26** is concavo-convex in cross section with a downwardly facing concave surface for exerting both a longitudinal and transverse clamping force upon the conductors **34**, **36**. Additionally, the legs **24** of the U-shaped clip **20** act to restrain lateral or transverse movement of the conductors to provide an effective clamping assembly.

While the present invention has been primarily designed to overcome the deficiencies of rocking U-shaped clamps when they simultaneously accommodate conductors of differing size or diameter, it is to be noted that the U-shaped clamps will be maintained in a substantially upright position even if only a single conductor is clamped. In the prior art devices, there was no assurance that the U-shaped clamp would be maintained in a substantially upright position when only a single conductor was secured to the terminal block since external forces could cause the U-shaped clip to rock about the axis of the fastener to the position shown in drawing figure designated "Prior Art." Furthermore, differences in the manufacturing tolerances of the aperture formed in the bight end portion of the clip could increase the likelihood that a portion of the clip would be forced against a terminal block. In the present invention, however, the clamping plate **26** will act to maintain the U-shaped clip **20** in a substantially upright position, and this is so even though the aperture formed in the bight end portion of the U-shaped clip may be comparatively larger than the shank of the fastener since the clamping plate **26** provides underlying support to the U-shaped clip so as to hinder tilting movement thereof when the bight end portion of the clip comes into contact with the clamping plate.

Where the conductors **34**, **36** are coated or wrapped with an insulation material, it has been necessary to remove this insulation material so that the metal surface of the conductors is exposed. To avoid the necessity of stripping insulation material from conductors, the clamping plate **26** of the present invention may be provided with elongated ridges **28** which will pierce the insulating material and provide a good electrical connection with the conductors. These ridges will also grip and restrain the conductors. One form of elongated ridges **28** is shown in FIG. 4 of the drawings; however, it is to be understood that other ridge configurations may also be provided.

To prevent retrograde movement of the electrical connector **10**, the toothed lock washer **18** is preferably preassembled to the fastener in the manner previously described. The angularly inclined teeth of the lock washer **18** will engage the undersurface of the head and create a diagonal bearing force of the threads **14** of the fastener with the threads of the terminal block **30**. It is possible that the electrical connector may be used without such a lock washer, and FIG. 5 of the drawings indicates this by showing only the clamping plate **26** and the U-shaped clip mounted on the smooth unthreaded portion **16** of the fastener **12**.

The terminal block **30** may have its aperture **32** provided with preformed threads, or it may be provided with a smooth wall for association with a fastener **12** of the thread cutting variety. Although the conductors in the drawings are shown as being circular in configuration, it will be obvious that other shapes may be used if desired.

From the foregoing, it will now be apparent that the terminal clamp or electrical connector of the present invention contemplates the maintenance of a predetermined minimum distance between adjacent terminal blocks, while at the same time affording clamping of one or several conductors of the same or different size.

While the preferred embodiments of the present invention have been shown and described herein, it is obvious that many structural details may be changed without departing from the spirit and scope of the appended claims.

1. An electrical connector for removably securing the terminal end of at least one conductor to an apertured workpiece comprising a rotary threaded fastener, clip means having downturned oppositely disposed flanges and an aperture formed therein between said flanges for receiving said rotary threaded fastener, the length and spacing of said downturned flanges of said clip means permitting the accommodation of said apertured workpiece therewithin, and clamping means positioned intermediate said clip means and said apertured workpiece and being nestably received between the downturned flanges of said clip means, said clamping means having an opening aligned with the aperture of said clip means when said clamping means is nestably received between the downturned flanges of said clip means for also accepting said rotary threaded fastener, said clamping means in conjunction with said workpiece forming a passageway therebetween for the acceptance of the end of said conductor, the rotation of said fastener and the mating engagement of the threads thereof with the aperture of said workpiece moving said clamping means in juxtaposed relation to said workpiece to accomplish pressure clamping of said conductor.

2. The electrical connector as defined in claim 1 including means formed on said bolt for retaining said clip and said clamping plate in axially restrained and rotatable relation thereon.

3. An electrical connector for removably securing the terminal end of at least one conductor to an apertured workpiece comprising a U-shaped clip and a terminal clamping plate positioned within said clip each having aligned apertures for accepting a headed rotary threaded fastener, said fastener having a smooth unthreaded portion adjacent the head thereof, said U-shaped clip and said clamping plate adapted to be positioned on the smooth unthreaded portion of said fastener with the legs of said clip extending downwardly in a direction away from the headed portion of the fastener and substantially parallel to the axis thereof, the maximum diameter of the threads on said rotary threaded fastener being greater than at least one transverse dimension of said clamping plate aperture for retaining said U-shaped clip and said clamping plate on the smooth unthreaded portion of said fastener, the length and spacing of the downwardly extending legs of said U-shaped clip permitting the accommodation of said apertured workpiece therewithin, said clamping plate in conjunction with said apertured workpiece forming a passageway therebetween for the acceptance of the end of said conductor, the rotation of said fastener and the mating engagement of the threads thereof with the aperture of said workpiece causing said clamping plate to be positioned in contacting engagement with the end of said conductor to prevent longitudinal and transverse movement thereof and assure a satisfactory electrical connection.

