United States Patent [19]

Clark

[11] **3,861,777**

[45] **Jan. 21, 1975**

[54] **SEPARABLE ELECTRICAL CONNECTOR**

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[22] Filed: **Sept. 20, 1973**

[21] Appl. No.: **398,991**

[52] **U.S. Cl.** ..... **339/92 R,** 174/152 R, 339/94 R, 339/116 C, 339/278 C

[51] **Int. Cl.** **H01r 13/54**

[58] **Field of Search** ..... 339/59–61, 339/92, 94, 114, 116, 268, 278 C; 174/152 R

[56] **References Cited**

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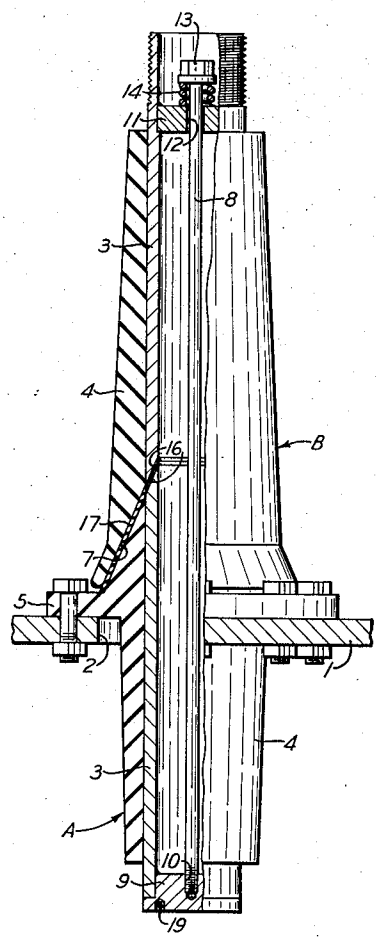
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[57] **ABSTRACT**

An electrical connector for attachment to the housing or frame of electrical apparatus includes a tubular electrical conductor having inner and outer ends and encircled by an insulating bushing joined to it. The conductor and bushing are separated transversely into adjoining inner and outer sections, the inner section being encircled by a flange for attachment to said housing around a hole through which the inner section extends. One of the adjoining ends of the two sections is tapered to form a conical end portion, while the other of said adjoining ends is provided with a tapered socket receiving the conical end portion. The two sections are detachably connected together under spring pressure that holds them tightly together.

