United States Patent [19]

Zifferer

[11] **3,742,809**

[45] **July 3, 1973**

[54] **EXPANSION ANCHOR WITH CONICALLY TAPERED AND THREADED INTERACTING PARTS**

[76] Inventor: **Kenneth B. Zifferer,** c/o U.S. Expansion Bolt Company, 500 State St., York, Pa. 17405

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[21] Appl. No.: **168,809**

[52] **U.S. Cl.** **85/84**

[51] **Int. Cl.** **F16b 13/06**

[58] **Field of Search** ..... 85/84, 83, 82, 74, 85/73, 75, 76, 79, 63, 67; 151/19 R

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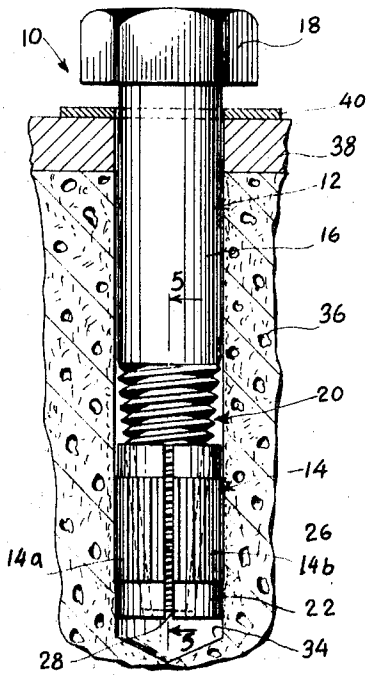
Primary Examiner—Ramon S. Britts
Attorney—Samuel J. Stroll et al.

[57] **ABSTRACT**

An expansion anchor comprising (a) a bolt having at one end a conically tapered and threaded end portion and, at its opposite end, means for engagement with a torque tool and a workpiece, and (b) an internally conically tapered and threaded expansion sleeve which engages said conically tapered and threaded end portion of the bolt. The outer diameter of the expansion sleeve corresponds substantially to the diameter of the bolt.

