ELECTRICAL CONNECTOR FOR TAPPING A CONCENTRIC ELECTRICAL CABLE


Filed: Aug. 9, 1973

Appl. No.: 387,071

U.S. Cl. 339/97 R
Int. Cl. H01r 11/20
Field of Search 339/97-99, 339/177; 333/6

References Cited
UNITED STATES PATENTS
2,097,426 11/1937 Arthur et al. 339/97 R
2,798,204 7/1957 Bennett 339/97 P
3,461,419 8/1969 Link 339/97 R

ABSTRACT

A connector assembly for tapping an energized underground distribution cable. The connector includes a two-section metallic housing which may be assembled and clamped around a properly prepared portion of the cable which is to be tapped. The housing includes a threaded opening into which a bushing plug is inserted. A conductor stud in the bushing plug has a pointed and threaded end which pierces the insulation and the inner conductor of the tapped cable. Insulating material is injected into the housing and a load-break connector is inserted into terminal on the bushing plug to complete the tap. The threads of the housing opening and of the stud end have the same pitch to provide the force for penetrating the insulation and the inner conductor.

8 Claims, 4 Drawing Figures
ELECTRICAL CONNECTOR FOR TAPPING A CONCENTRIC ELECTRICAL CABLE

BACKGROUND OF THE INVENTION

1. Field Of The Invention:
   This invention relates, in general, to electrical connectors and, more specifically, to electrical connectors for tapping an energized concentric electrical cable.

2. Description Of The Prior Art:
   Underground power distribution systems present certain unique problems associated with tapping onto the system as compared to overhead power distribution systems. Underground distribution systems use concentric electrical cables which have inner and outer conductors that are separated by a solid insulating material.

   Several arrangements may be used to tap onto the electrical cable, but each arrangement has specific disadvantages. Taps could be installed relatively easily if the cable was de-energized; however, this would interrupt service to existing customers served through the cable. All of the taps could be installed during the initial installation of the cable; however, this would prove inefficient since it is impossible to determine in advance where all future taps will be needed.

   One of the best solutions to the tapping of energized underground cables is provided by electrical connectors which may be placed around the cable and which force an electrode or contact through the insulation and into the inner conductor of the cable. U.S. Pat. No. 3,461,419 and U.S. Pat. No. 3,602,872, the latter patent being assigned to the assignee of this invention, disclose such connectors. The connectors described in both of the referenced patents are useful; however, they exhibit certain characteristics which may be undesirable in some applications. The connectors of the prior art require a substantial amount of force to be applied to the cable to pierce its insulation. Also, the tapping cable is energized at the moment the connector pierces the insulation and comes into contact with the inner conductor. In addition, no convenient method may be used to disconnect the tapping cable. Therefore, it is desirable, and it is an object of this invention, to provide an electrical cable connector which may be used to conveniently, safely and quickly provide a useful tap onto an energized underground electrical power distribution cable.

SUMMARY OF THE INVENTION

   There is disclosed herein a new and useful electrical connector for tapping an energized concentric cable. The connector disclosed does not energize the tapping cable during the installation of the connector, does not exert a relatively large amount of force against the cable insulation, and provides a convenient method for disconnecting the tapping cable if desired.

   The connector includes a two-section housing which is located at a properly prepared portion of the energized cable. A lower section of the housing supports the cable and includes a terminal to which the outer conductors of the tapped and tapping cables are connected. An upper section of the housing includes a threaded opening into which a bushing plug may be inserted. The plug includes a stud which has a threaded and pointed lower end. As the plug is screwed into the housing opening, the stud is screwed into the insulation of the cable and into the inner conductor of the cable. The pitches of the threads on the stud and in the housing opening are equal, thereby permitting coordinated movement of the stud through the insulation. An insulating material is inserted into the housing to insulate the stud from the metallic housing. Final connection is accomplished by plugging a suitable load-break connector into the plug.

BRIEF DESCRIPTION OF THE DRAWING

   Further advantages and uses of this invention will become more apparent when considered in view of the following description and drawing, in which:

   FIG. 1 is a sectional view of an electrical connector constructed according to this invention and disposed around a concentric cable; FIG. 2 is a sectional view of the upper portion of the bushing plug shown in FIG. 1; FIG. 3 is an exploded view of the housing assembly of the electrical connector shown in FIG. 1; and FIG. 4 is a view of a bushing plug constructed according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

   Throughout the following description, similar reference characters refer to similar elements or members in all of the figures of the drawing.

   Referring now to the drawing, and to FIG. 1 in particular, there is shown an electrical connector 10 constructed according to this invention and assembled around an electrical cable 12. The purpose of the connector is to provide an insulated tap on the cable 12 which can be safely installed when the cable 12 is energized.

