Sept. 21, 1954 C. C. SUNDERLAND 2,689,389

SOCKET FOR WIRE STRANDS AND THE LIKE

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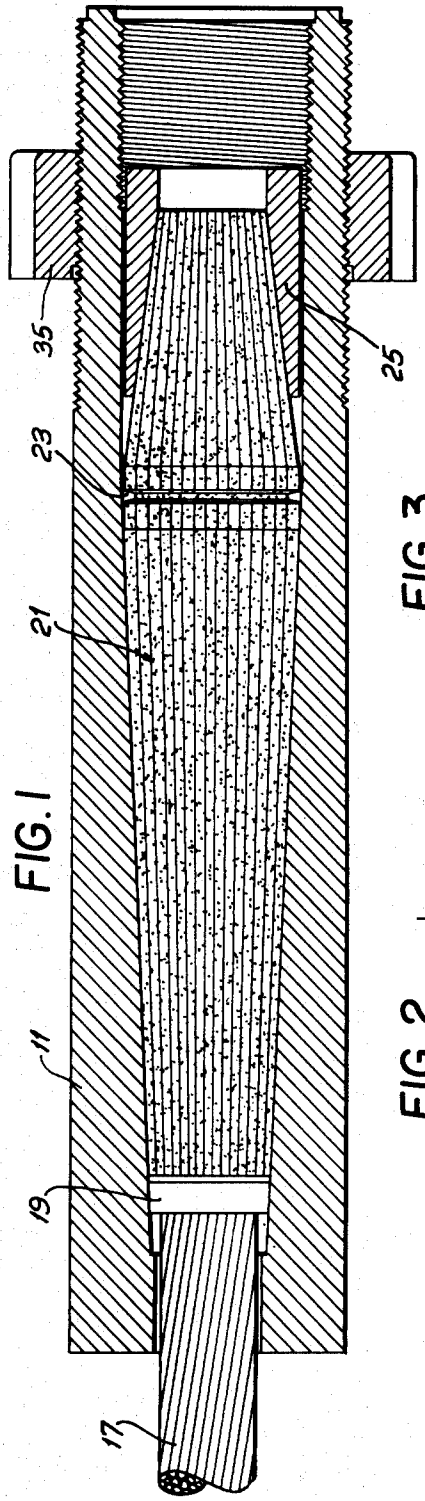



FIG. 1

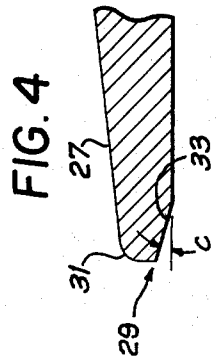



FIG. 4

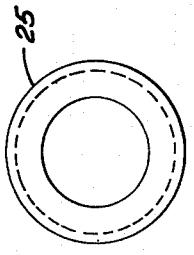



FIG. 3

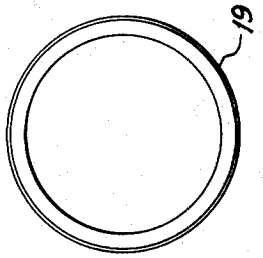



FIG. 6

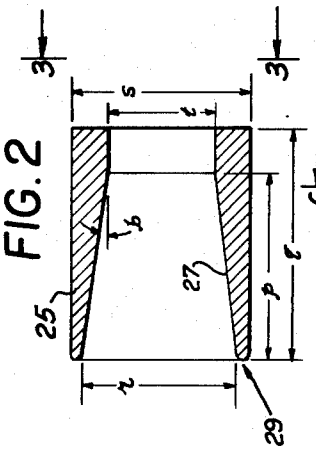



FIG. 2

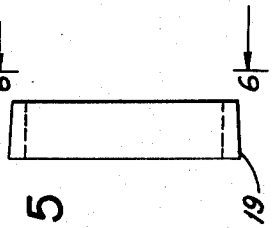



FIG. 5

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SOCKET FOR WIRE STRANDS AND THE LIKE

