Nov. 4, 1958 T. A. FELTON 2,859,425

ELECTRICAL CONNECTION WITH TAPERED PLUG

Filed Dec. 21, 1955 3 Sheets-Sheet 1

FIG. 1

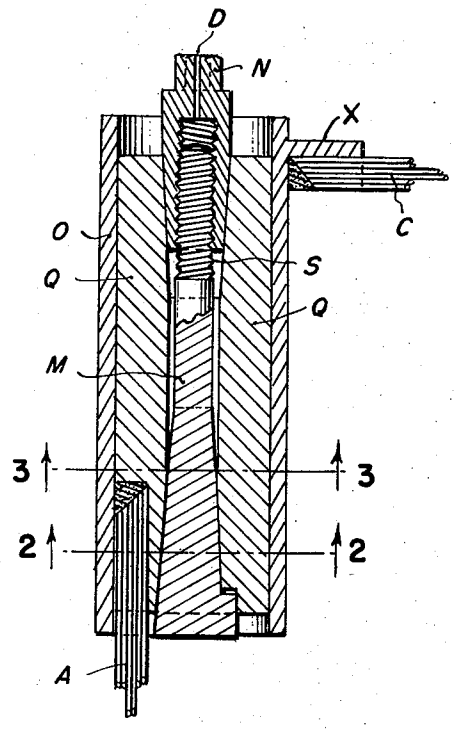


FIG. 2

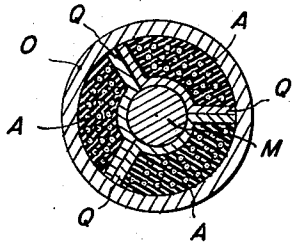
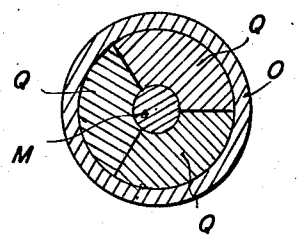


FIG. 3



INVENTOR

THOMAS A. FELTON

BY Wenderoth, Lind & Ponack

ATTORNEYS

Nov. 4, 1958 T. A. FELTON 2,859,425

ELECTRICAL CONNECTION WITH TAPERED PLUG

Filed Dec. 21, 1955 3 Sheets-Sheet 2

FIG. 4

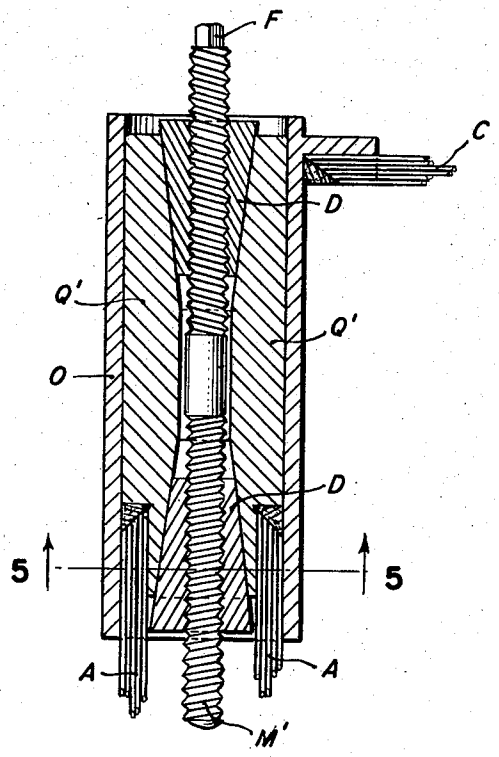
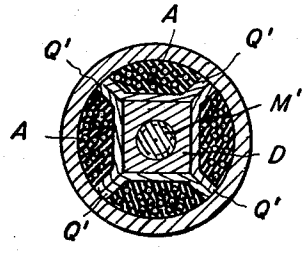


