United States Patent [19]

Kraft

[11] **3,848,956**

[45] **Nov. 19, 1974**

[54] **SELF-SEALING UNDERGROUND TAP CONNECTOR**

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[73] Assignee: **Fargo Mfg. Company, Inc.,** Poughkeepsie, N.Y.

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[21] Appl. No.: **439,235**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 232,742, March 8, 1972, abandoned.

[52] **U.S. Cl.** ..... **339/98,** 339/223 R, 339/265 R

[51] **Int. Cl.** **H01r 11/20**

[58] **Field of Search** 339/94, 97–99, 339/223, 265

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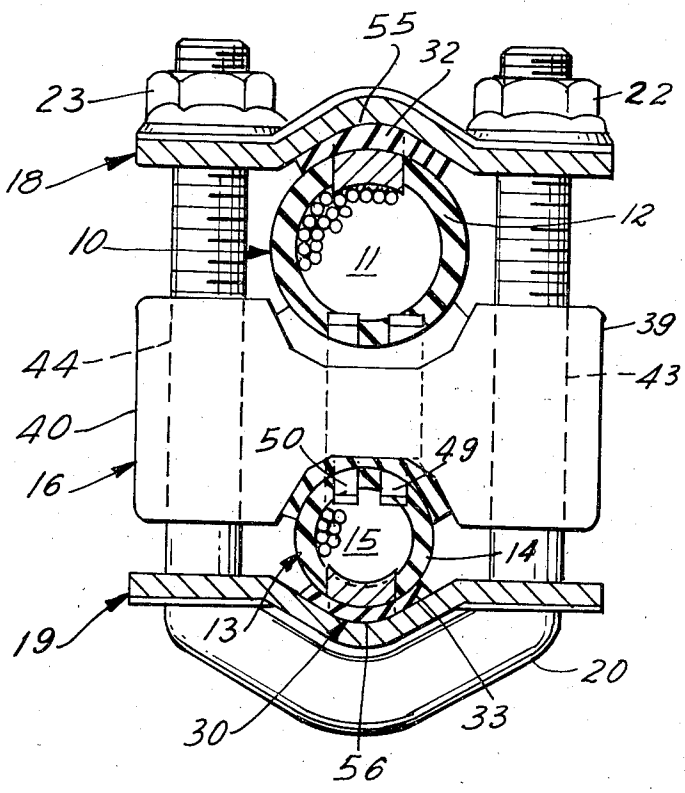
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Primary Examiner—Joseph H. McGlynn

[57] **ABSTRACT**

A connector for joining a high current capacity tap conductor to an unbroken run conductor in an underground application without removing the insulation from the run cable and which will provide a moisture-proof seal at the points of connection of the tap conductor and run conductor.

