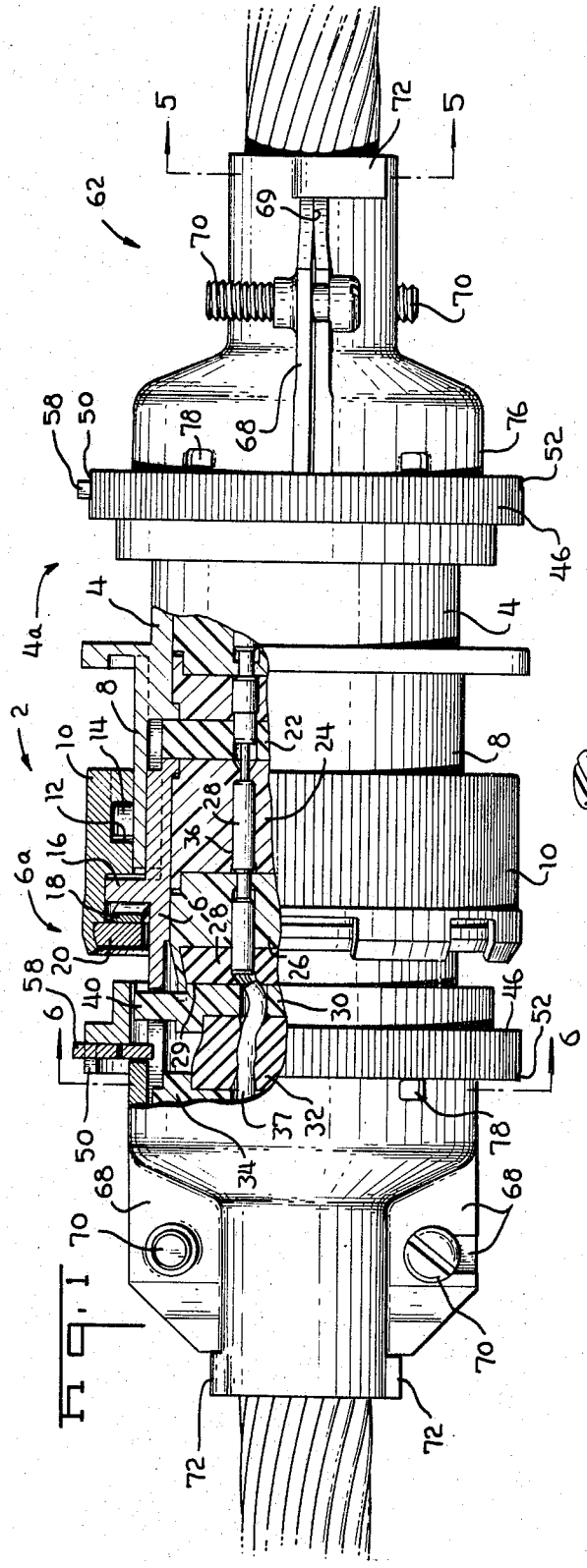
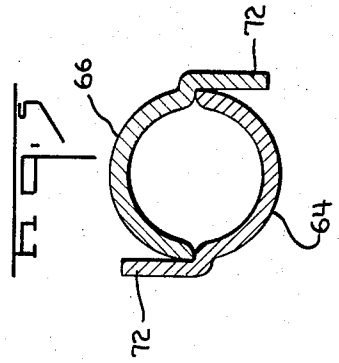
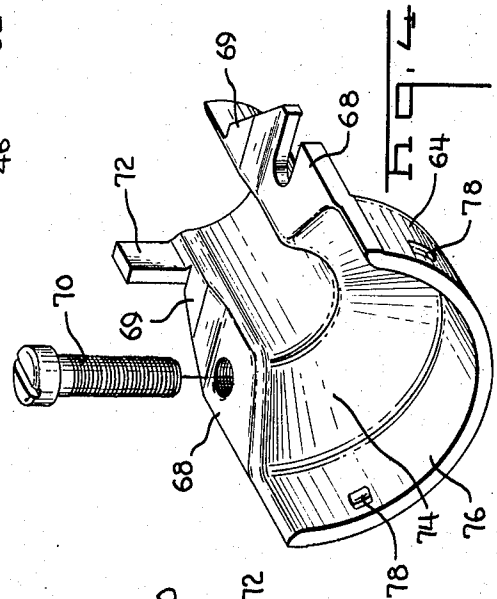
Oct. 24, 1967 C. L. PAULLUS ETAL 3,349,364