FIG. 5



INVENTOR
THOMAS A. FELTON

BY Wenderoth, Lind & Ponack

ATTORNEYS

Nov. 4, 1958 T. A. FELTON 2,859,425

ELECTRICAL CONNECTION WITH TAPERED PLUG

Filed Dec. 21, 1955 3 Sheets-Sheet 3

FIG. 6

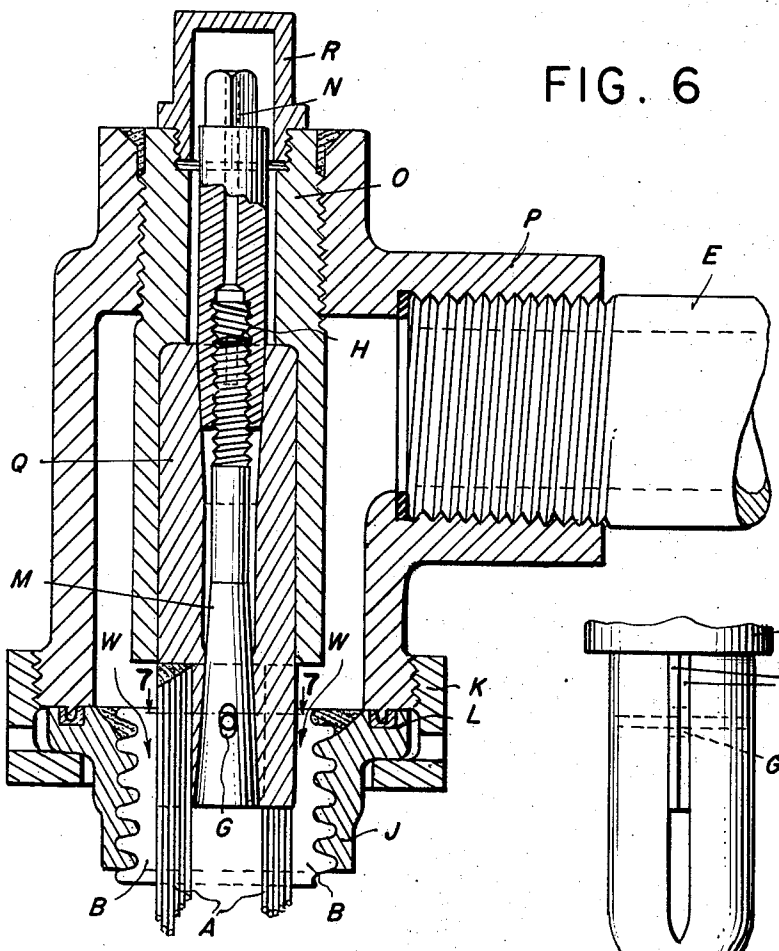


FIG. 8

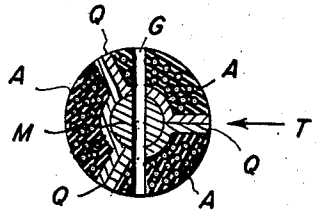


FIG. 7

INVENTOR
THOMAS A. FELTON

BY Wenderoth, Lind & Ponack

ATTORNEYS

United States Patent Office 2,859,425 Patented Nov. 4, 1958

2,859,425

ELECTRICAL CONNECTION WITH TAPERED PLUG

Thomas Alfred Felton, Newton, Porthcawl, Wales, assignor to The Distillers Company Limited, Edinburgh, Scotland, a British company

Application December 21, 1955, Serial No. 554,447

Claims priority, application Great Britain January 8, 1955

10 Claims. (Cl. 339—270)

The present invention relates to a new type of electrical connector and in particular to an electrical connector suitable for carrying a very high amperage current and for withstanding high temperatures.