10 Claims, 5 Drawing Figures



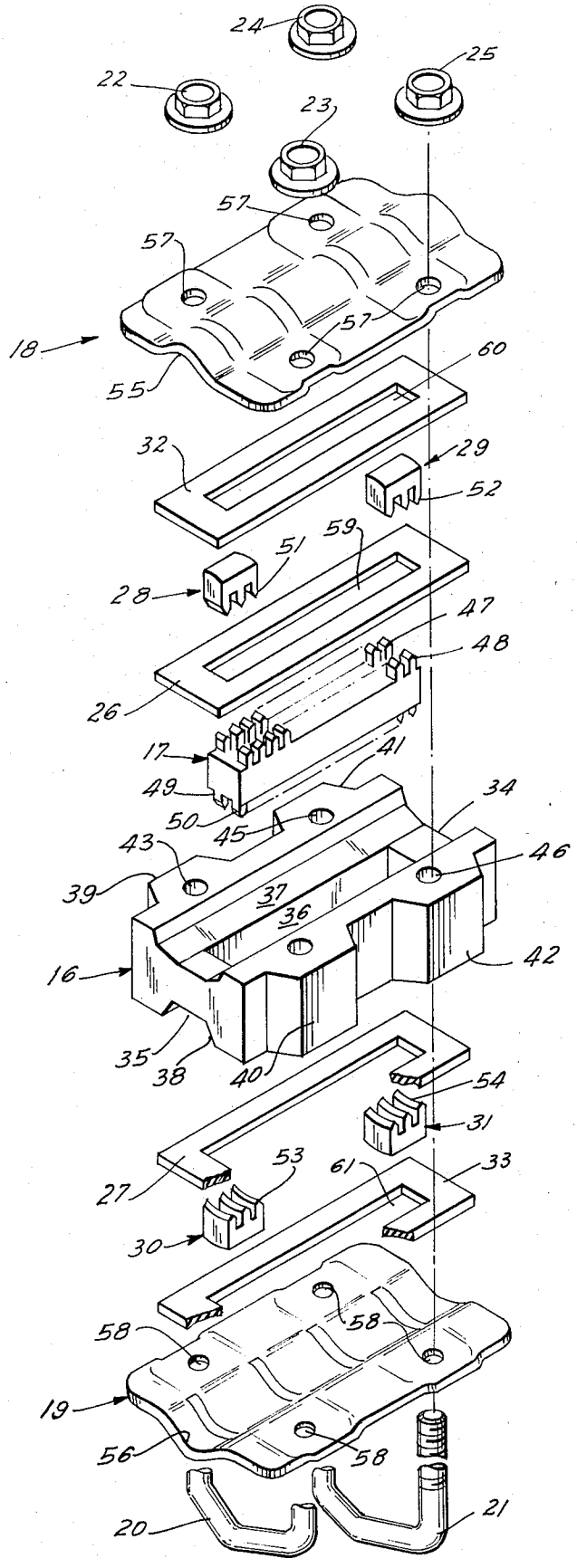

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FIG. 1

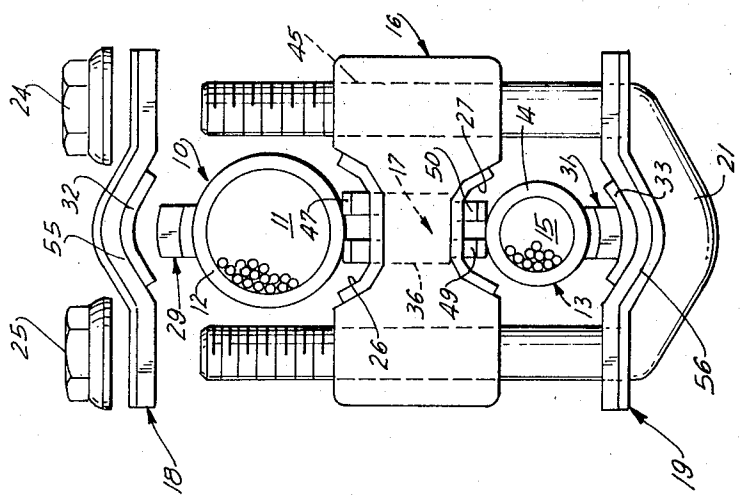

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FIG. 3

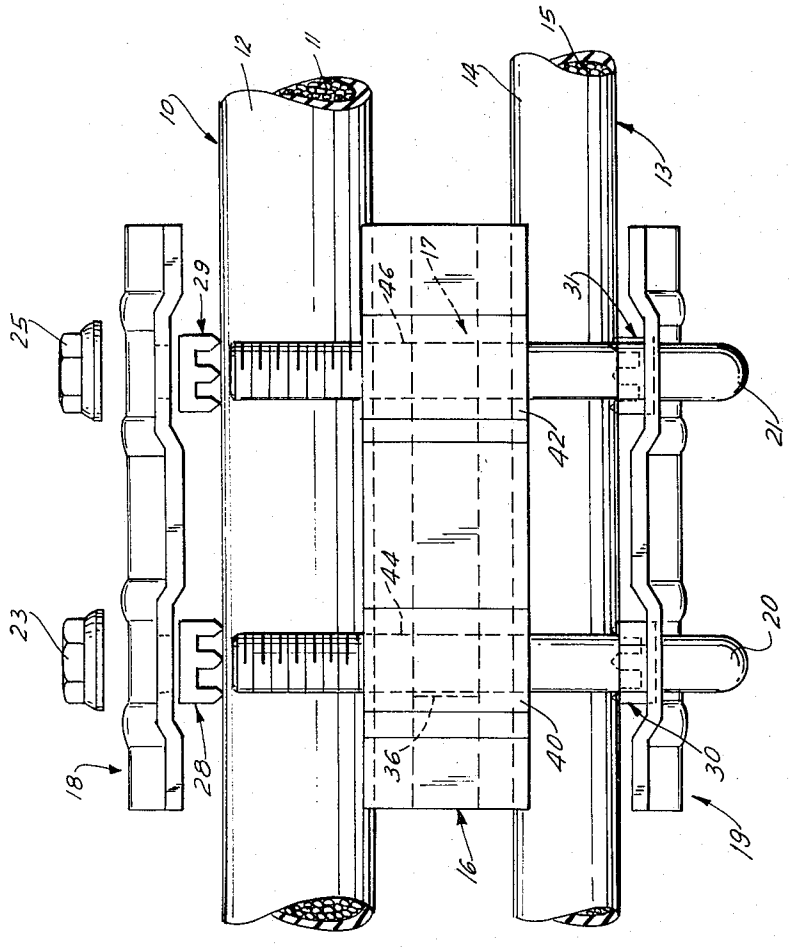

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FIG. 2