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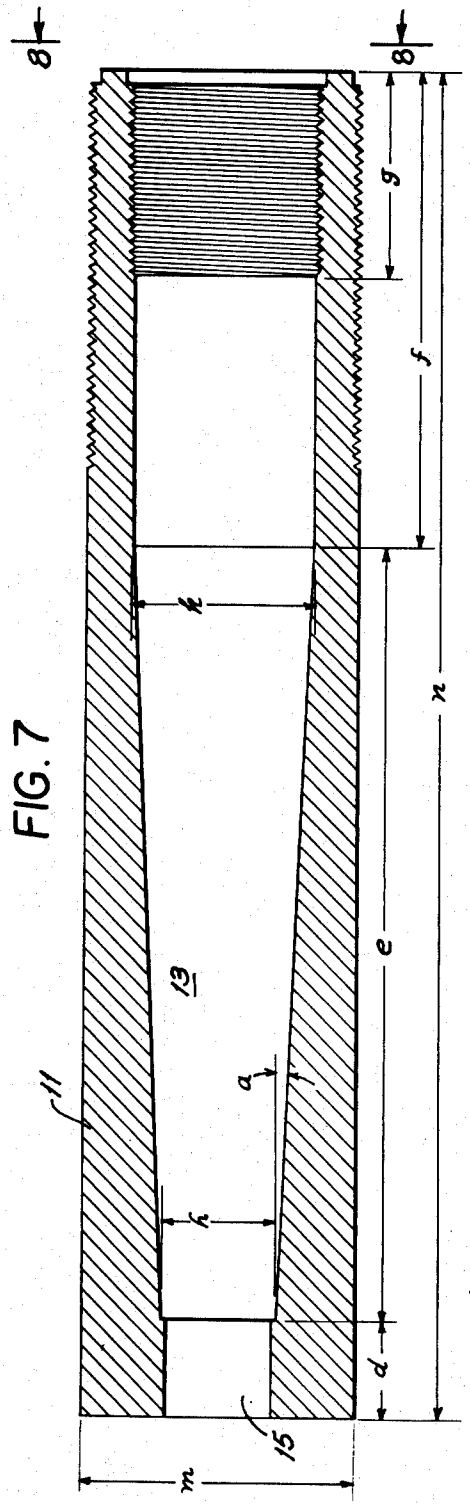



FIG. 7

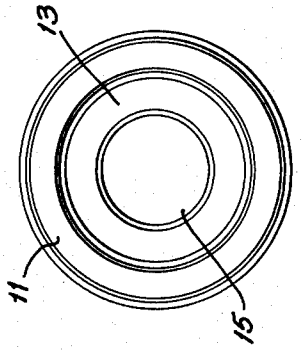



FIG. 8

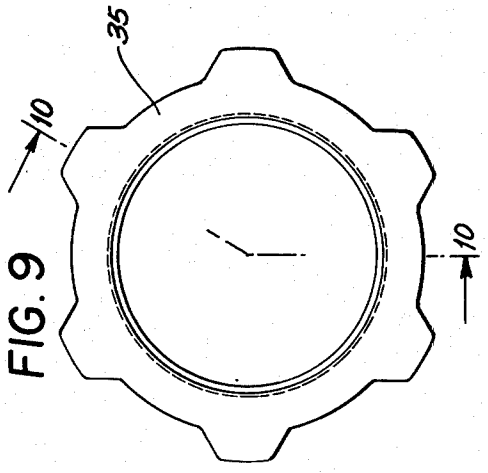



FIG. 9

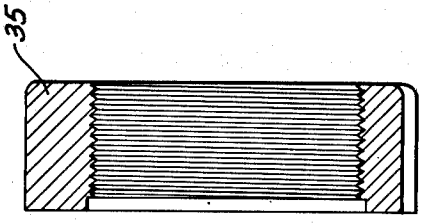



FIG. 10

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# UNITED STATES PATENT OFFICE

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## SOCKET FOR WIRE STRANDS AND THE LIKE

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Application April 26, 1952, Serial No. 284,670

3 Claims. (Cl. 24—122.6)

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The present invention relates to apparatus and a method for securing the ends of wire strands, wire ropes, wire cables, or similar wire materials. More particularly, the invention relates to a socket for securing the ends of high-strength wire materials of the type mentioned and to a method of applying such a socket.