The supply of electric current to apparatus such as electric arc furnaces for producing calcium carbide, ferro-alloys, phosphorus and the like frequently involves the use of flexible conductors in the electrical circuit in a position adjacent to the electrodes. Such conductors, which normally consist of composite cables having at least two and preferably numerous strands, have to be capable of carrying a very high amperage current, for instance up to 300,000 amperes in a single electrode single phase furnace, and may be water-cooled to enable them to withstand the high temperatures to which they are subjected by reason of their proximity to the furnace. A flexible conductor of this type is advantageously provided with a connector which enables it to be easily disconnected from the current supply at one end and/or from the electrode assembly at the other end when the furnace is not in operation. The provision of connectors for this purpose has always been a matter of extreme difficulty particularly where it is necessary to provide internal and external water cooling for the flexible conductor as well as for the connector. To ensure the efficient conduction of the high amperage current through the connector it is necessary for the contacts to be locked together under pressure, for instance by means of a number of bolts, and the connectors employed hitherto have been subject to failure amongst other reasons as a result of stresses and strains being set up on the heat expansion of the metal locking means, giving rise to failure of one or more of the securing bolts.

It is an object of the present invention to provide an electrical connector which allows efficient conduction of a high amperage electric current and which is capable of withstanding high temperatures. It is a further object of the present invention to provide a water-cooled electrical connector having these properties.

Accordingly, the present invention for an electrical connector for connecting two conductors at least one of which is a flexible composite cable conductor comprises a contact sleeve adapted to be conductively connected to one of the conductors, a contact plug adapted to fit closely inside the contact sleeve, the contact plug having a longitudinal bore of regular cross-section which tapers from each end to a minimum cross-section substantially in the centre of the length of the plug and being split longitudinally into at least two segments, each segment being adapted to be welded or brazed to part of the other conductor which is a composite flexible conductor, a tapered member shaped to fit the taper at one end of the bore, a second tapered member shaped to fit the taper at the other end of the bore, and means for screwing the two tapered members together when in position in the bore whereby the segments of the contact plug are forced outwards against the inner surface of the contact sleeve, thereby making the electrical connection.

The term "brazed" is used to include the fixing of the plug to the conductor by the fusion of any suitable metal or alloy.

The invention is further illustrated with reference to the accompanying drawings.

Figure 1 is a longitudinal section through one embodiment of the electric connector of the present invention.

Figure 2 is a cross-section along the line 2—2 in Figure 1.

Figure 3 is a cross-section along the line 3—3 in Figure 1.

Figure 4 is a longitudinal section through a second embodiment of the electrical connector of the present invention.

Figure 5 is a cross-section along the line 5—5 in Figure 4.

Figure 6 is a longitudinal section through a water cooled electrical connector according to the present invention.

Figure 7 is a cross-section along the line 7—7 in Figure 6.

Figure 8 is a view in direction of arrow T in Figure 7.

In Figure 1 a rectangular projection X, from the contact sleeve O, is permanently connected, e. g. by welding, to the conductor C. The contact plug Q is shaped to fit closely inside the contact sleeve O and has a longitudinal bore S of circular cross-section. The bore tapers from each end to a minimum diameter substantially in the centre of the length of the plug. The contact plug Q is split longitudinally into three segments, as shown in Figures 2 and 3, each segment being welded on to about one third of the strands of the flexible composite cable conductor A. The bolt M fits into the bore of the contact plug, is threaded at one end to receive the nut N, and is shaped at the other end (i. e. the head of the bolt) to fit the taper of the bore. The nut N is also shaped to fit the taper at the other end of the bore and is provided with an air-hole D to allow escape of air on tightening the nut. To assemble the connector the nut N is screwed one or two turns on to the bolt M, and the combined nut and bolt is inserted between the opened-out segments of the contact plug with the head of the bolt towards the ends of the segments which are welded on to the flexible composite cable conductor A. The segments are closed up and the plug is inserted into the contact sleeve O. The nut N is tightened on to the bolt M, and as the two are screwed together the segments of the contact plug, by virtue of the tapers on the nut and bolt acting on the tapers in the bore, are forced outwards against the inner surface of contact sleeve O, thereby making the electrical connection.