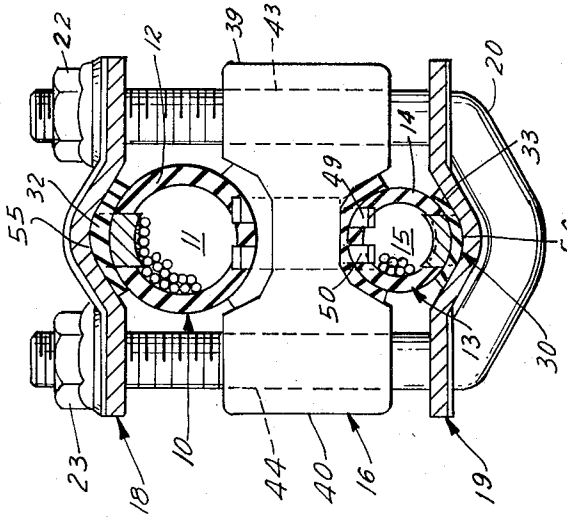

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FIG. 5

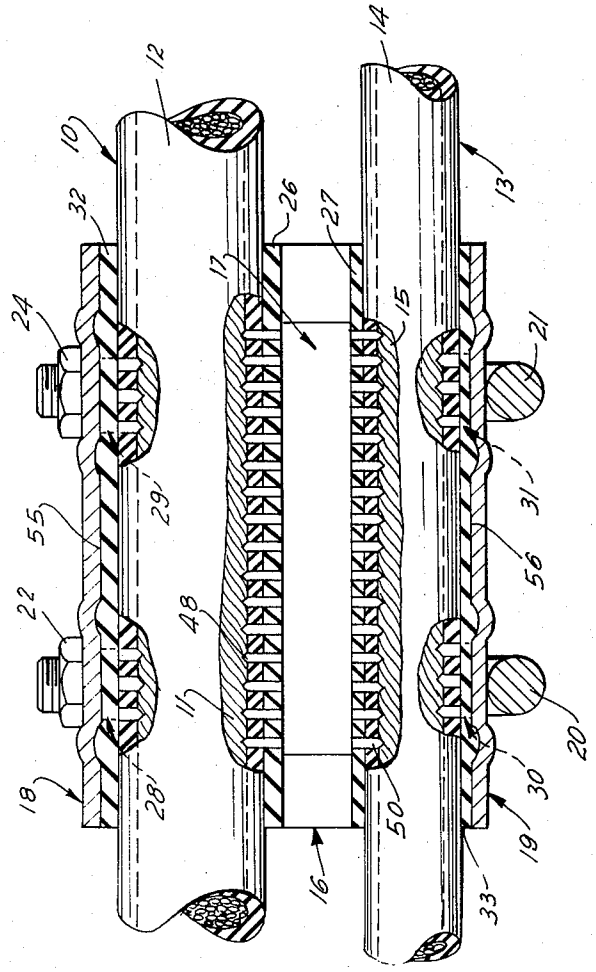

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FIG. 4

SELF-SEALING UNDERGROUND TAP CONNECTOR

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. application Ser. No. 232,742, filed Mar. 8, 1972, and now abandoned.