7 Claims, 4 Drawing Figures



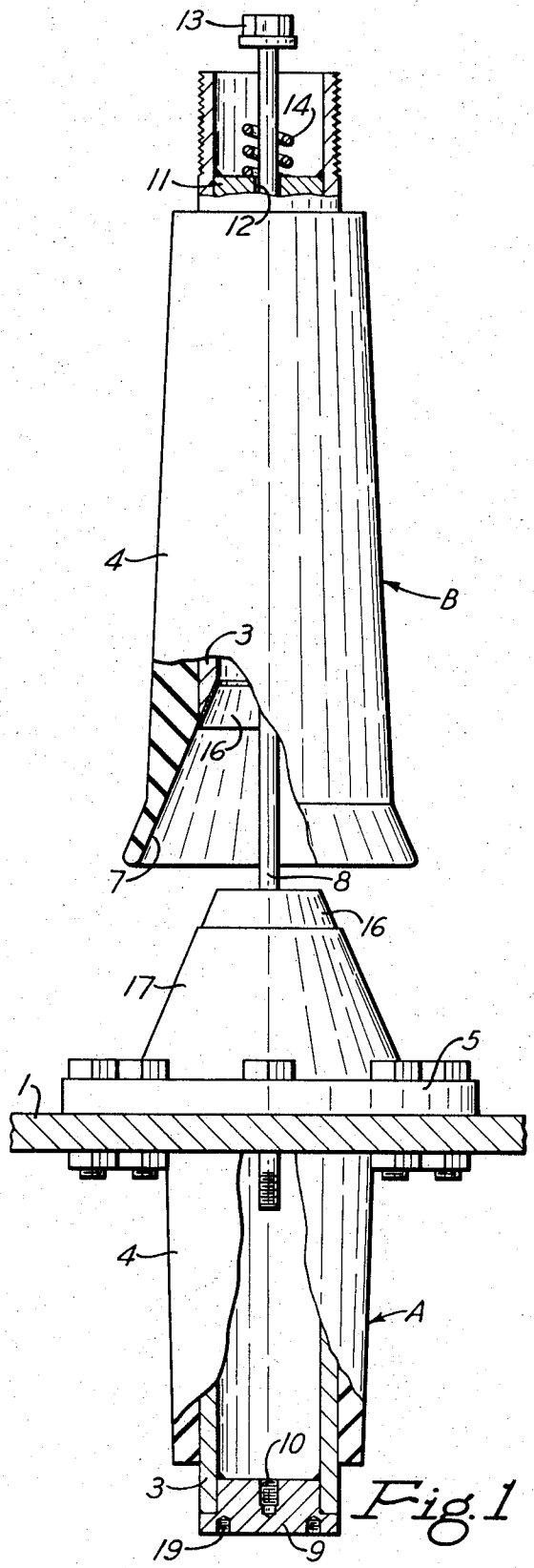

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Fig. 1

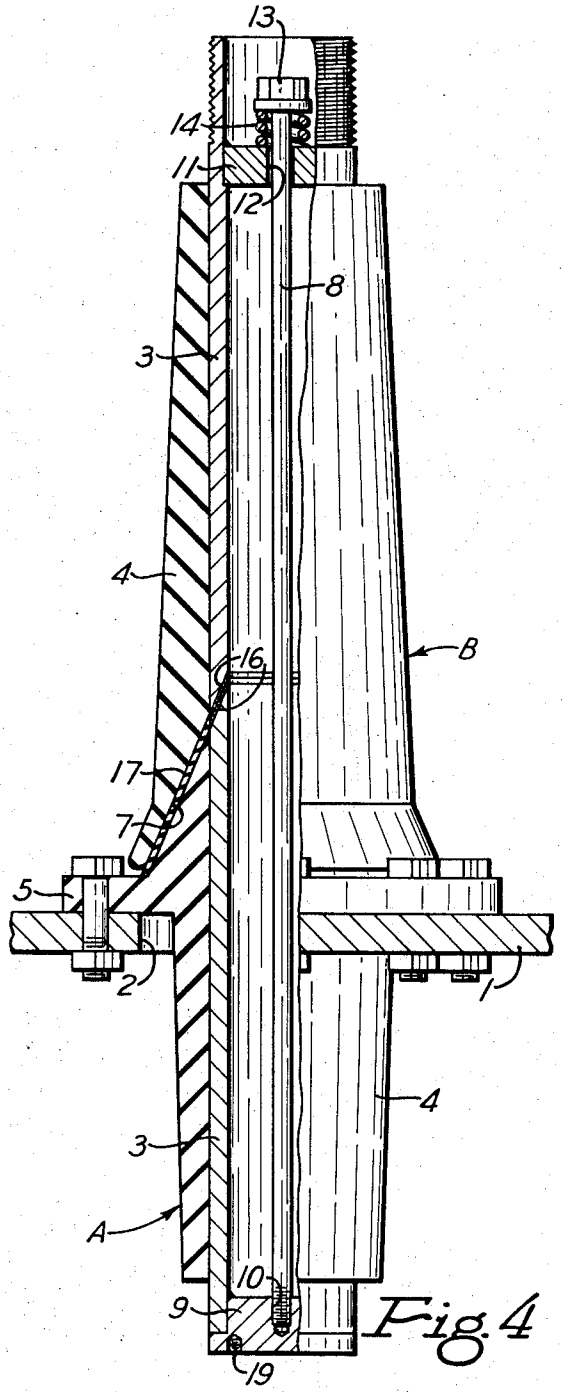

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Fig. 4

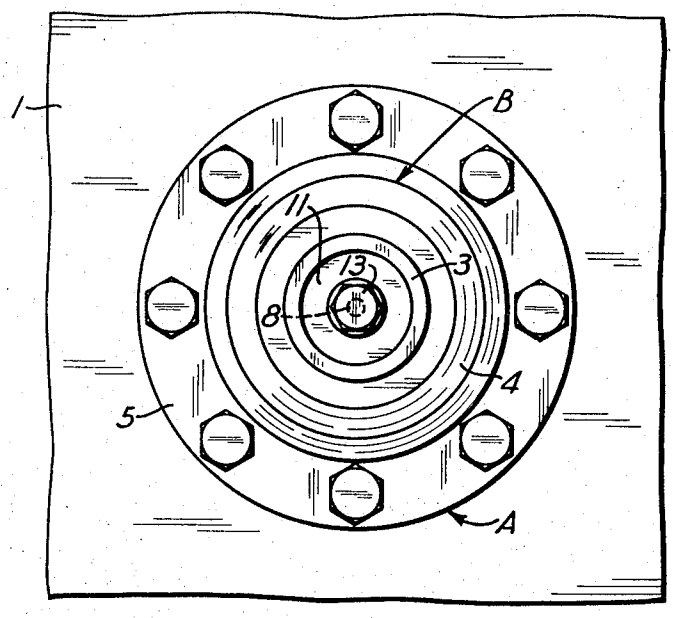


Fig. 2

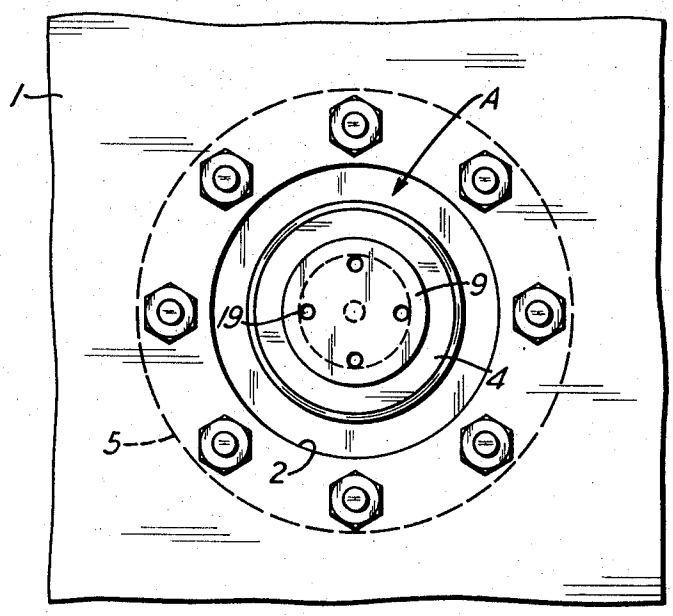


Fig. 3

SEPARABLE ELECTRICAL CONNECTOR

In the construction of large electrical apparatus, such as generators, transformers, circuit breakers and the like it is necessary to provide electrical connectors that extend through the housings or frames of the apparatus to connect it with bus bars or the like outside. These connectors include insulating sleeves or bushings that encircle and insulate the conductors from the housings. Also, in many cases, the housings must be gas-tight because the apparatus is cooled by gas, for the electrical connectors must be sealed in the housings. For electrical reasons the connectors must extend a material distance out from the housings, which can cause problems when the apparatus is shipped from the manufacturing plant to the power station or other location where it is to be installed. Thus, the outwardly extending connectors are subject to damage during handling of the apparatus and they increase the clearance requirements along the shipping route. Because of these problems, the present practice is to ship the connectors separate from the electrical apparatus and to install them at the job site, but this practice is time-consuming and expensive. It not only requires internal connections from the electrical windings to the connectors to be made in the field, but it requires that means be provided for sealing the openings for the connectors in the housings during shipment.

It is an object of this invention to provide electrical apparatus with an electrical connector, part of each of which is connected to the apparatus housing by the manufacturer and projects only a short distance, and the other part of which can be shipped separately and then quickly and easily attached to the first part at the job site. Another object is to provide such a connector in which the two parts make lasting good electrical engagement with each other.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which