4. The electrical connector as defined in claim 3 including elongated ridges on the clamping surface of said clamping plate for engagement with said conductor.

5. The electrical connector as defined in claim 3 including a lock washer positioned between the head of said rotary threaded fastener and said U-shaped clip to prevent retrograde movement of said electrical connector.

6. A terminal clamp for removably securing the end of at least one conductor to an apertured workpiece comprising a U-shaped clip and a terminal clamping plate each being preassembled to a rotary threaded fastener, said terminal clamping plate being nestably received within said U-shaped clip and adapted to teeter about the axis of said rotary threaded fastener, and said terminal clamping plate in conjunction with said workpiece forming a passageway therebetween for the acceptance of the end of said terminal, the rotation of said fastener and the mating engagement of the threads thereof with the aperture of said workpiece moving said clamping means in juxtaposed relation to said workpiece to accomplish pressure clamping of said conductor and assure a good electrical contact.

7. A terminal clamp for connecting a pair of conductors to a terminal block comprising a rotary threaded fastener having a head and a generally radially extending clamping surface provided on the undersurface thereof, a U-shaped clip having an aperture formed in the bight end portion thereof for accepting said rotary threaded fastener, a clamping plate adapted to be nestably received within the legs of said U-shaped clip and having an aperture aligned with the aperture of said U-shaped clip for also receiving said rotary fastener therein, said U-shaped clip and said clamping plate adapted to be positioned on a smooth unthreaded portion of said fastener adjacent the head thereof whereby the bight end portion of said U-shaped clip is positioned in close proximity to said generally radially extending clamping surface of said rotary threaded fastener, said U-shaped clip having leg portions which extend downwardly toward the unheaded portion of the fastener when mounted thereon, the length and spacing of the legs of said U-shaped clip being such as to accommodate the terminal block therewithin, the maximum diameter of the threads of said rotary threaded fastener being greater than at least one transverse dimension of said clamping plate aperture for axially restraining said U-shaped clip and clamping plate on the smooth unthreaded portion of said fastener, said clamping plate being substantially concavo-convex in cross section and presenting a downwardly facing concave surface for overlying one face of said terminal block, said clamping plate in conjunction with said workpiece forming a passageway therebetween for the acceptance of the end of said conductor, said fastener adapted to be received within the aperture of said terminal block whereby upon rotation thereof, the legs of the U-shaped clip will be positioned over the terminal block and said clamping plate will accomplish pressure clamping of said conductor.

8. The terminal clamp as defined in claim 7 wherein the aperture of said clamping plate is greater than the smooth unthreaded portion of said rotary threaded fastener whereby to cause the clamping plate to teeter about the axis of said fastener for accommodating a plurality of conductors of different size.

9. In combination, a terminal clamp for each of a plurality of terminal blocks to releasably secure at least one conductor to each terminal block and maintain a predetermined minimum spacing between adjacent terminal blocks, each of said terminal clamps comprising a bolt having a head, a threaded shank, and a smooth unthreaded portion therebetween, a U-shaped clip and a terminal clamping plate having aligned apertures for accommodating the shank of said bolt therein, said terminal clamping plate adapted to be positioned within said U-shaped clip for mounting said clip and plate on the smooth unthreaded portion of said bolt shank, said U-shaped clip when mounted on said shank having the legs thereof extending downwardly from the bolt head and substantially parallel to the bolt axis, the maximum diameter of the threads of said bolt being greater than at least one transverse dimension of said clamping plate aperture for assembling said clamping plate and U-shaped clip on the smooth unthreaded portion of said bolt shank, the legs of said U-shaped clip adapted to be positioned over an associated terminal block when said clamping plate is moved into engagement with the end of said conductor resting atop

each of said terminal blocks, each of said terminal blocks having an opening for receiving the threaded shank of the bolt whereby the rotation of the latter accomplishes the pressure clamping of the end of said conductor by way of the terminal clamping plate, the aperture of said clamping plate being greater than the smooth unthreaded portion of said bolt shank whereby to permit said clamping plate to teeter about the bolt axis for accommodating conductors of different size.

10. The terminal clamp as defined in claim **9** wherein the width of each terminal block is not materially greater

than the spacing between the legs of said U-shaped clip whereby to maintain the legs thereof in substantially parallel relation to the bolt axis.

References Cited by the Examiner

UNITED STATES PATENTS

812,287	2/1906	Nagel	339—246 X
3,081,507	3/1963	Gribble	339—246 X
3,173,741	3/1965	Crowther	339—246

JOSEPH D. SEERS, *Primary Examiner.*