BACKGROUND OF THE INVENTION

It has become highly desirable to bury electrical transmission cables underground. Assemblies for such underground applications, for example, connectors wherein a tap conductor is joined to a run conductor, must be specifically designed with this underground use in view. Where direct burial has taken place, the connection of electrical conductors is made and left without benefit of enclosure in the ground or vault frequently. The connector must be moistureproof and proper sealing must be provided. This problem is aggravated by the fact that in underground installations there is a tremendous buildup of pressure due to variations of moisture in the earth and the connector must be designed with this factor being recognized.

A connector whereby a branch tap conductor can be joined to a main run conductor without the necessity of "skinning" the conductor and at the same time provide a watertight seal, is disclosed in U.S. Pat. No. 3,579,173; however, the connector shown therein is especially adapted to use with low current capacity taps. The requirement for a satisfactory high current capacity tap has remained. A connector for such use must be easily applied without the use of special tools and provide for installation while the cable is "live," provide good mechanical and electrical connections with appropriate moisture seals, have long life underground and be capable of easy disconnect of the tap conductor with a minimum of repair for the run conductor required. Additionally there must be no need of cutting the main cable during installation or "skinning" either the main run conductor cable or tap conductor and there must be no installation damage to the line or cable resulting from the application of the connector.

SUMMARY OF THE INVENTION

A connector for joining a tap conductor to a run conductor in which the connector includes a spacer bar formed of a non-conducting material, a slot in the spacer bar extending from one side to another with a conducting bar extending from one side to another with a conducting bar disposed within the slot, first and second rows of piercing teeth formed on the conducting bar and protruding from the slot, pressure means for pressing the run conductor and tap conductor toward the conducting bar and the teeth through the insulation of the run connector and tap conductor to produce a firm mechanical and electrical connection between the conductor bar and the run conductor and the tap conductor non-conducting idler teeth disposed respectively in spaced relation with said first and second piercing teeth for respectively receiving therebetween said run conductor and said tap conductor and said pressure means pressing the idler teeth into the run conductor and the tap conductor and insulation means respectively surrounding the connections of the tap conductor and run conductor to the conductor bar and the idler teeth.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a self-sealing underground tap connector constructed in accordance with the teachings of this invention with portions broken away to disclose to view details thereof;

FIG. 2 is a partially exploded longitudinal sectional view of the tap connector shown in FIG. 1 with a run conductor and tap conductor to be connected thereto shown in relative position immediately prior to the making of the connection;

FIG. 3 is a transverse view of the tap connector shown in FIG. 2 taken along the line 2—2 in the direction of the arrows in FIG. 2;

FIG. 4 is a longitudinal sectional view of the tap connector, run connector and tap conductor shown in FIGS. 2 and 3 with the connection completed; and

FIG. 5 is a transverse sectional view taken along the line 5—5 in the direction of the arrows in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The run conductor which is to be tapped by the tap connector disclosed herein is illustrated in the Figures and indicated by the numeral **10.** Cable **10** consists of electrically conducting strands **11** covered by insulation **12.** The insulation is of the type commonly used in underground installations such as rubber, plastics and paper. The tap conductor or branch conductor which is to be connected to conductor **10** is indicated in the Figures by the numeral **13** and includes its own insulation **14** around conductor **15.** The tap conductor shown in the Figures is also a stranded conductor and the insulation again is of the type commonly used in underground installations.

The tap connector consists of spacer bar **16,** conductor bar **17,** clamp pads **18** and **19,** U-bolts **20** and **21,** clamp nuts **22, 23, 24** and **25,** conductor bar sealant pads **26** and **27,** idler members **28, 29, 30** and **31** and idler sealant pads **32** and **33.**

The spacer bar **16** is molded, hard rubber but can be formed of any suitable non-conducting material. It is provided with guide channels **34** and **35** and through slot **36** which extends from its upper surface **37** to its lower surface **38** as seen in the Figures. Shoulders **39, 40, 41** and **42** project outwardly from the spacer bar **16** to provide circular openings **43, 44, 45** and **46** respectively for passage of the ends of U-bolts **20** and **21** therethrough.

