March 18, 1952 M. A. GRAHAM ET AL 2,589,368

PIGTAIL ELECTRIC CONNECTOR

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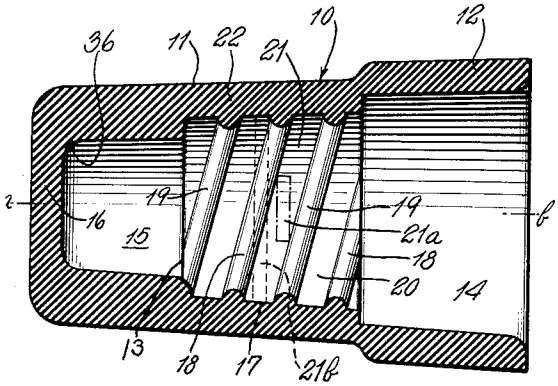


Fig. 1.

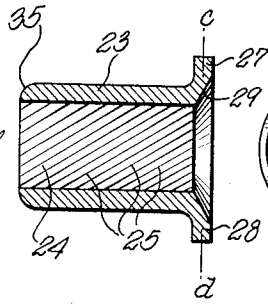


Fig. 2.

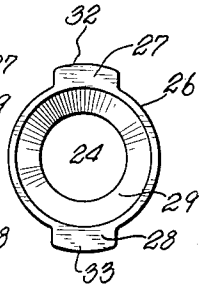


Fig. 3.

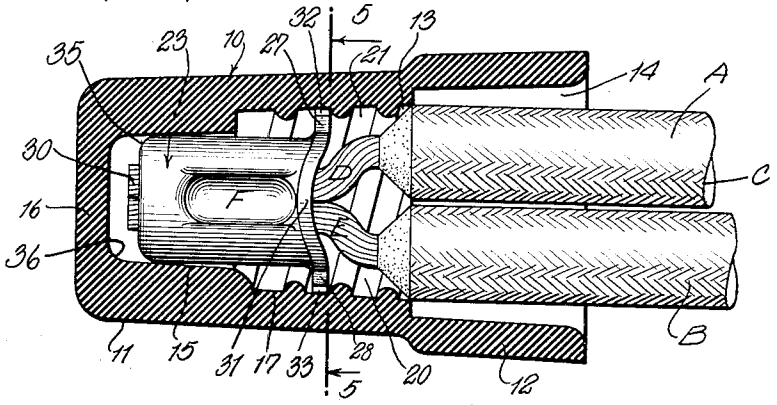


Fig. 4.

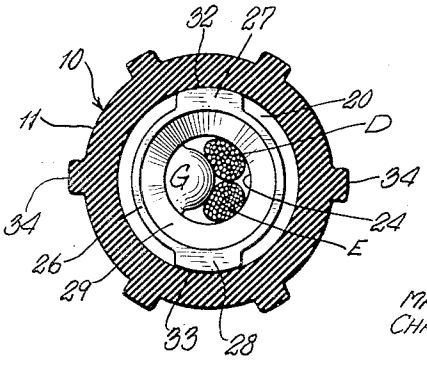


Fig. 5.

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PIGTAIL ELECTRIC CONNECTOR

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9 Claims. (Cl. 174—87)

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The invention relates in general to an improvement in that class of electric connectors in which a plurality of bared ends of conductors laid in parallel relation are contained in a metallic splicing sleeve screwed into a protective insulator cap, and which form of connectors are generally identified in the trade as "pigtail splicers." It is known in this art to intrude the bared conductor ends into the bore of a contractible metal splicing sleeve which is provided with thread forming members, such as the outstanding helicodal flange sections of relatively steep pitch shown in the patent to Jasper 2,040,383, May 12, 1936, turning in screw threaded engagement with matching threads formed to receive the same in the bore of the insulating cap which is fashioned to contain the sleeve. It has been the general practice in this art to use the outer insulator cap which is screwed on to the metallic splicing sleeve with a single lead threaded connection therebetween, and which cap is otherwise organized as a means to compress the splicing sleeve in several different ways on to the bared conductor ends contained therein. This practice has many objections particularly when considered with the necessity in this art of providing for high mechanical pressure applied on the splicing sleeve in order to obtain an approximate cold weld of the electric wires to each other, so that such a strong mechanical and low resistance bond is obtained between the conductors as is demanded in this art.