In socketing strand and the like, it is customary to separate the ends of the wires of the strand and to embed them in a body of filling material, such as zinc or tin. A basket surrounds the strand and is adapted to receive, engage, and grip the body of filling material, and thereby grip and hold the strand. The front or strand end of the body of filling material may be given a tapered, conical shape, and the interior of the basket may be correspondingly conically tapered, so as to give a gripping action when the strand is placed under tension. That is, both the cone of filling material and the basket are tapered to smaller cross section toward the strand end, and when the strand is placed under tension, the cone of filling material is drawn farther down into the tapered basket, resulting in compression of the filling material, and consequent gripping of the strand.

One difficulty with such arrangements heretofore results from the fact that the filling materials begin to flow if the pressure to which they are subjected exceeds a certain amount. For example, zinc, which is often used for the filling material, begins to flow if the pressure exceeds 40,000 pounds per square inch. It has consequently been necessary heretofore to design the shape and size of the sockets so that the pressure on the zinc would not exceed 40,000 pounds per square inch when the strand was placed under a tension equal to its ultimate strength. Such designs have resulted in sockets larger than are desirable. In some applications, for example, in prestressed concrete, it is often necessary to group a number of strands together, and the best designs heretofore have produced sockets of such large outside diameter as to make it impossible to obtain the required close spacing of strands in a concrete beam.

One object of the present invention is to provide a socketing method and apparatus which, by operating upon a novel principle, makes possible the design and production of a socket of reduced outside diameter, while gripping the wire with sufficient intensity to develop the ultimate strength of the strand, or like material.

In one embodiment of the present invention, there is provided a basket having a cavity therein,

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the front portion of which is conically tapered and the rear portion of which is cylindrical. Within the cavity of the basket and gripped by its walls is a shaped body of filling material having the separated ends of the wires of the strand embedded therein. The body of filling material has two conical surfaces, a front one and a rear one. The front one converges toward the front, that is, toward the main length of strand, and engages the similarly conically shaped front portion of the wall of the cavity. The rear one converges toward the rear. Cooperating with and forming a portion of the front conical surface of the filling material is a tapered steel bushing surrounding the strand and having a conical outer surface fitting snugly with a wedging action against the front, conically tapered portion of the wall of the cavity. A tapered sleeve is forcibly wedged between the rear conical surface of the filling material and the cylindrical rear portion of the wall of the cavity of the basket. In applying the socket, the cone of filling material is drawn into the basket, and tension is applied to the strand, thus tending to compress the filling material. While this tension is on the strand, the tapered sleeve is forced into the rear end of the basket with its leading edge wedging between the filling material and the basket. This pressure of the tapered sleeve against the filling material further increases the pressure exerted throughout the filling material, thereby increasing its gripping action on the strand embedded therein. In one preferred embodiment, in applying the socket, the pressure in the filling material is thus increased, by the combination of tension on the strand and the force applied to the tapered sleeve, to an extent great enough to provide a gripping action sufficient to develop the ultimate strength of the strand. The tapered sleeve, in addition to serving the purpose of increasing the pressure on the filling material, also serves as a seal at the rear end of the basket. The inner wall of the sleeve, at its smallest diameter, fits closely enough to the wires in the filling material to prevent escape of the filling material, even though the pressure may be great enough on the filling material to cause it to tend to flow, if it were not confined within the cavity. The bushing at the front end confines the filling material at this point. In some embodiments the pressure is, in fact, greater than that at which the filling material flows.

Because the method and apparatus of the present invention operate upon the novel principle of

compressing the filling material within an enclosed confine, and because of the consequent possibility of obtaining pressures of a magnitude heretofore impossible, much greater gripping action is obtained, and one result is the important advantage of being able to reduce the diameter of the socket and still develop the ultimate strength of the strand. The reduction of diameter of the socket is an especially important advantage where close spacing of strands is needed, as, for example, in prestressed concrete.