CABLE CLAMP FOR ELECTRICAL CONNECTOR

Filed June 9, 1965 2 Sheets-Sheet 1







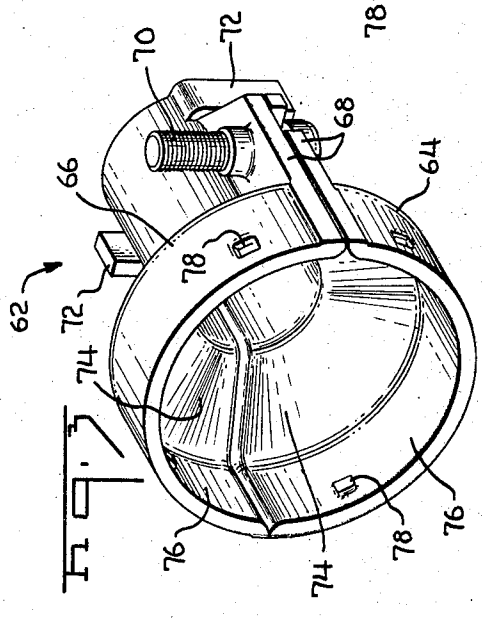


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Fig. 2

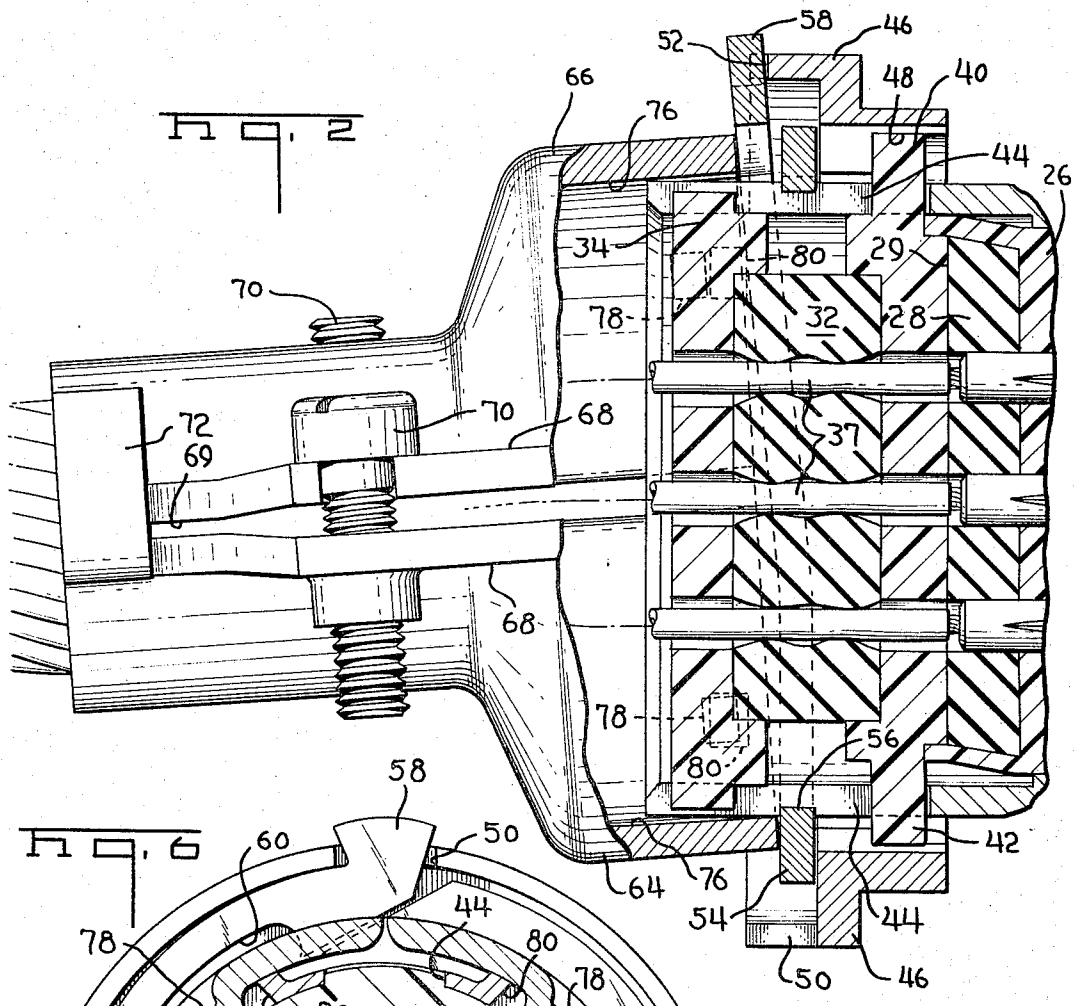


Fig. 6

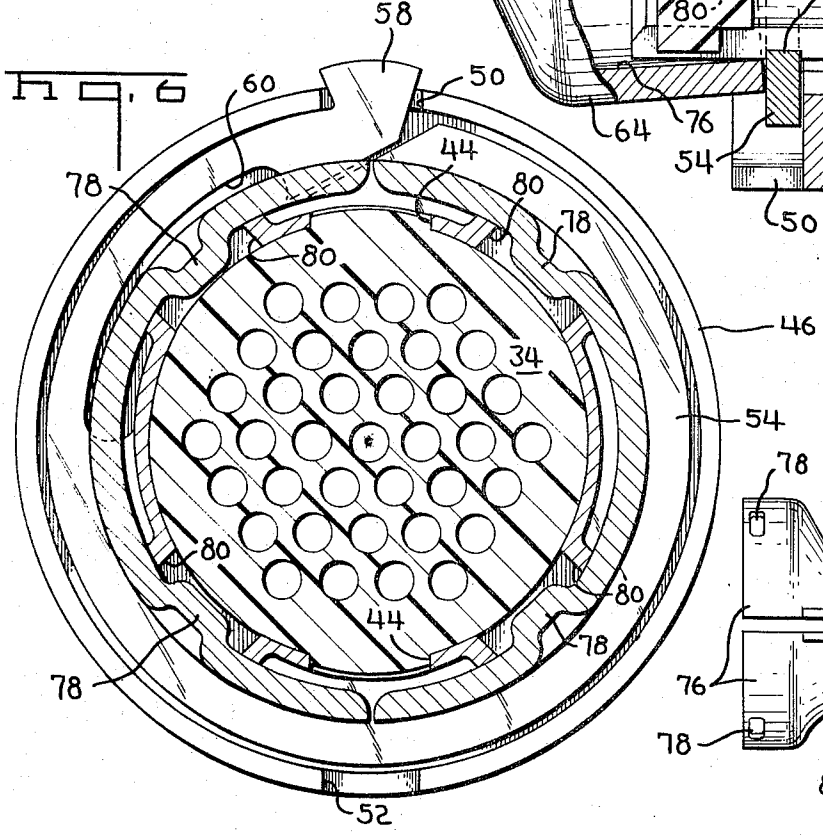
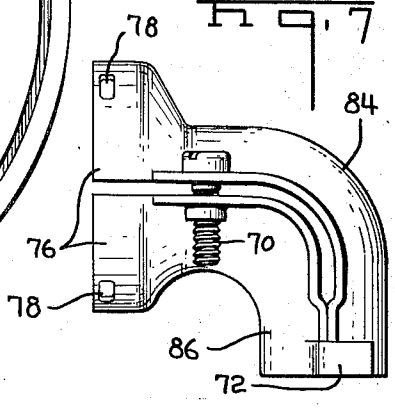