FIG. **1** is a side view, partly in section, showing an electrical connnector separated into its two parts but about to be joined together;

FIG. **2** is a view of the outer end of the connector;

FIG. **3** is a view of its inner end; and

FIG. **4** is a side view, partly in section, showing the connector completely assembled.

Referring to FIGS. **1** to **3** of the drawings, a frame or housing **1** of electrical apparatus, such as an electric generator for example, is provided with an opening **2** (FIG. **4**) through which extends an electrical connector for electrically connecting wires inside the housing to a bus bar or the like outside of the housing. The electrical connector includes a tubular electrical conductor **3**, preferably copper, that is encircled for most of its length by an insulating sleeve or bushing **4** joined to the tube. The bushing is provided with an integral flange **5** that is bolted to the housing around the opening therein. The tubular conductor projects a short distance from each end of the bushing to facilitate making electrical connections to it.

It is a feature of this invention that when the electrical apparatus is shipped from the manufacturer, the electrical conductor projects only a short distance from the housing to reduce shipping clearance requirements and the possibility of the connector being damaged by something striking its outer end. Accordingly, the connector is separated transversely into two parts, an inner section A and an outer section B. The flange **5** is a part of the inner section and is bolted to housing **1** by the manufacturer, who at that time also makes the necessary electrical connections inside the housing to the inner end of the tubular conductor **3**. The outer section B is shipped separately. The connector is not separated in a flat plane perpendicular to its axis to form the two sections. Rather, one of the adjoining ends of the two sections is tapered to form a conical end portion. Preferably, it is the outer end of the inner section A that is so tapered, the taper beginning at flange **5** and extending outwardly. In that case the inner end of the outer section B is provided with a tapered socket **7**, in which the conical end portion of the inner section will fit with a wedge fit.