9 Claims, 16 Drawing Figures



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SHEET 1 OF 2

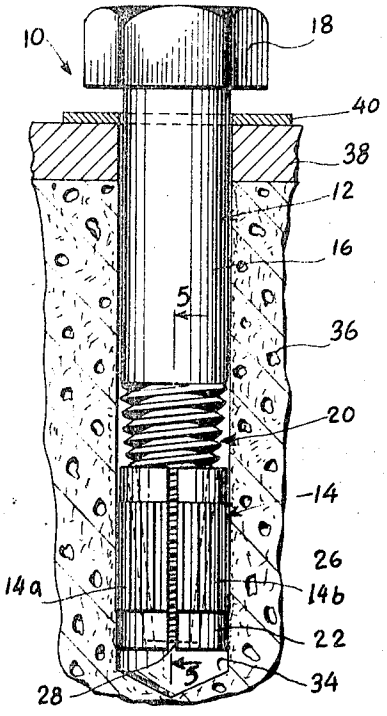

Fig. 1

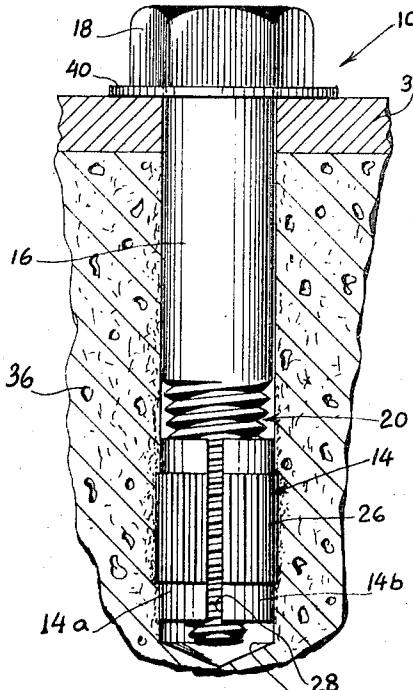

Fig. 2

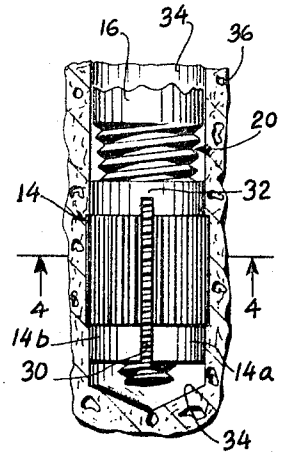

Fig. 3

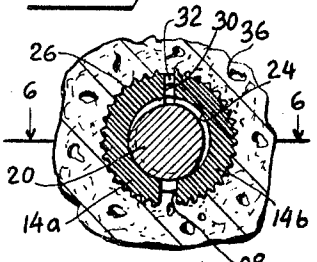

Fig. 4

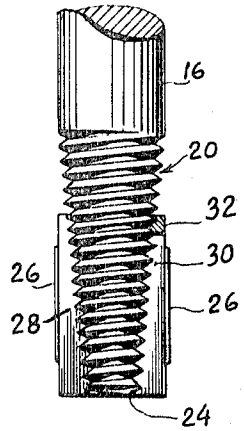

Fig. 5

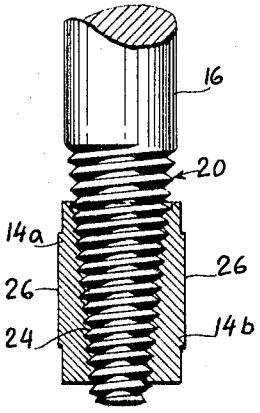

Fig. 6

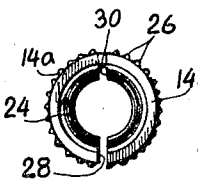

Fig. 7

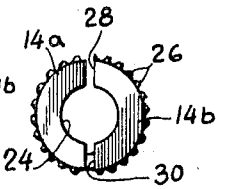

Fig. 8

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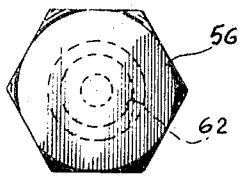