Fig. 7



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CABLE CLAMP FOR ELECTRICAL CONNECTOR

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6 Claims. (Cl. 339—105)

ABSTRACT OF THE DISCLOSURE

The invention relates to a cable clamp for a multi-contact electrical connector of the type comprising a shell and an insert within the shell. Contacts are mounted in cavities extending through the insert which has a radially displaceable element. A camming ring on the external surface of the shell can be rotated to a "locked" position to shift the insert element and render the cavities tortuous thereby to lock the contacts in the cavities. The present invention comprises a cable clamp which can be mounted on the shell only when the camming ring is in the "locked" position. Presence of the cable clamp on the connector shell thereby certifies that the contact terminals are retained and locked in the connector insert.

This invention relates to multi-contact electrical connectors.

One common type of multi-contact electrical connector comprises a metallic shell or housing, an insulating insert in the housing, and a plurality of contact terminals contained in the insert with the wires, which are secured to the terminals, extending rearwardly from the shell. Connectors of this type are adapted to be engaged with, and disengaged from, a complementary connector thereby to engage or disengage the contact terminals in the connectors. Usually, a cable clamp, which serves as a strain relief device for the wires, is mounted on the shell at the rearward end thereof. The cable clamp serves to clamp the wires at a location adjacent to the shell so that if these wires are pulled when the two connectors of the connector assembly are de-coupled, the resulting tensile forces will be transmitted from the wires through the clamp to the shell and the contacts themselves will not be subjected to tensile forces.

The present invention relates specifically to an improved cable clamp or strain relief for an electrical connector and particularly, but not exclusively, to a cable clamping device for a connector of the type disclosed and claimed in the co-pending application of Clarence Leonard Paullus et al., Ser. No. 567,331, filed Oct. 20, 1966. In this co-pending application, the two connectors of the connector assembly are each provided with a camming ring rotatably mounted on the external surface of the shell. This camming ring controls the position of a shiftable insert grommet which, in turn, locks the contacts within the insert assembly. When the camming ring is in one position, the contact terminals are retained or locked in the insert assembly while the contact terminals are retained when the ring is rotated to a second position. The cable clamp of the present invention cooperates with a rotatable camming ring of the type shown in the Paullus et al, application to prevent rotation of the ring when the cable clamp is mounted on the shell. The advantage of such an arrangement is that after the contact terminals have been mounted in the insert assembly and the shiftable insert grommet has been moved to its locking position for the terminals, the cable clamp can be positioned on the shell

to serve the functions of preventing rotation of the camming ring and transmitting the tensile forces applied to the wires directly to the shell.

The present invention also relates to a cable clamp which can be assembled to the connector after the contacts have been assembled to the connector insert. By virtue of this feature, the wires extending from the contacts need not be threaded through the cable clamp prior to their being mounted in the connector insert. This feature of the invention is not directly related to connectors of the type shown in application Ser. No. 567,331. In other words, a clamp in accordance with the invention can be used in connectors of types other than the type shown in application Ser. No. 567,331.

It is accordingly an object of the invention to provide an improved cable clamp for a multi-contact electrical connector. A further object is to provide a cable clamp which prevents rotation of a camming ring mounted on the shell of the connector. A further object is to provide a cable clamp which can be assembled to the shell after all of the contacts have been mounted in the insert of the connector and which thus avoids the necessity of threading the contacts and the wires through the clamp.