Another advantage, also flowing from the novel principle of compressing the filling material within definite confines, is that a variety of materials may be used for the filling material. In addition to zinc, lower-compressive-strength materials, such as lead and antimony, may be used, because the gripping action is purely mechanical. The fact that such materials are compressed beyond the pressure at which they flow does not impede the satisfactory operation of the apparatus.

The above-mentioned, as well as other objects, together with many advantages obtainable by the practice of the present invention will be readily comprehended by persons skilled in the art by reference to the following detailed description taken in connection with the annexed drawings, which respectively describe and illustrate preferred embodiments of the invention, and wherein

Fig. 1 is an assembly view, in longitudinal section, showing the socket applied to the strand, including the double-cone of filling material within the basket.

Fig. 2 is a longitudinal sectional view of the tapered sleeve, which is shown in its ultimate position in Fig. 1.

Fig. 3 is an end elevational view of the tapered sleeve of Fig. 2.

Fig. 4 is an enlarged detail view in longitudinal section showing the shape of the forward, lower edge of the tapered sleeve of Fig. 2.

Figs. 5 and 6 are side elevational and end elevational views, respectively, of the tapered bushing which terminates the forward end of the cone of filling material, as shown in Fig. 1.

Fig. 7 is a longitudinal sectional view of the basket alone.

Fig. 8 is an end elevational view of the basket shown in Fig. 7.

Figs. 10 and 9 are longitudinal sectional and end elevational views respectively of the nut shown in operative position in Fig. 1.

Reference is made to Figures 1 and 7. There is shown a main, outer sleeve or basket 11 having an internal cavity 13 of circular cross section. Throughout the greater portion of its length, in its left-hand or forward portion, the cavity 13 is conical in shape, tapering to smaller diameter toward the forward end. In a smaller portion of its length, toward the rear of the basket, the cavity 13 is of cylindrical cross section. The basket 11 is open at its right-hand or rear end. There is an opening 15 through the front wall of the basket 11, leading to the cavity 13.

Internal threads are provided toward the extreme right-hand end of the cavity 13 in the basket 11. External threads are provided at the right-hand end of basket, extending a greater distance along it than do the internal threads.

In applying the socket described herein to strand or the like, the basket 11 is first slipped over the end of the strand, by passing the strand, designated by the reference numeral 17 in Fig. 1, through the opening 15 at the front of the basket. The strand is pushed through the basket so that its end projects out the right-hand end far enough so that a shaped, double-tapered body or "button" of filling material, for example, zinc, may be formed on the strand, in a manner to be described.

After the strand 17 is pushed through the basket, a steel tapered bushing 19, shown in Figs. 5 and 6, is passed over the strand, with the smaller end of the bushing being toward the main length of strand. The outside wall of the bushing is tapered so as to be of conical shape, and is adapted to fit snugly against the tapered, conical interior wall of the cavity 13, when ultimately in place.

The wires of the strand 17 are then separated so that they flare throughout a major portion of their lengths, and then converge toward their extreme ends, as shown in Fig. 1. The separated length of strand, with the bushing 19 in its desired ultimate position on the strand, are then placed in a mold, not shown, and a shaped body or button 21 of filling material, for example, zinc, is cast.

The shape of the zinc button is shown in Fig. 1. Starting at the left hand or front end, it will be seen that the steel bushing 19 is cast as a part of the zinc button, so as to form the front end of it. The bushing fits very closely over the strand, and the zinc fills any small spaces between the wires of the strand and the inner wall of the bushing 19. The zinc button is formed to have a conical tapered shape on its forward end throughout the major portion of its length, so as to fit the tapered walls of the basket 11.