The insulator caps of the prior art devices, in addition to their primary function of insulating the splicing sleeves from contacting with adjacent objects, are thus intended to have two functions; that is, to secure the splicing sleeve fixed to the cap, and also to exert a radially directed squeeze pressure on the collapsible splicing sleeve so as to secure it to the conductor ends contained therein. It is obvious that more material must be used in the manufacture of these insulating caps in order to give sufficient structure strength to thus act as a clamp, than would be necessary if this sleeve compressing clamp action was not required. It is a fundamental observation that electric wires cannot be cold welded together simply by clamping them in a screw actuated clamp as practiced in the known art. The most satisfactory method of cold welding electric wires known at present is by crimping a distortable tube about them and the present disclosure features this means of securing the splicing sleeve to the bared conductor ends. The present disclosure also involves a technic in

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clamping the conductors to each other in such way as will weld the conductors to each other independently of and prior to the subsequent use of the insulator cap in which the spliced conductor ends so previously welded are housed.

Further, in these prior art sleeves the outwardly projecting thread forming flanges, ears, or lobes, hereinafter referred to generically as lobes, had to be formed more or less accurately as portions of a true screw thread, and thus with a turning fit in the corresponding troughs or channels between the threads formed on the bore wall of the insulator cap. Splicing sleeves with such known forms of thread forming elements or helicodal lobes, are difficult to manufacture cheaply as a factory proposition on a large scale, and unless carefully formed the sleeve is very apt to cant, cock or otherwise to run unevenly as it is screwed, often under powerful contracting pressures, into the insulator sleeve.

The invention has for an object in so far as its method aspect is concerned to suggest a simple and easily practiced technic for positively and permanently securing the bared ends of conductors in cold welded relation to each other and to their splicing sleeve and thus to secure them together independently of whatever may be used thereon subsequently as their insulator cap protection.

The primary objects of the invention in so far as the article aspects of the invention are concerned are to provide a simplified and thus more easily and cheaply manufactured form of pigtail splicer than has been known heretobefore; to avoid the above mentioned objectionable features of known similar devices and in general to provide a form of pigtail splicer capable of positively securing together a plurality of conductors in mutually spliced relation, as by crimping, so as to form the conductors and their splice together as a unit complete per se even before it is inserted in its subsequent automatically self-locked relation in the insulator cap.

Various other objects and advantages of the invention will be in part obvious from a consideration of the method features of the disclosure; from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one method for practicing the invention and of one form of device embodying the article aspect of the invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

In the accompanying drawings:

Fig. 1 is an enlarged view in axial section of the insulator cap element, considered as the outer shroud forming part of a two-part article of manufacture forming a preferred embodiment of the invention, before the cap element is installed in operative position in engagement with its associated splicer sleeve element as shown in Fig. 4;

Fig. 2 is a similar view of the coacting splicer sleeve element of the completed two-part assembly before being crimped on to the cable conductors;

Fig. 3 is an end view of the right end of the splicer sleeve shown in Fig. 2;

Fig. 4 is an axial sectional view of the completed assembly of the cap and sleeve elements shown in the preceeding figures, and in their final operative position connecting a pair of cable conductors in pre-fixed electrical and mechanical relation; and

Fig. 5 is a transverse sectional view of the completed assembly taken on the line 5—5 of Fig. 4 looking in the direction indicated by the arrows.

In the drawing and referring first to Fig. 1, there is shown an insulator cap 10 formed of any usual plastic insulating material, such as molded thermosetting substance of the phenol-formaldehyde type (Bakelite) and comprising a closed end barrel 11 and with its opposite open end forming a shroud 12. The bore 13 of the cap is of a stepped character; the outer open end portion 14 within the shroud being of maximum diameter and slightly tapered; and the inner portion 15 adjacent the wall 16 forming the closed end of the bore being of the least diameter and also like the portion 14 slightly tapered down from right to left.