These and other objects of the invention are achieved in a preferred embodiment comprising a cylindrical cable clamp formed in two semi-cylindrical sections. The adjacent sides are provided with radially extending flanges or ears through which suitable fasteners extend to secure the sections in assembled relationship. The forward end of the clamp is provided with circumferentially spaced-apart bosses which are adapted to enter correspondingly spaced-apart openings in the rearward end of the shell, the arrangement being such that the sections of the cable clamp can be secured to the shell by positioning the bosses in the openings. The forward end of the clamp also serves the function of preventing rotation of a camming ring mounted on the connector shell when the clamp is in position by virtue of its position on the shell relative to a lock washer which abuts the camming ring. The clamp thus prevents tampering with the camming ring and/or accidental removal of the contacts when it is in position on the shell.

In the drawing:

FIGURE 1 is a sectional side view, with parts broken away, of a connector and cable clamp in accordance with the invention;

FIGURE 2 is a fragmentary sectional side view similar to FIGURE 1 but showing only the left-hand portion of the connector with the cable clamp improperly mounted on the shell and with the parts shown in the positions they occupy when the contacts are not retained;

FIGURE 3 is a perspective view of a connector cable clamp in accordance with the invention;

FIGURE 4 is a perspective view of one section of the clamp of FIGURE 3;

FIGURES 5 and 6 are views taken along the lines 5—5 and 6—6 of FIGURE 1; and

FIGURE 7 is a side view of an alternative embodiment of the invention.

A connector assembly **2** in accordance with the teachings of the previously identified application, Ser. No. 567,331, comprises a connector **4***a* and a complementary connector **6***a*, these two connectors being shown in coupled relationship in FIGURE 1. The connectors **4***a*, **6***a* comprise outer cylindrical shells **4**, **6**, the shell **4** having a forwardly extending hood **8** which projects over the mating end of shell **6**. The two connectors are coupled and de-coupled by means of a locking ring **10** which is rotatably mounted on the section **6** and which has a spiral groove **12** on its underside into which a pin **14** on the

hood portion 8 extends. The locking ring 10 is retained in position on the shell section 6 my means of a circumferential flange 16 on the shell section 6 and a lock washer 20 on the locking ring. A spring washer 18 is interposed between the flange 16 and the lock washer 20 to bias the ring 10 leftwardly in FIGURE 1.

Since the two connectors 4*a* and 6*a* are complementary to each other and substantially identical in most respects, a description of one will suffice for both. Therefore, only the connector 6*a* of the connector assembly will be described in detail and corresponding structural parts of the connector 4*a* will be identified by the same reference numerals differentiated by prime marks.

A composite insert assembly is mounted in the shell of the section 6, this insert assembly comprising an interface sealing grommet 22, a pair of relatively firm grommets 24, 26, a relatively soft, thin, elastically deformable grommet 28, an adjacent hard grommet 30, an additional soft grommet 32 and a back grommet 34 which is, again, of relatively firm material. The grommets 24, 26, 30, and 34 are advantageously of a firm epoxy resin or of a material having similar physical properties. The grommets 22, 28, 32 are of a suitable soft and yieldable insulating material such as neoprene rubber. Advantageously, most of the interfaces between adjacent grommets and between the peripheries of the grommets and the internal surfaces of the shell are sealed with suitable adhesives. The grommet 28 is bonded to the grommet 30 at their common interface 29 in a manner such that the grommet 30 can be displaced laterally, as in apparent from a comparison of FIGURES 1 and 2, without failure of bond.

Registered openings extend through the several grommets of the insert assembly to form cavities 36. Contact terminals 38 are mounted in these cavities with the rearward ends of the terminals being disposed in the soft grommet 28 and forwardly of the interface 29. The wires 37 which are secured as by crimping to these contacts extend leftwardly through a portion of the grommet 28, and through the grommets 30, 32, 34.