In casting the zinc button, the mold has means, such as a ring, adapted to hold the flared wires away from the walls of the mold, so as to provide a suitable layer of zinc on the outside of the wires. In the absence of this arrangement, there would be a tendency for the wires to touch the walls of the mold, and as a result, the wires would have some bare region, uncoated with zinc, at the points where they touch the walls of the mold. The ring of the mold which holds the wires inwardly produces a groove 23 in the zinc button. As may be seen in Fig. 1, the walls of this groove taper so as to converge toward the bottom of the groove. It will be understood that the wires of the strand do not flare outwardly beyond the diameter of the bottom of the groove 23. To either side of the groove 23, the zinc button 21 has a flat region, as shown in Fig. 1. To the left of this flat region the button converges conically toward the main length of the strand. To the right of this flat region the button converges conically toward the end of the strand. Hence the button, or shaped body of filling material, has a portion tapering toward the front, and a shorter portion tapering toward the rear.

After the button 21 is formed, it is moved down into the basket 11, as shown in Fig. 1. The strand 17 is then placed under tension, for example, a tension equal to about two-thirds of the ultimate strength of the strand. A tapered sleeve 25, shown in Figs. 2, 3 and 4, is then forced into the back end of the basket, by jacking means, not shown. The final relative positions of the basket 11, the button 21, and the tapered sleeve 25 are shown in Fig. 1.

The tapered sleeve 25 has a cylindrical outer surface shaped to have a sliding fit with the inner wall of the right-hand end of the basket. The

tapered sleeve **25**, throughout most of its inner surface, is tapered so that, in longitudinal section, the forward portion of its wall appears generally in the shape of a wedge pointing toward the left or forward end of the basket.

The tension on the strand **17**, in drawing the tapered button **21** into the tapered cavity **13**, causes compression in the button. Additional compression is caused by forcing the tapered sleeve **25** inwardly so that its tapered portion engages the tapered portion of the right hand end of the button.

As may be seen in Fig. 1, the inner tapered surface of the tapered sleeve **25** engages the rear conical tapered surface of the button. When the tapered sleeve **25** is driven in, the compression produced within the zinc button cause the wires of the strand to be gripped by the zinc with sufficient intensity to develop the ultimate strength of the strand.

In this manner very high pressure is exerted on the zinc filling material, and in some embodiments the pressure is sufficiently great to exceed the pressure at which the filling material begins to flow. It is possible in this manner to produce pressures as high as, for example, 100,000 pounds per square inch, provided the basket and other components are strong enough. The various components of the socket must be designed to resist the existing pressure which is developed in the filling material, and must confine the filling material and prevent it from escaping from the cavity **13**. Escape of the filling material at the front or left hand end of the main sleeve **11** is prevented by the bushing **19**. The outer wall of this bushing fits snugly against the wall of the cavity **13**, and, having a tapered fit with this cavity, the greater the pressure of the button, the tighter the fit between the bushing **19** and the wall of the cavity **13**. Because of the close fit of the bushing over the strand, even under the existing pressure within the button, zinc may not escape the cavity **13** between the bushing and the strand.

The tapered sleeve **25** has a cylindrical longitudinal opening toward its rear end. This opening tends to prevent the wires from being pushed by the sleeve when it is forced into the basket. At the right-hand end of the button, the wires are jammed closely together, and the inner surface of the tapered sleeve **25** fits sufficiently closely around these wires that an effective seal is provided against escape of zinc through the opening in the right-hand end of the tapered sleeve **25**.

In the illustrative embodiment it may be seen that the right-hand end of the button, after the socketing operation has been completed, extends to approximately the right hand extremity of the tapered portion of the wedge **25**.

As the tapered sleeve **25** is driven in, the pressure produced in the zinc tends to cause this sleeve to expand somewhat, particularly near its left-hand or leading edge. This edge is designed so that, even when the sleeve expands, the edge will not tend to dig into the wall of the basket. Reference is made to Fig. 4, which shows the shape of the edge **29** of the tapered sleeve **25**. The outer portion of this edge is beveled, as shown at **33**. The inner corner is rounded, as shown at **31**. A radius of, for example, $\frac{1}{16}$ inch is suitable for this purpose.