The intermediate portion 17 of the bore is of frusto-conical form, tapered at about three degrees with its larger entrance end at the outer enlarged portion 14 of the bore; wide open thereto and forming a shoulder therewith. The intermediate portion of the bore wall is provided with two inwardly projecting integral threads or leads 18 and 19, disposed 180 degrees apart to thus form a double lead thread in the cap. It is a feature of this disclosure that the troughs or grooves 20 and 21 formed between the pairs of adjacent threads or leads are of some material width measured axially, and each has a spiral, ribbon-like contour as if wrapped about the surface of a slightly tapered cone with the threads separating each strip. In this way every portion of the groove 20 for instance on one side of the axis *a*—*b* of the bore is diametrically opposite a corresponding portion of the other groove 21 formed between the adjacent threads or leads at the opposite side of the bore and which opposing relation is indicated by the diametric parallel dotted lines 21*b* in Fig. 1.

As viewed in axial cross section in Fig. 1, the threads 18—19 are provided with well rounded crowns and with a pitch of about ten threads per inch at pitch lead of five thread double lead. The bore parts are dimensioned to receive the splicer sleeve 23 hereinafter described and the threaded portion 17 is dimensioned to permit the splicer sleeve to be advanced with its screw forming elements into a jammed tight fit between the threads 18—19 before the advanced end of the sleeve reaches the closed end wall 16 of the insulator cap.

It is a feature of this cap that it is formed of the least possible cross section of material in its relatively thin but substantially strong cylindrical wall 22 and end wall 16. These walls are formed of an amount of material merely sufficient to give them their necessary insulating effect, and to maintain their own configuration without too much distortion when subjected to the screwing action of the splicer sleeve 23. The double lead character of the threads herein featured also has the advantage of assisting in stripping the cap readily from its mold at the time it is formed and to give a highly desirable fast lead for the lobes of the splicer sleeve as it is screwed into place as shown in Fig. 4.

The splicer sleeve 23 as shown in its initial manufactured form in Figs. 2 and 3, is simply a drawn, open end tube of thin sheet metal, such as sheet copper, and in general of the style and gauge commonly used at present when such tubes are designed to be crimped onto electric conductors in splicing the same together. The sleeve is provided with an open end bore 24 of uniform cross section and in the instant case is dimensioned to receive at least two or more conductors, usually three or four. The wall outlining the bore 24 is preferably provided with spirally inclined serrations 25, or the bore wall is otherwise roughened, to enhance the gripping effect of the sleeve on the bared ends of the conductors and to penetrate oxides and dirt for clean low resistance contact when the sleeve is crimped or otherwise distorted as it is squeezed thereon as hereinafter described. The sleeve is provided at one end with an outstanding narrow annular flange or bead 26 located to strengthen the intake end of the sleeve. A pair of thread engaging lobes 27 and 28 project outwardly from diametrically opposite sides of the flange 26 as best shown in Fig. 3 to form in effect a flat, uniplanar, mutilated lead. It is a feature of this disclosure that the lobes are both in the same transverse plane *c*—*d*, perpendicular to the bore axis *a*—*b* as best shown in Fig. 2, and thus are not bent at an angle to form the inclined threads or helicodal flange sections of the prior art. These lobes are designed each to have a screw fit in its associated spiral trough or groove 20—21; to have a width to fit angularly between the threads 18—19 as shown in dot and dash outline at 21*a* of Fig. 1, and collectively to have a diametrical length in the plane *c*—*d* eventually to fit snugly between the opposing portions of the grooves 20 and 21 as shown in Figs. 4 and 5. The lobes 27 and 28 are of uniform circumferential and radial width as viewed in Fig. 3; and their outer curved edges 32 and 33 are in the same circle whose center is at the axis *a*—*b* as best shown in Fig. 5.

The end of the sleeve provided with the flange 26 and associated lobes has its bore countersunk to provide a funnel shaped entrance 29 to the bore and which bevelled entrance acts to facilitate the intrusion of the cable ends 30 as they are passed into and along the bore 24. The flange 26 tends to compensate for any weakening of material by reason of removing metal to form the bevel at 29. Incidentally, the bevel face 29 provides an exposed flat surface as shown in Fig. 5 designed to have identifications, trademark matter, and like usual matter stamped or otherwise impressed therein.

It is understood that different numbers and sizes of conductors are intended to be inserted in the splicer sleeve and that the size of its wire contents, as well as the manner in which the crimping is made, will affect the final dimension of the sleeve when ready to be inserted into the insulator cap. Normal variations in the final

size of the sleeve are anticipated by giving the troughs or grooves 20 and 21 some material extent of depth and by designing the diametric distance between the curved edges 32 and 33 so as to be slightly less, when the crimping operation is completed, than the diameter of the grooves or troughs 20 and 21 at their intake ends.