The conductor bar **17** is formed of soft aluminum with a body configuration such that it fits snugly within slot **36** which is shaped to receive it with upper and lower rows of piercing teeth protruding from the spacer **16** at surfaces **37** and **38.** There are two upper rows of teeth and these are designated in the figures by the numerals **47** and **48.** Each row has a multiplicity of teeth with teeth of respective rows arranged side by side in transverse orientation on either side of the longitudinal center line of the conductor bar **17** at surface **37** so that the outer edges of adjacent teeth define a line and the lines so defined by each pair of teeth all lie in a single plane.

Likewise, there are two lower rows of teeth and these are designated in the figures by the numerals **49** and **50.** Each of these rows has a multiplicity of teeth with teeth

of respective rows arranged side by side as with the teeth in the upper rows in transverse orientation on either side of the longitudinal center line of the conductor bar **17** at surface **38** so that the outer edges of adjacent lower teeth define a line and the lines so defined by each pair of lower teeth all lie in a single plane which, of course, is a different plane than the plane in which the outer edges of the upper teeth lie.

The lower teeth are substantially identical to the upper teeth; however, in the embodiment disclosed herein, as is best seen in FIGS. **3** and **5** the upper teeth are somewhat larger than the lower teeth since it is intended that the run conductor which is of larger diameter than the tap conductor will be applied at the upper surface as seen in the Figures and to the upper teeth with the tap conductor **13** being connected at the lower surface and to the lower teeth of the conductor bar.

The slot **36** in spacer bar **16** is formed to hold the conductor bar **17** in a snug, tight fit which, due to the elastomeric material of the spacer bar, allows the conductor bar to "float" and allow for adjustment to the cable and line.

The clamp pads **18** and **19**, together with the U-bolts **20** and **21** and associated nuts **22, 23, 24** and **25**, provide a pressure means for pressing the cable **10** and line **13** toward the conductor bar and pressing the cable **10** toward upper teeth **47** and **48** and the line **13** toward the lower teeth **49** and **50** which presses the teeth through the insulation of the run conductor and tap conductor to produce a firm mechanical and electrical connection.

Idler members **28, 29, 30** and **31** are also formed of non-conducting material, although other material can be used, with each having a row of transverse protruding teeth such as teeth **51** of idler member **28**, teeth **52** of idler member **29**, teeth **53** of idler member **30** and teeth **54** of idler member **31**. The teeth are formed somewhat arcuately in the transverse direction.

The idler teeth **51, 52, 53** and **54** convey the compressive force from the outside plates directly to the conductor itself since these teeth also pierce adjacent conductor insulation when the nuts **22, 23, 24** and **25** are tightened on the U-bolts. The firm balanced grip prevents creep and movement and results in a firm mechanical hold. In certain designs it may be desirable to have the smaller or fixed part of a clamping device in which case there will only be piercing members on one side of the connector.

The piercing teeth of the conductor bar consists of a soft aluminum tooth configuration shaped to cut through the conductor insulation and then fold around the internal strands without causing damage to the strands, thus the conductor is not damaged because of penetration and the contact area is increased. Since this piercing tooth concept does not cause conductor damage, it is possible to provide multiple teeth to increase the current transfer capabilities of the connector.

Teeth can be provided to pierce the conductor insulation at different points around the circumference, such as top and bottom, triangular configuration, or to provide a cradle effect to maintain all mechanical pressures on the metallic strands and eliminate mechanical pressure on the insulating material. With all of the contact pressure exerted by teeth on the strands the nature of the insulation becomes a neglible factor in maintaining contact pressure. Since different insulations have varying flow characteristics under pressure and temperature variations it is most desirable to avoid reliance on this insulation as a permanent component in the contact pressure system.

When this approach of placing teeth around the circumference of the metallic strands is used, the teeth can be metallic where current flow is desired and non-metallic where insulating characteristics are required. Non-metallic teeth can be made with the same configuration as the soft aluminum teeth and fabricated of a material that is softer than the metallic strands so that it will fold over these strands without causing any physical damage.