   The connector 10 illustrated in this specific embodiment includes a two-section housing which is constructed of a suitable metallic material, such as bronze. When assembled, the lower section 14 of the housing meets the upper section 16 to form the joint 18 which is located at the center level of the cable 12. A supporting block 20 is attached to the lower section 14 by the bolt 22. The supporting block 20 is constructed of a suitable insulating material, such as epoxy. An outer conductor terminal 24 is also attached to the lower section 14. The purpose of the terminal 24 is to provide means for attaching the outer conductors of the cable 12 and of the tapping cable which is to be tapped to the cable 12 to each other and to the connector housing.

   The connector housing may also be constructed of either a molded thermoplastic or thermoset material. With this type of construction, the molding compound could include a conducting filler or provided with a conductive coating to ensure electrical continuity over the semiconductive layers of the cable. Also, the supporting block 20 could be an integral portion of the lower section of the housing and left free of the conductive coating, thus remaining as an insulator. Provision would still be made on the external portion of the lower housing section for a terminal used in connecting together the outer conductors of the cable 12 and of the tapping cable.

   The upper section 16 of the connector housing is shaped to extend around the cable 12 and to mate with the lower section 14. The "cone" shape of the housing sections reduces the electrical stress gradient within the
3 connector housing. The sections 14 and 16 of the housing are fastened together by the clamps 26 and 28. The upper section contains a threaded opening 30 into which the bushing plug 32 may be inserted.

The portion of the cable 12 shown in FIG. 1 includes a semiconductive coating 34, insulation 36, and an inner conductor 38 which is normally formed from a plurality of wire strands. The outer conductor of the cable 12 is not shown in FIG. 1 since, before making the tap as illustrated, the outer conductor would have been removed from around the portion of the cable 12 which is illustrated.

The bushing plug 32 includes a body portion 40 which is constructed of an insulating material such as epoxy. A conductor stud 42 is embedded in the body portion 40 and is constructed of a suitable electrically conductive material such as copper. The lower end of the stud 42 is pointed for easy penetration into the insulation 36. The pointed end of the stud 42 is provided with threads 44 to facilitate penetration into the insulation 36 and the conductor 38. The threads 44 substantially reduce the force which must be applied to the plug 32 to effect the penetration, minimize damage to the insulation 36 and the conductor 38 during penetration, and improve the electrical contact between stud 42 and the conductor 38. Threads 44 and 46 have the same pitch so that, as the stud 42 is advanced by rotating the plug 32, there is no tendency for the threads 44 to elevate or depress cable 12 with respect to the support block 20. Such motion of the cable 12 would tend to cause the threads 44 to remove chips from the conductor 38 instead of threadably engaging with it, thus weakening the conductor and impairing electrical contact with the conductor 38.

The body portion 40 of the plug 32 also includes a polygonally shaped surface 48 which is conveniently shaped to permit the application of a wrench thereto for ease in rotating the plug 32. The threads 46 are large enough to permit a relatively large amount of downward force to be developed when the stud 42 is piercing the insulation 36.

The upper portion of the plug 32 is shown in FIG. 2. The stud 42 is threadably engaged with a finger contact 50. The insulating material 52 surrounding the contact 50 may be of any suitable composition, such as rubber, which permits some outward movement of the fingers of the contact 50 when a probe from a suitable electrical connector is inserted therein. The sleeve 54 is constructed of an arc-extinguishing material to help prevent the drawing of an arc out of the plug 32 when the probe which would be inserted therein is removed under load.

FIGS. 3 and 4 illustrate an exploded view of the electrical connector 10 shown in FIGS. 1 and 2. Reference to FIGS. 3 and 4 will be helpful in understanding the steps performed in making a tap with the connector 10. The electrical cable 12 is first prepared for tapping by moving the outer conductor 60 to fully expose the semiconductive coating 34. The conductor 60 is to be electrically attached to the upper section 14 of the housing. Continuity of the electrical circuit may be achieved by cutting half of the strands comprising the outer conductor 60 and connecting them to the lower section 14. After this has been completed, the other half of the strands may be cut and connected. With this procedure, a current path for the outer conductor current is maintained during the tapping process.

The semiconductive coating 34 is removed from a portion of the cable 12 to expose the insulation 36. The upper section 16 and the lower section 14 are placed around and centered with the insulation 36 and clamped tightly thereto by the clamps 26 and 28. The semiconductive coating 34 comes into electrical contact with the housing sections 14 and 16. The insulation 36 which surrounds the inner conductor of the cable 12 is positioned in the channel 62 of the supporting block 20. The supporting block 20 is shaped to prevent transverse motion of the cable 12 during the tapping operation.