To permit the two sections of the connector to be quickly and easily connected together tightly in the field after assembly, a tie rod **8** is provided. Sealed in the inner end of the tubular conductor is a rigid member or plug **9** provided with a central threaded opening **10**. Another rigid member **11** like a heavy washer is rigidly mounted in the outer end of the tube. The threaded inner end of the tie rod is passed through the axial passage **12** in this rigid member and is moved inwardly until it reaches the opening in the plug. The head **13** on the outer end of the rod then is turned to screw the rod into the plug. However, the head is not screwed up against the rigid member in the outer end of the tube, but is spaced from it. In this space there is a coil spring **14** or spring washer of any suitable type that is compressed by the head against member **11** with considerable force as shown in FIG. **4**. Consequently, the spring continually presses the outer section B of the connector inwardly against the inner section and therefore maintains tight engagement between the adjoining ends of the two sections to form a unitary connector with the inner end of the outer section spaced slightly from flange **5**. The two sections can be quickly and easily connected in this manner.

The tapered joint between the two sections of the connector not only provides for a wedge fit, but it also establishes and maintains perfect alignment between the two sections. A further important advantage of tapering the joint is that it materially increases the areas of the opposing end surfaces of the two sections of the metal tube forming the electrical conductor. This holds the contact resistance between the two parts of the tube to a minimum, so the heating that could result from appreciable contact resistance is substantially eliminated. To prevent contact resistance from increasing later, due to oxidizing of the opposed metal surfaces of the joint, it is advisable to plate the tapered surfaces with a metal **16** that is much more resistant to oxidizing than the metal of the tube. Tin or silver can be used for this purpose advantageously. To form a good seal between the adjoining ends of the inner and outer sections of the insulating bushing **4**, it is desirable to coat one of its tapered surfaces with a thin layer **17** of elastomeric material which will be compressed when the two parts of the connector are forced together by the tie rod and spring.

One way of connecting wires within the housing to the inner end of the tubular conductor is to provide the inner end of plug **9** with tapped holes **19**. The outer end of the conductor is shown provided with a screw thread, by which bus bars can be connected to it. How-

ever, other ways of connecting bus bars or cables to the outer end of the conductor can be used.

With an electrical connector constructed as disclosed herein, only a short portion projects from the housing or frame in which it is mounted at the factory. This short portion seals the opening in the housing so that a separate shipping seal is not required. At the location where the apparatus is to be used, all that remains to be done is to remove any protective cap that may have been fitted over the projecting cone, apply the outer section of the connector to the inner section and connect them by means of the tie rod, and then make the usual electrical connection to the outer end of the tubular conductor.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A separable electrical connector for electrical apparatus having a housing, the connector having inner and outer ends and comprising a tubular electrical conductor, an insulating bushing encircling the conductor and joined thereto, the conductor and bushing being separated transversely into adjoining inner and outer sections, the inner section of the bushing being adapted to extend through a hole in a said housing and being encircled by a flange for attachment to the housing around such a hole, one of the adjoining ends of said sections being tapered to form a conical end portion in which the end surfaces of the bushing and conductor are tapered, the other of said adjoining ends being provided with a tapered socket receiving said conical end portion, the end surfaces of the bushing and conductor forming the side wall of the socket being tapered in the same direction as said conical end portion, corrosion-resistant metal plated on the opposed tapered surfaces of the tube sections in said socket, and means including a spring pressing said sections tightly together.

2. A separable electrical connector according to claim **1**, including a sealing layer of elastomeric material between the tapered surfaces of the conical end portion and socket of said insulating bushing.

3. A separable electrical connector according to claim **1**, including a sealing layer of elastomeric material between the tapered surfaces of the conical end portion and socket of said insulating bushing, the inner end of said outer section being provided with said socket.

4. A separable electrical connector for electrical apparatus having a housing, the connector having inner and outer ends and comprising a tubular electrical conductor, an insulating bushing encircling the conductor and joined thereto, the conductor and bushing being separated transversely into adjoining inner and outer sections, the inner section of the bushing being adapted to extend through a hole in a said housing and being encircled by a flange for attachment to the housing around such a hole, one of the adjoining ends of said sections being tapered to form a conical end portion in which the end surfaces of the bushing and conductor are tapered, the other of said adjoining ends being provided with a tapered socket receiving said conical end portion, the end surfaces of the bushing and conductor forming the side wall of the socket being tapered in the same direction as said conical end portion, and means extending through said tubular conductor for connecting said sections, said means including a spring pressing said sections tightly together.

5. A separable electrical connector according to claim **4**, in which said connecting means include a rod in said tube extending axially thereof, means secured to the inner section of the tube removably holding one end of the rod therein, a rigid member secured in the outer section of the tube and provided with a central opening through which the rod extends, a head on the outer end of the rod, and resilient means compressed between said head and said rigid member and pressing said sections tightly together.

6. A separable electrical connector according to claim **5**, in which said rod-holding means is a plug in the inner end of said connector, the plug being formed for attachment to an electrical conductor.

7. A separable electrical connector according to claim **5**, including corrosion-resistant metal plated on the opposed tapered surfaces of the tube sections in said socket, and a sealing layer of elastomeric material between the tapered surfaces of the conical end portion and socket of said insulating bushing.

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