Each of the clamp pads is provided with a guide channel such as guide channel **55** in pad **18** and guide channel **56** in pad **19**. The guide channels are arcuate bands centrally of the clamp pads which in the case of pad **18** channel **55** overlies guide channel **34** in the spacer bar and in the case of clamp pad **19**, the guide channel **56** overlies or faces guide channel **35** in the spacer bar. Additionally holes are provided in the clamp pads allowing the legs of the U-bolts **20** and **21** to pass therethrough as well as through the holes in the spacer bar to allow threaded end portions of the legs of the U-clamps to be engaged with nuts **22, 23, 24** and **25**. For the sake of simplicity, each of the holes in pad **18** are indicated by the numeral **57** and each of the holes in the pad **19** are indicated by the numeral **58**.

The sealant pads **26, 27, 32** and **33** are rectangular, soft easy flowing elastomeric members each of which is provided with a central rectangular slot through which teeth can project and which provide automatic sealing making the unit waterproof for direct burial in any type of soil, wet or dry. Pad **26** is provided with slot **59** through which teeth **47** and **48** project to embrace main cable **10** and pad **32** is provided with slot **60** through which teeth **51** and **52** can project to also embrace run conductor **10**. Pad **27** is provided with slot **61** through which teeth **49** and **50** can project to embrace tap conductor **13** and pad **33** is provided with slot **61** through which teeth **53** and **54** can project to also embrace tap line **13**. The pads, when used, provide water insulation means surrounding the rows of piercing teeth. When the pads are not used, this insulation is provided by the pressing of the insulation of the conductor directly against the tooth bearing members.

In assembling, the run conductor or main cable is wiped clean and dry in the area where the tap is to be made. The end of the tap conductor can be sealed by a standard commercial tap or with tape. The combination of the spacer bar, conductor bar, idler members, clamp pads and U-clamps is taken and the clamp nuts, top pad **18** and idler members **28** and **29** are removed. Spacer bar **16** is then raised high enough to thread the tap line **13** into position in channel **35** together with idler members **30** and **31** and sealant pad **33**, and the sealant pad **27** is placed between the spacer bar **16** and the tap line **13**. The spacer is then pressed downwardly and pad **26** placed in position with idler member **28** and **29** and pad **32** and the connector held up against the main cable. Clamp **18** is then placed in position over the cable and the nuts **22, 23, 24** and **25** are tightened. The connection is then complete.

It is seen that there has been no necessity to cut the run conductor or skin or remove insulation from either the run conductor or the tap conductor. The soft aluminum piercing teeth of the conductor bar cut through

the insulation of the run conductor and tap conductor with minimum damage to the insulation with the piercing teeth deforming around the harder aluminum strands of the conductors. These teeth do not cut or damage in any way the current capability of the run conductor since the material from which these teeth are formed is softer than the material from which the conductor strands are formed. The piercing teeth, however, being stronger than the insulation surrounding either the run conductor or the tap conductor can readily pass through this insulation.

The multiplicity of piercing teeth increases the contact area on the strands of the respective conductor making electrical contact with numerous strands making a safe, high current connection. By multiplying the number of teeth or contact surfaces along with increased contact surface due to the use of soft material teeth increases the current capabilities of the device making it a full or high current device rather than a limited current device as are presently existing products. No special tools are required for the installation and no extreme forces or special knowledge is needed to install. The double rows of teeth aids in centering the respective run or tap conductors on the conductor bar and the floating of the conductor bar aids this. The teeth provide a short, direct current transfer path and the mass of the conductor bar, together with the metal in the conductors, acts as a heat sink and conducts heat away from the contact teeth thereby deterring excessive heat buildup at the contact surfaces. The teeth are driven through both conductors simultaneously and the connection can be made to an energized run conductor with no special precautions. The seal is completed before the teeth completely penetrate the cable insulation and the energized parts are never exposed thereby minimizing danger to the installer. The U-bolt clamping mechanism assures positive rigid connection in a system able to withstand forces which pull, bend and tend to flex the conductors.

The idler teeth (top and bottom) of non-conducting material are added to convey the compressive force without pressing on a soft non-rigid material such as the cable insulation. The idlers provide a clamping chain from U-bolt to plate to idler teeth to tap conductor strands to piercing bar (and teeth) to run conductor strands to idler teeth to tap plate to nuts. This chain will maintain clamping pressure, ensuring a more permanently tight and good connection.