When the tapered sleeve **25** is forced into the main sleeve to its ultimate position, the tapered sleeve **25**, the button **21**, and the main sleeve **11** become practically bonded together. The taper of the rear cone of the button and of the tapered sleeve **25** should be flat enough to produce such a good bond that the sleeve will remain in position under all working conditions. A suitable angle of taper of the inner surface of the sleeve **25** with respect to its outer surface, in a practical embodiment, is 5° 43′ (tan.=0.1).

As may be seen in Fig. 1, not only does the outer surface of the filling material have two conical portions, one converging toward the front and one toward the rear, but the wires of the strand also have this over-all shape. That is, first they diverge from the main length of the strand, and then they converge at their ends.

In the manner described, the button **21** is compressed to the full compression which would exist at the breaking strength of the strand, and this is done at the time the socketing arrangement is attached. One advantage of this arrangement is that, when the strand and its socket is in actual use, there will be no further forward movement of the button as the working load is applied.

Usually the socket is applied to the strand at the factory. After the socket is applied, as described above, the tension in the strand may be released. In using the strand bearing its socket, perhaps at a later time and place, a threaded member such as a jack rod, not shown, is screwed into the internal threads at the right-hand end of the basket **11**, and tension is applied to the strand through the jack rod and the basket. When the tension has been adjusted in this manner to the proper value, the nut **35**, which is carried on the external threads at the right-hand end of the basket **11**, is positioned at the right point so that its left-hand or forward surface engages a suitable member adjacent the socket, and in this manner the nut **35** holds the socket in the desired position.

To illustrate the high values of filling material pressure which may be employed, and the usefulness of designs in which the pressure exceeds that at which the filling material begins to flow, it will be stated that, in one embodiment, when the socket is applied, in order to develop substantially the ultimate strength of the strand, the pressure on the zinc filling material is about 85,000 pounds per square inch. When the strand and socket are first installed, the pressure may be about 70% of the original 85,000-pound figure, or 60,000 pounds per square inch. After the strand and socket have been in use for long enough for conditions to stabilize, the pressure may be about 50% of the 85,000-pound figure, or more than 40,000 pounds per square inch, and hence more than the pressure at which zinc begins to flow. It will be understood that in various applications of the present invention the pressures employed will be different.

Since the pressure may satisfactorily exceed the value at which the filling material begins to flow, the design is not limited to high-compressive-strength filling materials. Lower-compressive-strength filling materials, such as lead, antimony and others may be used, since the gripping of the wire is purely mechanical. This gripping action is of much higher intensity than has been possible in sockets heretofore.

With the method and apparatus of the present invention, the size of the socket, and particularly its diameter, may be significantly reduced as compared with prior arrangements, and still obtain the ultimate strength of the strand. As an illustration, for $1\frac{9}{16}$ inch diameter strand, a socket heretofore having an outside diameter of 5⅝ inch, may be satisfactorily replaced by a

socket having an outside diameter of about 4 inches.

Although in the preferred embodiment the shape of the tapered surfaces of the various tapered members is conical, it will be understood that other converging or tapered shapes may be employed.

While the present invention, in its broadest sense, is not limited to any particular dimensions, suitable dimensions for one practical embodiment of a socket applicable to $1\frac{9}{16}$ inch bridge strand are shown below. The letters in the table below correspond to reference letters on the drawings.

*Angular dimensions*

*a* 2°52′ (tan=0.05)
*b* 5°43′ (tan=0.1)
*c* 15°

*Linear dimensions*

*d* 1½ inches
*e* $11\frac{5}{16}$ inches
*f* $1\frac{1}{8}$ inches
*g* 3 inches
*h* 1.697 inches
*k* 2.878 inches
*m* 4⅛ inches
*n* $22\frac{3}{8}$ inches
*q* $3\frac{1}{16}$ inches
*r* 2.484 inches
*s* $2\frac{55}{64}$ inches
*t* 1.889 inches

While a suitable form of apparatus and method to be used in accordance with the invention have been described in some detail, and certain modifications have been suggested, it will be understood that numerous changes may be made without departing from the general principles and scope of the invention.