The plug 32 is then inserted into the opening 30 in the upper section 16. Rotation of the plug 32 forces the tapered or pointed end 64 of the stud through the insulation 36 and into the inner conductor of the electrical cable 12. As can be seen in FIG. 1, the shoulder of the surface 48 is positioned to limit the amount of movement of the plug 32 into the housing. Thus, the stud 42 will not extend below the bottom surface of the inner conductor 38. When the conductor 38 is of relatively large diameter compared to the tapered portion of the stud 42 and it is desired to increase the area of contact between the stud 42 and the conductor 38, a longer stud which may penetrate completely through the cable 12 may be utilized. When a longer stud is used, the support block 20 is modified to provide a clearance hole around the projecting tip of the stud 42 which allows the insulation 68 to completely surround the insulating section of the stud 42.

After the plug 32 has been properly tightened, a suitable electrical insulating material 68, as shown in FIG. 1, is inserted into the housing through the opening 66 in the upper section 16 of the housing. The insulating material 68 may be inserted into the opening 66 in the form of a liquid or foam which becomes a solid after a sufficient length of time. The various epoxy resins which are commercially available are particularly suitable for this type of application. As shown in FIG. 1, the opening 70 permits the escape of air and any excess insulating material 68 during the filling process.

Another filling arrangement may be used whereby the insulating material 68 is placed into the housing before the plug 32 is rotated sufficiently to make electrical contact with the inner conductor 38. Any excess insulating material 68 is pushed out a suitable opening in the housing, such as opening 70, as the plug moves farther into the housing to make electrical contact. This arrangement provides insulation around the stud 42 at all times after it acquires the high potential of the energized inner conductor 38 and reduces corona effects.

After the plug 32 has been fully inserted into the housing and the insulating material 68 has been properly inserted, a suitable load-break electrical connector may be plugged into the upper portion of the plug 32 to complete the electrical tap. In most applications, an insulating cap should be placed over the upper end of the plug 32 until the load-break connector is to be installed.

The apparatus described herein provides a convenient and reliable arrangement for tapping an energized concentric power distribution cable. The arrangement is particularly suitable for underground or buried cables. Since numerous changes may be made in the above-described apparatus, and since different embodiments of the invention may be made without
departing from the spirit thereof, it is intended that all of the matter contained in the foregoing description, or shown in the accompanying drawing, shall be interpreted as illustrative rather than limiting.

We claim as our invention:

1. An electrical connector for tapping a concentric electrical cable, comprising:
   a housing disposable around the cable to be tapped;
   a plug inserted through an opening in said housing, said plug having threads thereon which are engageable with threads on said housing;
   terminal means located on said plug and adapted for electrical connection of a tapping cable; and
   piercing means for penetrating the insulation around the inner conductor of the cable to be tapped, said piercing means being located on said plug and being electrically connected to said terminal means, with the threads on said plug and housing advancing the piercing means toward the inner conductor when the plug is rotated, thereby forcing the piercing means through the cable insulation and into the inner conductor to establish electrical contact, said piercing means comprising an electrical conducting stud having a substantially pointed end, said stud including threads thereon which have the same pitch as the threads which engage the plug and the housing.

2. The electrical connector of claim 1 wherein the stud is embedded in and extends substantially through the plug.

3. The electrical connector of claim 1 wherein the housing comprises a bottom section constructed of an electrical conducting material, and a top section constructed of an electrical conducting material, said top section containing the opening through which the plug is inserted, with the threads on said housing extending around the inside of the portion of the top section which defines the opening.

4. The electrical connector of claim 1 wherein the plug comprises a body portion constructed of an electrical insulating material, with the threads on the plug extending around the outside of said body portion.

5. The electrical connector of claim 1 wherein the terminal means is located at an end of the plug and is adapted for engagement with a load-break electrical connector.

6. The electrical connector of claim 1 wherein a cable supporting block is attached to the housing and is positioned to support the cable when the piercing means is being forced into the cable.

7. The electrical connector of claim 1 wherein a solid insulating material substantially fills the space between the exposed portion of the piercing means and the housing.

8. An electrical connector for tapping an energized concentric electrical cable, comprising:
   a metallic housing suitable for placement around the cable to be tapped, said housing containing a threaded opening therein;
   a plug containing a metallic stud embedded in an insulated body portion of said plug, said body portion containing threads around the outside thereof; and
   terminal means for electrically connecting the tapping cable to said stud, with an end of said stud being substantially pointed and having threads disposed thereon, with the threads on said stud and the threads around the body portion of said plug having substantially the same pitch.