In operation let it be assumed that two insulated conductors or cables A and B have this insulation C stripped back for an inch or so to expose a pair of bared ends D and E of their associated conductors. They are grouped when coming through the outlet box or junction box and then sometimes twisted together and tested for their proper circuits before the permanent connection is made. If no preliminary circuit testing is required, the wires may be inserted into the sleeve bore without twisting. The bared ends are then properly related to each other; laid into contacting parallel relation as indicated in Fig. 4, and advanced into the splicer sleeve bore through the intake end 29 and disposed so that in the completed assembly they will extend entirely through the bore 24 and preferably with their free ends 30 projecting slightly beyond the opposite end of the sleeve but spaced from the wall 16 as shown in Fig. 4. It is also suggested that the cables A and B be advanced with their bared ends extending through the bore 24 until their insulation abuts the bevel face 29 or the flange 26. In this way the lengths of exposed conductors at D and E are minimized.

With the conductors so located in the sleeve 23, that portion thereof between the flange 26 and the opposite open end is then crimped on to the conductor ends D and E by means of any of the powerfully acting hand pliers or power tools now known following any of the known methods for crimping a metal sleeve by distorting one or opposite sides of the same onto the conductors intruded into its bore. The loose and excess ends of the wires or conductors are then clipped off close to the end of the sleeve to provide neat ends 30 to the assembly of bared ends and to the crimped sleeve. In the instant case, the crimping results in a long, lengthwise, flat-oval form of distortion of the metal of the tube forming a depression, indent, indenture or groove F on the outside of the sleeve 23 as shown in Fig. 4, and a long inwardly projecting rib or bead G, on the inside as shown in Fig. 5. Incidentally this has the effect of bending the side of the flange 26 adjacent thereto from the initially flat form as shown in Fig. 2, into the inwardly curved or arched form shown at 31 at Fig. 4. The outstanding lobes 27—28 are in no way affected by this crimping operation and at all times remain in the plane *c—d* and remain substantially so when the indenture is placed in its circumferential relation to the ends D and E as illustrated on the drawing. However, when the indenture is placed at ninety degrees or relatively so from the position indicated, that is, in line with the lobes 27—28 the distance between the edges 32—33 is drawn closer together. The taper of the inside walls and threads of the insulator cap takes care of this by allowing the metal splicer sleeve to enter deeper into the insulator cap where it will eventually tighten because of the smaller pitch diameter of the bore in the portion 17 as the wall 16 is approached.

It is understood that at this point of the operation the two cables A and B have their bared ends D and E mutually distorted and permanently crimped together in a cold weld and that

the resulting assembly of crimped sleeve and cable ends is in its final completed form ready to receive the cap 10. The assembly was thus completed without and independently of the cap.

It has been found, especially when the bore of the sleeve is roughened as herein indicated, that there is an increase in the "pull-out" of the various size wires used to form the cable conductors, and the instant device will develop high resistance to any relative shifting of the ends D and E and will act to prevent the wires forming the conductors separating from the sleeve. It is thus seen that the conductors are in their final clamped position, connected mechanically and electrically before the resulting assembly is screwed into the insulator cap. The cap has no other mechanical function except to secure itself to the electric assembly of cables and spliced sleeve thus formed and to insulate the splice.

In attaching the cap to the assembly the splicer sleeve is simply located with one of its lobes 27—28 in the trough or groove 20 at one side thereof, the other lobe in the portion of the groove 21 at the other side of the axis *a—b*, and the cap screwed axially into place as far as it will go. The turning is facilitated in the illustrated device by the use of external ribs 34 as shown in Fig. 5 which form a hand grip on the outside of the cap.

As the cap with its slightly tapered threaded portion 17 of its bore is tightened on to the splicing sleeve 23, the outer edges 32 and 33 of the lobes engage and gradually bear more and more firmly on the bottom of the grooves 20 and 21 until the cap can be turned no further.