The grommet 30 has diametrically opposed radially projecting ears 40, 42 (FIGURE 2) which extend through axial slots 44 in the shell 6. These ears bear against an eccentric (with respect to the connector axis) camming surface 48 of a rotatable camming ring 46 mounted on the shell 6 adjacent to its rearward end. As explained more fully in application Serial No. 567,331, when it is desired to insert contact terminals into the cavities 36, the camming ring 46 is rotated until the portion of each cavity lying in the grommet 30 is in axial alignment with the portions of the corresponding cavities in the remaining grommets of the insert. The contact terminals can then be inserted until their rearward ends are in the soft grommet 28 as shown in FIGURE 2.

In order to retain the contacts in the insert assembly, the camming ring is rotated through an angle of 180° thereby to shift the hard grommet 30 from the position of FIGURE 2 to the position of FIGURE 1 and to impart a degree of tortuosity to each cavity which prevents rearward movement of the terminals from the position shown in FIGURE 1. Specific details of this retention system are described fully in the above-identified co-pending application, however, it will be apparent from what has been said thus far that the camming ring 46 must be held in the position of rotation shown in FIGURE 1 to assure retention or locking of the contacts 38 in their cavities 36. The cable clamp in accordance with the invention performs the function of retaining this camming ring in the position of FIGURE 1 as will now be explained.

The camming ring 46 is provided with a pair of diametrically opposed notches 50, 52 extending inwardly from its left-hand side as viewed in FIGURES 1 and 2. The notch 50 is relatively deeper than the notch 52 for reasons explained below. A split spring washer 54 is mounted on the shell 6 adjacent to the left-hand side of the camming ring and has a radially projecting ear 58 adjacent to its gap. The underside of the washer adjacent to the ear is cut away as shown at 60 (FIGURE 4) and the washer is seated in a suitable circumferential groove 56 on the shell 6. The arrangement is such that the ear 58 is normally disposed in either of the notches 50, 52 although this ear can be resiliently moved leftwardly and unseated from either notch to permit manual rotation of the camming ring. The washer thus serves to both retain the camming ring on the shell and to latch the ring in either position of rotational adjustment. When the camming ring is in a position such that ear 58 is seated in the relatively deep notch 50 (FIGURE 1), the grommet 30 is in the position of FIGURE 1 and the contacts are retained or locked in the insert assembly. When the ear 58 is seated in the shallow notch 52, the grommet 30 is in the position of FIGURE 2 and the contacts are not retained in the insert assembly. It should also be noted that when ear 58 is seated in notch 50, the ear will be co-planar with the remaining portions of the split ring and will be as remote as possible from the end of the shell. On the other hand, when the ear 58 is disposed in the shallow notch 52, this ear will be held somewhat closer to the end of the shell by the camming ring than when it is in the ear 50.

The cable clamp, generally indicated at 62, is formed in two sections 64, 66, each section being semi-cylindrical and complementary to the other section. Laterally extending flanges 68 are provided on the adjacent edges of the sections, one of these flanges of each section being provided with a threaded hole while the other flange is provided with an inwardly directed slot for the accommodation of screws 70 by means of which the two sections can be clamped together. These flanges 68 are slightly spaced-apart intermediate the ends of the clamp but abut each other as shown at 69 adjacent to the rearward end of the clamp. The portions 69 of the flanges are not shown in abutting relationship in FIGURE 7 for the reason that the clamp is improperly positioned on the connector shell in this view. Each section is also provided with a tangentially extending ear 72 at its rearward end which extends past the surface of the adjacent section when the clamp is assembled.

The forward ends of the sections 64, 66 are flaired as shown at 74 to provide an enlarged cylindrical end 76. The inside diameter of this end of the clamp is such that it will fit over the end the shell 6. Two inwardly directed bosses 78 are provided on each section 64, 66 in the cylindrical portion 76, these bosses being angularly spaced apart by 90°. The bosses 78 are adapted to enter rectangular holes 80 in the rearward end of the shell 6, the holes 80 being also spaced apart by 90°. The holes 80 are disposed between the split washer 54 and the end of the shell and the split washer itself is located relatively close to the rearward end of the shell 6.