The dimensions of the electrical connector can vary according to the purpose for which it is intended, and the approximate size of connector needed to carry any particular electrical current can readily be determined by one skilled in the art. The electrical connector is constructed of any suitable conducting material, e. g. metals such as steel, copper, brass and the like; the exact materials for a connector needed to carry any particular electrical current may readily be determined by one skilled in the art.

The electrical connector as illustrated in Figures 1 and 2 can be modified in many ways without departing from the principle of the invention. Thus although it is convenient to construct the contact sleeve O, as a cylindrical member, it may also be formed in a number of other cross-sectional shapes, preferably regular in pattern, e. g. square, pentagonal, hexagonal, etc. To obtain the most effective electrical connection the contact plug Q must fit closely inside the contact sleeve; the optimum external shape of the plug is therefore determined by the internal shape of the contact sleeve. The bore of the contact plug

is preferably circular in cross-section in the interests of ease of construction, but may be any other regular cross-sectional shape over part or all of the length of the bore. Thus in the embodiment illustrated in Figures 1 and 2 the bore is of necessity circular at the top end to enable the nut N to be screwed on to the bolt M. However, the lower end of the bore can be of any regular cross-sectional shape, e. g. square or hexagonal, provided that it tapers towards the centre. If the lower end of the bore in Figure 1 is made square, the tapering head of the bolt M has also to be made square to conform with the bore. This arrangement has the advantage that the bolt cannot turn when the nut N is being screwed or unscrewed. Alternatively, in the case of a bore of circular cross-section as shown in Figures 1 and 2, the head of the bolt M may have a lug S which fits into a recess U in the wall of the contact plug to prevent the bolt revolving. The angle or degree of taper in the bore of the contact plug is also not critical. However, it will be apparent that the flatter the angle of the taper the greater will be the leverage exerted on the contact plug and the greater will be the pressure exerted by the contact plug against the inner surface of the contact sleeve. The optimum angle of taper for any particular electrical connection can readily be determined by a skilled engineer.

The number of longitudinal segments into which the contact plug is split may be two or more. It is preferred to use a contact plug split into three segments.

A second embodiment of the invention is illustrated in Figures 4 and 5. In this embodiment the contact plug Q^1 is split longitudinally into four segments and has a longitudinal bore of square cross-section throughout its length which tapers from each end towards the centre. Two tapered members D are shaped to fit into the bore at either end and are threaded internally, one with a left hand thread and the other with a right hand thread. The stud M^1 is provided with left hand threads at one end and right hand threads at the other. When the stud M^1 is turned by means of the square head F, the tapered members D are drawn together, or forced apart, depending on which way the stud is turned, the electrical connector being tightened or loosened accordingly.

A preferred embodiment of the invention is illustrated in Figures 6, 7 and 8 which show a water-cooled connector for connecting a rigid tubular conductor E with a hollow flexible composite cable A, surrounded by a flexible corrugated metal sheath B. The connector consists of the contact sleeve O, the contact plug Q, which has a bore of circular cross-section tapering from each end and which is longitudinally split into three segments, each of which is brazed on to a portion of the strands of the hollow flexible composite cable A, and the bolt M, suitably threaded at its narrow end to take the nut N, both the bolt M and the nut N being tapered to fit the tapered bore of the contact plug. The contact sleeve O, is screwed into and welded to an elbow member P, one arm of which is connected by means of a threaded joint to the rigid tubular conductor E, while the other arm is joined to the flexible corrugated metal sheath B. The joint between the elbow member P and the sheath B is made by means of the flange J, which is soldered around the sheath. The flange is pulled tightly against the elbow member by means of the nut K, and the joint is made watertight by means of a gasket L, e. g. of silicone rubber, inserted in a recess of the flange J. The cooling water passes through the tubular conductor E, circulates around the connector portion of the assembly, and passes through the flexible sheath B, by arrows W, both inside and outside of the hollow flexible cable A. Leakage of cooling water up the contact sleeve past the nut N is prevented by means of the screw cap R.