As the cap reaches the limit of its advance the curved edges 32—33 of the lobes develop a jammed tight fit in the grooves 20 and 21 as shown in Fig. 5. It is perhaps true that there is developed a slight radial distention of the cap if sufficiently flexible to permit this, or at least it is strained outwardly and thus by elastic reaction squeezes inwardly more or less on the aligned lobes 27—28 to bind the splicer sleeve positively within the cap but this has no effect on the crimped portion of the sleeve. Anyhow as the inner end of the crimped sleeve, or as illustrated, the more or less short stiff ends 30 of the conductors, bear on the wall 16 the sharp edges of the lobes 27—28 have a tendency to dig into the threaded portion of the cap. The resulting jammed tight fit tends to keep the crimping sleeve assembly and the insulator cap together and the resulting frictional connection tends to prevent the parts from separating under the loosening effects of vibration to which such devices are sometimes subjected. It is also suggested that the taper of the bore of the inner portion 15 of the cap be designed so that the rounded advanced edge 35 of the splicer sleeve 23 bind against the smooth faced tapered wall 36 thus giving a more secure fitting than would be the case if the advance end was loose in the bore.

While Fig. 4 shows the sleeve 23 with its tubular end portion in advance of the lobes 27—28, it is possible to reverse the position of the sleeve so that the end provided with the lobes may be at the advanced end of the assembly.

Thermosetting and thermo-plastic materials have a characteristic resiliency so that the inner wall surface of the thread root will permit the edges 32 and 33 of the metal lobes to imbed themselves slightly into the cap 10 after tightening for a short while, which gives additional security against vibration loosening. The depth

of seating is so slight, however, that it will permit reverse turning under manual effort to remove the cap from the fitting.

It is particularly noted that the outer cap 10 is not required to react on the splicer sleeve 23 with any squeeze effect and thus need not be designed to so function.

The cap 10 is designed solely to have a screw action on the splicer sleeve in order to secure them together but is not designed to squeeze either the sleeve nor its contained conductors and thus can be made of relatively frail construction compared to the more rugged insulator caps of the prior art.

The splicer sleeve can be formed on conventional tube drawing machinery and it is particularly noted that the flat lobes 27—28 are more easily formed on such machinery than if they were formed to provide the usual pitched threads now known in this art.

We claim:

1. In a pigtail splicer, the combination of a plurality of conductors having bared ends, a metallic splicer sleeve formed of thin sheet metal and a portion of which is of tubular form and into the bore of which the bared ends of the conductors intrude, said splicer sleeve being crimped onto the intruded conductor ends to secure the conductors permanently to the splicer sleeve, an insulator cap having a tapered bore into which the crimped splicer sleeve with its associated conductor ends are intruded, the wall outlining the tapered bore provided with threads and said splicer sleeve provided at one end thereof with a pair of oppositely projecting outstanding lobes at all times disposed in a common transverse plane and extending perpendicular to the axis of the bore and said lobes being in threaded engagement with the threads of the cap and angularly disposed relative thereto.

2. An article of manufacture comprising two telescoped members, the outer member formed of insulating material and having a bore, a portion of which is slightly tapered, said tapered portion provided with threads, said outer member having a relatively thin cross section of material and not intended to transmit any inwardly directed squeeze action onto the inner member, the inner member forming a distortable metallic tube having a pair of outstanding flat lobes at all times disposed in the same transverse plane and forming flat plates of a single thickness of material adapted to have a screw-like engagement in opposite sides of the grooves formed between the threads of the outer member.

3. The article defined in claim 2 and in which the outer edges of the lobes are in the same circle whose diameter is slightly less than the diameter of the grooves at their intake ends whereby as the outer member is turned on the inner member the lobes are jammed tight on the portion of the outer member defined by the grooves.

4. In an article of manufacture, the combination of two units in inter-threaded telescopic relation and each prefabricated and complete per se before being assembled in their final screw-threaded telescopic relation, one unit comprising an insulator cap provided with a bore at least a portion of the wall of which is slightly frusto-conical and provided with a thread forming a wide spiral groove between the turns of the thread, and the other unit comprising a sleeve formed of one piece of ductile metal, and a plurality of conductors intruded into the same, said sleeve provided on opposite sides thereof with a pair of indents permanently crimping the sleeve on to the conductors, said sleeve provided at one end thereof with a narrow annular flange for reinforcing the sleeve at said end, and a pair of flat lobes projecting integrally from the flange in diametric relation and at all times disposed in a common transverse plane and fashioned with a snug fit in the groove formed between the threads of the cap to form a screw-threaded connection between the crimped sleeve and the cap, the portion of the annular flange between the lobes being each curved from said transverse plane of the lobes inwardly towards its associated indent.