In the event the tap conductor is to be disconnected or otherwise discarded, all parts of the connector can be removed and the run conductor strands are left undamaged and only the insulation thereof needs to be repaired to provide a watertight seal over the tooth holes in the insulation. When the sealant pads are used, pressure applied will squeeze out any excess of the pad so that they enhance rather than interfere with the creation of a good insulation means. Thus, a tap connector for large current capacity tap connections has been provided.

I claim:

1. A connector for joining a tap conductor to a run conductor in which said tap includes a spacer bar formed of a non-conducting material, first and second surfaces of said spacer bar, a slot formed in said spacer bar extending from said first to said second surface, a conductor bar disposed within said slot, first and second groups of piercing teeth formed on and extending from said conductor bar protruding from said slot at said first and second respective surfaces of said spacer bar, a first idler member of said tap, first non-electrical conducting idler teeth of said first idler member disposed in spaced relation with said first group of piercing teeth for receiving said cable therebetween, a second idler member of said tap, second non-electrical conducting idler teeth of said second idler member disposed in spaced relation with said second group of piercing teeth for receiving said conductor therebetween pressure means for pressing said first group of piercing teeth and said first idler teeth and said second group of piercing teeth and said second idler teeth toward each other whereby said first and second groups of piercing teeth respectively pierce through the insulation of said run conductor and said tap conductor to produce a firm mechanical and electrical connection between said conductor bar and said run conductor and said tap conductor, and said first and second idler teeth respectively pierce through the insulation of said conductor and said line to produce a firm mechanical connection, and first, second, third and fourth insulation means respectively surrounding said first and second groups of piercing teeth and said first and second idler teeth.

2. A connector for joining a tap conductor to a run conductor in accordance with claim **1** in which said first and second insulation means are respectively the insulation of said run conductor and said tap conductor respectively embracing said spacer bar.

3. A connector for joining a tap connector to a run conductor in accordance with claim **1** in which said spacer bar is formed of an elastomeric material so that said conductor bar is maintained in floating relationship thereby.

4. A connector for joining a tap conductor to a run conductor in accordance with claim **1** in which said pressure means includes first and second clamp pads respectively embracing said cable and said line and drawn together by bolt means.

5. A connector for joining a tap conductor to a run conductor in accordance with claim **1** in which said first insulation means is a first elastomeric pad surrounding said first group of piercing teeth with a slot formed therein through which said teeth project with one side of said pad embracing the insulation of said main or run conductor and the remaining side thereof embracing said first surface, said second insulation means is a like pad surrounding said second group of piercing teeth through which said teeth project with one side of said pad embracing the insulation of said tap conductor and the remaining side thereof embracing said second surface and said third and fourth insulation means respectively surround said first and second idler teeth embracing said run conductor and said tap conductor respectively and said pressure means.

6. A connector for joining a tap conductor to a run conductor in accordance with claim **5** in which said pressure means includes first and second clamp pads respectively embracing said run conductor and said tap conductor and said third and fourth insulation means respectively embrace said first and second clamp pads.

7. A connector for joining a tap conductor to a run conductor in accordance with claim **1** in which said piercing teeth can pierce the insulation of said cable and said tap conductor and are formed of a material

which is softer than the conducting material of said run conductor and said tap conductor whereby said teeth can readily pierce the insulation without damaging the conducting material of said cable and said line and allowing said teeth to deform and embrace the conducting material thereby increasing the contact surface.

8. A connector for joining a tap conductor to a run conductor in accordance with claim **7** in which said idler teeth can pierce the insulation of said run conductor and said tap conductor and are formed of a material which is softer than the conducting material of said run conductor and said tap conductor whereby said teeth can readily pierce the insulation without damaging the conducting material of said run conductor and said tap conductor and allowing said teeth to deform and embrace the conducting material.

9. A connector for joining a line to a cable in accordance with claim **7** in which each of said first and second groups of teeth has a multiplicity of teeth with teeth of respective groups arranged in rows with teeth of respective rows arranged side by said in transverse orientation on either side of the longitudinal center line of the conductor bar.

10. A connector for joining a line to a cable in accordance with claim **9** so that the outer edges of adjacent teeth in each of said rows defines a line and the line so defined by each pair of teeth all lie in a single plane.

* * * * *