In use, the camming ring will be in the position of FIGURE 2 with ear 58 seated in shallow notch 52 while the contacts are being inserted into the insert assembly. After completion of this inserting step, the technician should rotate the camming ring through an angle of 180° to the position of FIGURE 1 before assembling the cable clamp to the shell in order to retain the contacts in the insert assembly.

The two sections 64, 66 of the cable clamp are then positioned around the conductors and the screws 70 of each section are partially tightened. The ears 72 serve to gather the conductors and retain them in the clamp during this assembling procedure. The clamp is then moved to the rearward end of the shell and the bosses 78 are located in the holes 80. The screws are then fully tightened to clamp the conductors extending from the wires. When the cable clamp is positioned on the rearward end of the shell, the end of the cable clamp prevents rearward movement of the ear 58 so that it is impossible to move the camming ring to the unlocked position when the cable clamp is assembed to the shell.

In the foregoing description, it is assumed that the

technician did, in fact, rotate the camming ring from the unlocked to the locked position after insertion of the contacts and before he assembled the cable clamp to the shell. If the technician should fail to rotate the camming ring and he attempts to assemble the clamp to the shell with the ear **58** seated in the notch **52**, he will be reminded of his mistake by the fact that the cable clamp cannot be properly positioned on the shell when the ear is in notch **52**, a condition illustrated in FIGURE 2. When the ear is in this relatively shallow notch **52**, the side of the split ring will interfere with the clamp and the clamp will not be axially aligned with the connector.

The arrangement of the bosses **78** and the openings of the disclosed embodiment of the invention is such that it might be possible to imperfectly mount the cable clamp on the shell when the ear **58** is seated in the shallow notch **52** of the camming ring. Alternative arrangements within the scope of the invention might be employed. For example, the notch **52** could be eliminated entirely and the width of the camming ring could be increased to a greater thickness than that shown in the drawing at a location opposite to the location of the notch **50**. An arrangement of this type could be devised which would absolutely preclude mounting of the cable clamp on the shell when the ear **50** is in the position of FIGURE 2.

FIGURE 7 shows an alternative embodiment comprising a right angle cable clamp in accordance with the invention comprising a pair of complementary sections **84, 86**. The forward ends of these sections are similar to the forward end portions **74, 76, 78** of the previously described embodiment. The embodiment of FIGURE 5 thus differs only from the previously described embodiment in that the two sections are curved intermediate their ends so that wires can be led through a right angle bent towards the connector.

The principles of the invention are particularly advantageous in the case of the right angle connector of FIGURE 7 since the clamp can be assembled to the connector shell in any one of four positions of rotation with regard to the shell.

The feature of the invention of utilizing the clamping ring as a device to guarantee proper retention of the contacts in the insert as well as a clamping means for the conductors can be utilized in connectors other than the specific type shown in FIGURES 1 and 2 and described fully in the co-pending application of Clarence Leonard Paullus et al., Ser. No. 567,331. For example, the co-pending application of Clarence Leonard Paullus, Ser. No. 446,352, discloses and claims a connector in which the contacts are retained in the insert by means of a threaded coupling ring on the rearward end of the shell. When this coupling ring is screwed along the shell to a predetermined location, the contacts are retained in the insert. It will be apparent that the cable clamp of the instant invention could be used with a connector of the type shown in the application Ser. No. 446,352 if the openings **80** were provided adjacent to the predetermined location of the clamping ring so that the clamping ring could not be assembled to the shell unless the contacts were retained in the insert.