The assembly and dismantling of the connector are facilitated by the hole G, which passes through the contact plug Q and through the bolt M. On assembling the connector, the bolt M is located along the axis of the contact plug Q and is held in position by passing a locating pin into the hole G, through both the contact plug and the bolt. The contact plug is then inserted into the contact sleeve O, and the nut N is screwed on to the small end of the bolt. After partially tightening the nut the locating pin is removed and the nut further tightened. To dismantle the connector it is convenient, particularly when the connector has been in position for some time and may be firmly fixed due to deposition from the cooling water, to loosen the nut N somewhat, to insert the locating pin through the contact plug and bolt at G and to tap the head of the nut so as to drive the contact plug out of the contact sleeve.

The assembly and dismantling of the connector are also facilitated by the use of the threaded recess H in the bolt M in Figure 6. A screw threaded pin can be inserted into recess H as a means of preventing the bolt M from slipping down out of reach while the nut N is being screwed on.

I claim:

1. An electrical connector for connecting two conductors at least one of which is a flexible composite cable conductor which comprises a contact sleeve, means forming part of said contact sleeve for attaching said sleeve to one of the conductors, a contact plug fitting closely inside the contact sleeve, the contact plug having an unthreaded longitudinal bore which tapers from each end to a minimum cross-section substantially in the center of the length of the plug and being split longitudinally into at least two segments, each segment having means forming a part thereof for attaching the segment to part of the other conductor which is a composite flexible conductor, a tapered member shaped to fit the taper at one end of the bore, a second tapered member shaped to fit the taper at the other end of the bore, and means for forcing the two tapered members towards each other when in position in the bore whereby the segments of the contact plug are forced outwards against the inner surface of the contact sleeve, thereby making the electrical connection.

2. An electrical connector as claimed in claim 1 wherein the contact sleeve is cylindrical.

3. An electrical connector as claimed in claim 1 wherein the bore of the contact plug is circular in cross-section.

4. An electrical connector as claimed in claim 1 wherein the contact plug is split into three segments.

5. An electrical connector as claimed in claim 1 wherein the first tapered member comprises a bolt threaded at one end to receive a nut and shaped at the other end to fit the taper at one end of the bore, and wherein the second tapered member comprises a nut adapted to be screwed on to the bolt.

6. An electrical connector as claimed in claim 5 wherein the nut comprises a tapered portion and a head portion, the head portion being configured for co-operation with a turning tool.

7. An electrical connector as claimed in claim 5 wherein the head of the bolt is provided with a lug, said contact plug having a recess in the wall thereof into which said lug fits.

8. An electrical connector as claimed in claim 5 wherein the bolt has a transverse passage which corresponds, when the bolt is in position in the connector, with a transverse passage through the portion of the contact plug not enclosed by the contact sleeve, whereby a tool can be passed through a passage in the contact plug and through the bolt.

9. An electrical connector as claimed in claim 5 wherein the threaded end of the bolt is provided with a longitudinal threaded recess, whereby the threaded end of a tool can be passed through the nut and screwed into the threaded recess.

10. An electrical connector as claimed in claim 1 wherein the contact plug is split into four segments and has a bore of square cross-section, wherein the two ta-

pered members are threaded internally one with a right-hand thread and the other with a left-hand thread, and wherein the means for screwing the two tapered members together comprises a stud with right-hand threads at one end and left-hand threads at the other end, whereby turning the stud in position screwed into the two tapered members causes the tapered members to be drawn together or apart.

References Cited in the file of this patent

UNITED STATES PATENTS

1,154,883	Portman	Sept. 28, 1915
1,922,099	Kilian	Aug. 15, 1933
1,957,533	Gelpcke	May 8, 1934
2,497,568	Thacker	Feb. 14, 1950
2,593,981	Capita	Apr. 22, 1952
2,685,632	Behinke et al.	Aug. 3, 1954