I claim:

1. A connection for securing wire strand, wire rope, wire cable, or similar wire material, comprising a basket, said basket comprising a main sleeve having a longitudinal cavity extending therethrough and a wire-material-receiving opening at its front end connecting with said cavity, the wall of said cavity having a conical front portion diverging toward the rear and terminating in a cylindrical rear portion, a shaped body of low-compressive-strength filling material formed on said wire material having a front conical portion converging toward the front and fitting snugly against said front conical portion of the wall of said cavity and a rear conical portion converging toward the rear in the region of said cylindrical portion of said cavity, a bushing surrounding said wire material and forming an integral part of said body at the front thereof, said bushing fitting snugly against said conical front wall of said cavity and sealing the front end of said cavity against escape of said filling material, and a tapered sleeve having an inner tapered wall engaging and pressed against said rear conical portion of said shaped body and an outer cylindrical wall engaging and pressed against said cylindrical rear portion of said wall of said cavity, said tapered sleeve being forcibly wedged between the rear portion of said shaped body and said basket and being shaped to prevent said filling material from escaping from the rear end of said cavity or from expanding in a rearward direction even under pressures at which it may flow, said shaped body of low-compressive-strength filling material filling interstices of said cavity from the rear surface of said bushing to the rearmost point where said filling material engages said tapered sleeve, and being incapable of moving farther forward within said main sleeve.

2. A connection for securing wire strand, wire rope, wire cable, or similar wire material comprising a basket having an internal cavity the wall of which tapers to decreasing cross section toward the front end of said cavity, said basket having an opening in its front wall leading into said cavity, said wire material extending through said openings into said cavity and terminating in a tapered body comprising low-compressive-strength filling material and the portions of said wire material embedded in said filling material, said tapered body being shaped to have a front tapered portion fitting the front portion of said cavity and a rear tapered portion decreasing in cross section toward the rear, said front tapered portion being longer than said rear tapered portion, said basket having an opening at its rear end leading into said cavity, a tapered sleeve extending into said rear opening and fitting snugly against the walls thereof, said tapered sleeve being wedged against the rear tapered portion of said tapered body with sufficient force to cause said filling material to be under such great pressure within said cavity that said socket and said filling material grip said wire material sufficiently strongly to develop substantially the ultimate strength of said wire material, and means including a tapered bushing surrounding said wire material at said front end of said cavity and including said tapered sleeve at the rear end of said cavity adapted to prevent said filling material from escaping from said cavity, despite the pressure to which it is subjected, even under conditions of flow, said tapered bushing being integral with said body.

3. In a connection for securing wire strand, wire rope, wire cable, or similar wire material, in combination, a shaped body of low-compressive-strength filling material formed on the end of said wire material, said body having a front portion tapering to smaller cross section toward the front, terminating in a tapered bushing, and a rear portion tapering to smaller cross section toward the rear and terminating at the end of said wire material, and socketing means enclosing said body and confining said filling material so as to prevent it from escaping from said socketing means even at pressures at which it flows, said socketing means including a hollow basket the inner wall of which fits said front tapered portion of said body of filling material and said tapered bushing, and a wedging member having a tapered sleeve portion slidably forced into the rear end of said basket and wedged between the inner wall of said basket and said rear tapered portion of said body of low-compressive-strength filling material so as to compress said filling material, said filling material substantially completely filling the space within said basket from said bushing to the rear of said body of filling material, except for the space occupied by said wedging member, said wire material within said basket being prevented by said filling material and said socketing means from moving farther forward with respect to said basket.

(References on following page)

**References Cited** in the file of this patent

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 677,036 | Laurent | June 25, 1901 |
| 728,689 | Am Ende | May 19, 1903 |
| 2,041,385 | Van Laanen | May 19, 1936 |
| 2,292,711 | O'Connor | Aug. 11, 1942 |



FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 3,839 | Great Britain | Sept. 24, 1879 |
| 4056 | Germany | Feb. 20, 1879 |
| 12,702 | Great Britain | June 9, 1896 |