The cable clamp per se also has utility in electrical connectors of previously known types which do not rely upon a rotatable camming ring or nut on the shell for retention as in application Ser. No. 446,352 and application Ser. No. 567,331. The principal advantages as discussed above of the cable clamp as shown in FIGURES 3 and 4 are that it can be assembled to the conductors after they have been mounted in the shell and the requirement that the conductors be directed through the clamp is avoided. The principles of the invention are not necessarily limited to circular connectors or cylindrical connectors but can be employed in rectangular connectors of the type commonly known to the art.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective against the prior art.

We claim:

1. A cable clamp for use with a cylindrical connector, said connector having movable means mounted externally on its shell adjacent to its rearward end, said movable means controlling the retention of contacts in said connector whereby said contacts are retained in said connector when said movable means is in one position, said cable clamp having secured means at one end to secure said clamp to said connector, means effective between said movable means and said securing means for rendering said securing means at least partially inoperative when said movable means is in a position other than said one position, whereby said cable clamp cannot be mounted on said connector unless said movable means is in said one position and said contacts are retained in said connector.

2. A device as set forth in claim **1** wherein said movable means comprises a ring on said connector, said securing means comprising interengaging means on said clamp and said connector.

3. A device as set forth in claim **1** wherein said clamp is divided along a plane extending through its axis.

4. A cable clamping device for an electrical connector, said connector comprising a shell member and insert means in said shell member, said insert means being adapted to receive electrical contact terminals with conductor cables extending from said shell and insert means at the rearward end thereof, said cable clamping device being divided in two sections in a plane extending through its longitudinal axis, the adjacent edges of said sections having radially extending abutting portions, fastening means extending through said abutting portions for securing said sections to each other thereby to maintain said sections of said clamping device in assembled relationship, securing means for securing one end of said clamping device to said shell, said securing means comprising a plurality of identical circumferentially spaced-apart cooperative interengaging devices on said shell and on each of said sections, the spacing between said devices being the same on said shell as the spacing between said devices on said sections of said clamp, said clamp being mountable on, and removable from, said shell after said contacts have been mounted in said insert means.

5. In a multi-contact electrical connector of the type comprising a cylindrical shell, an insulating insert means in said shell, cavities extending axially through said insert means, and contact terminals in said cavities, said insert means including a radially movable section, said movable section having a pair of ears extending radially beyond said shell and a rotatable camming ring on the external surface of said shell for displacing said movable section transversely of the axis of said shell thereby to render said cavities tortuous and lock said contacts in said insert means, the improvement comprising: a split spring washer on said shell bearing against the rearward side of said camming ring, an ear on said washer and a pair of diametrically opposed notches in said ring, said ear extending into one of said notches and being movable out of said one notch to permit rotation of said camming ring relative to said shell, whereby said ring can be latched in either of said positions and can be rotated to either of said positions, and conductor strain relief means removably secured to said shell and disposed adjacent to said washer, said strain relief means preventing rearward movement of said washer, whereby said ear cannot be disengaged from said camming ring and said camming

ring cannot be rotated when said strain relief is mounted on said shell.

6. In a multi-contact electrical connector of the type comprising a cylindrical shell, insulating insert means in said shell, cavities extending axially through said insert means, contact terminals in said cavities, said insert means including one laterally shiftable section, said contact terminals being retained in said insert means when said shiftable section is in one position and said terminals not being retained when said shiftable section is in a second position, said shiftable section having ear means extending radially through said shell, a camming ring rotatably mounted on said shell in engagement with said ear means for shifting said shiftable section from said one position to said second position upon rotation of said camming ring, the improvement comprising: a split washer on said shell adjacent to the rearward end of said camming ring, said washer having a radially extending ear, a pair of notches in said camming ring for reception of said ear whereby said camming ring can be locked in either of two positions when said ear is disposed in one of said notches, said ear being disengageable from either of said notches upon rearward movement of said ear with concomitant resilient deformation of said ring, and a strain relief clamp removably secured to said shell at the rearward end thereof, said strain relief clamp preventing said rearward movement of said ear whereby said camming ring cannot be rotated when said strain relief clamp is secured to said shell.

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