5. An article of manufacture including an outer hollow cap of insulating material and an inner metallic sleeve of ductile material adapted to be crimped onto conductors intruded into its bore, said sleeve provided with a pair of diametrically related rigid, flat, outstanding lobes located in a plane substantially perpendicular to the axis of the sleeve, a portion of the bore of the cap being tapered and provided with means coacting with the lobes to form a screw connection between the cap and sleeve, said means forming at least one groove of materially greater width than the thickness of the lobes turning in the same and in which groove the lobes each extends at an angle to the length dimension of the groove.

6. An article of manufacture constituting a one-piece splicer sleeve formed of thin sheet ductile metal provided with a bore and having a cylindrical portion with a continuous wall free of joints and sufficiently thin to be crimped by manual force on to one or more conductors intruded into the bore, said sleeve provided at one end thereof with a narrow outstanding continuous annular flange outlining the adjacent end of the bore- externally of the sleeve, and a pair of diametrically related outstanding lobes projecting outwardly and integrally from the flange, said flange integrally connecting the root ends of the lobes in circumferentially spaced-apart relation, said lobes being disposed in the same transverse plane and adapted to function as elements of a screw connection for connecting the sleeve to a cap screwed on the sleeve, the outer exposed edges of the lobes being disposed in the same circle concentric with the axis of the bore, the bore at the end of the sleeve having the flange countersunk to provide a funnel-shaped entrance to the adjacent end of the bore and said funnel-shaped entrance being encircled by the annular flange.

7. In a device of the class described, the combination of two preformed elements in screw-threaded telescopic relation, the inner of said two elements constituting a metallic splicer sleeve, a portion of which is of cylindrical form and fashioned to be crimped onto conductors in its bore before the sleeve is inserted in the outer element, said sleeve provided at one end with a pair of outstanding lobes disposed in a plane extending at right angles to the axis of the sleeve and whose outer edges define a circle of greater diameter than the cylindrical part, the outer of said two elements forming a molded cap of thermosetting insulating material having a bore for receiving the sleeve, a portion of said bore being provided with a groove in which the lobes turn, the entrance end of the groove having a diameter slightly greater than said lobe-forming circle and its other end having a diameter less than that of

said circle and said lobes when the device is turned into a jammed-tight engagement with the lobes tending to bite into the thermosetting material forming the bottom of the groove to effect a frictional tight binding engagement between the sleeve and cap.

8. The combination of two elements, one telescoping within the other in rotative screw-threaded engagement, the outer of said two elements provided with a bore whose wall is provided with an inwardly-facing spiral groove, the inner element provided with at least a pair of outstanding lobes running in the groove, said lobes being each substantially flat, extending at an angle to the length dimension of the groove in which it runs and disposed in a plane approximately perpendicular to the axis of relative rotation of the two elements.

9. In a device of the class described, the combination of a hollow cap of insulating material having a bore of stepped character and forming three portions and open at one end and a splicer sleeve of ductile material adapted to be crimped onto a conductor and inserted therewith into the bore of the cap through its open end, the portion of the cap bore at said open end being of maximum diameter and forming a shroud, the portion of the bore at its opposite end being of least diameter, the portion of the bore forming the shroud and its outer end being smooth, the intermediate portion of the bore lying between the shroud and said inner end at every part thereof having a diameter materially less than the diameter of the shroud-forming portion and materially greater than the diameter of the portion of minimum diameter, the intermediate portion and the other portion being each slightly tapered in the same direction, the bore in its intermediate portion provided with a screw thread forming a wide groove between the turns of the thread, the splicer sleeve dimensioned at one end to have a wedging fit in the smooth, tapered other end of the cap bore, and said sleeve provided with a pair of lobes having a threaded engagement in said groove, said lobes projecting outwardly from diametrically opposite sides of the sleeve, disposed in the same transverse plane, perpendicular to the axis of its bore with the outer edges of the lobes lying in the same circle and which circle has a diameter greater than that of the threaded intermediate portion of the cap bore at its minimum diameter and less than that at its maximum diameter.

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