Fig. 10

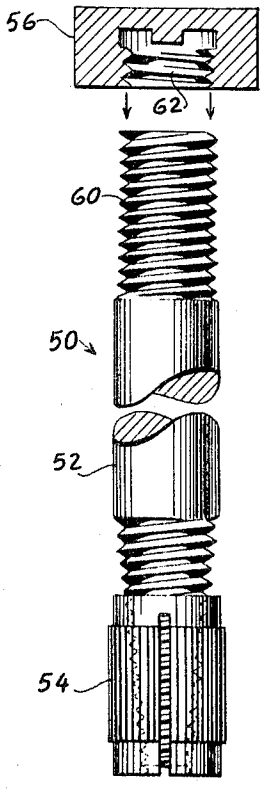

Fig. 9

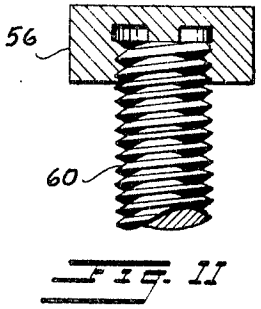

Fig. 11

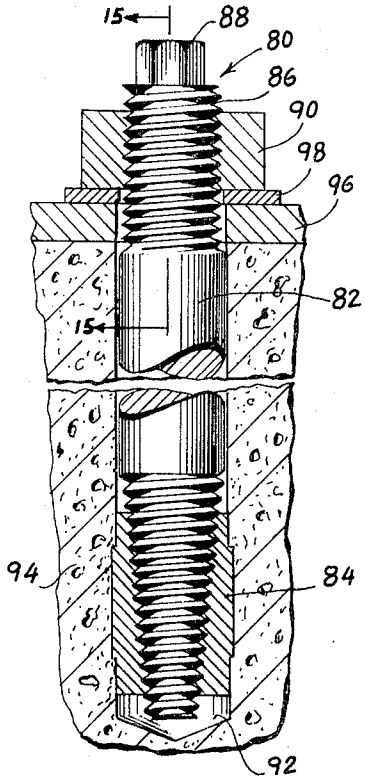

Fig. 13

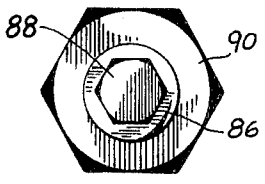

Fig. 14

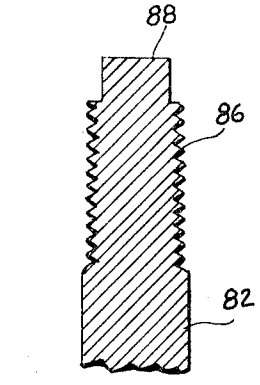

Fig. 15

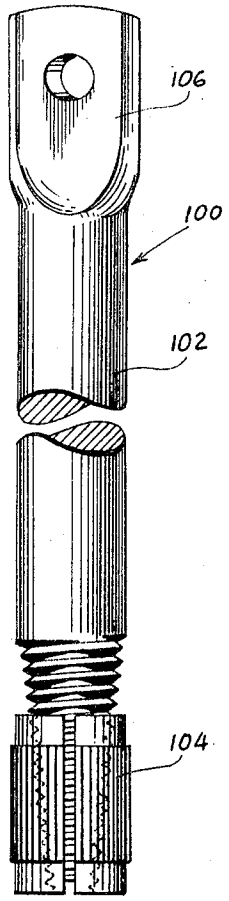

Fig. 16

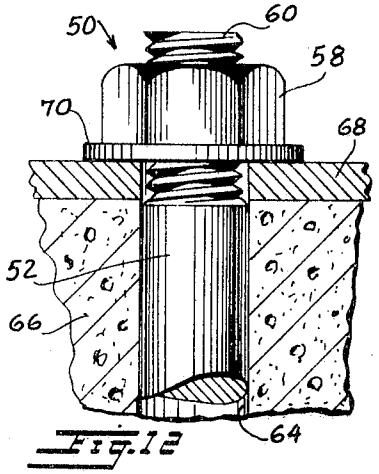

Fig. 12

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EXPANSION ANCHOR WITH CONICALLY TAPERED AND THREADED INTERACTING PARTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

Expansion anchors for use in concrete and masonry floors, walls, ceilings and the like.

2. Description of the Prior Art

The closest prior art known to applicant consists of the following groups of prior art devices and patents:

a.	1,365,719	Ogden
	1,394,925	Marshall
	2,018,251	Croessant
	2,343,143	Gill
	3,030,705	Gill
	3,236,143	Wing
	3,400,627	Raynovich, Jr.
b.	1,066,512	Masor
	1,072,246	Masor
	1,101,302	Masor
	1,549,327	Pleister
	3,469,407	Kovacs
	3,472,111	Ono
	3,528,253	Kovacs
	3,546,998	Lerich
	3,277,770	McCulloch

c. Conventional lag-screw and wood-screw shields and anchors.

SUMMARY OF THE INVENTION

The present invention provides an expansion anchor which has many important features and advantages not possessed by the prior art. It comprises a new and important development in bolt construction and a new and important development in expansion sleeve. The bolt is provided at one end with a conically tapered and threaded end portion, and it is provided at its opposite end with means for engaging a torque tool and a workpiece. The expansion sleeve is internally conically tapered and threaded to receive the conically tapered and threaded end portion of the bolt in screw-threaded engagement therewith. The longitudinal dimension of the tapered, threaded end portion of the bolt is at least equal to the longitudinal dimension of the tapered, threaded internal portion of the expansion sleeve. The expansion sleeve is generally cylindrical in external configuration, and its outer diameter, prior to expansion, corresponds, substantially, to the diameter of the bolt. Consequently, a hole drilled into a concrete anchorage or the like need be no larger in diameter than the diameter of the bolt. Radially outwardly extending projections are provided on the outer cylindrical surface of the expansion sleeve for engagement with the wall in the drill hole.

Installation of this device requires that it be inserted into the drill hole either manually or by means of a hammer, depending upon the clearance between the expansion sleeve (including its radial projections) and the wall of the drill hole and depending also upon the nature of the material of the anchorage. A torque tool (e.g., a wrench) is then applied to the torque tool engageable means on the bolt (e.g., a bolt head), and the bolt is caused to rotate in and relative to the expansion sleeve. Engagement of the expansion sleeve — and more particularly its radial projections — with the wall of the drill hole prevents rotation of the expansion sleeve during the bolt torqueing operation. The bolt is thereby drawn deeper into the expansion sleeve and into the drill hole; the expansion sleeve remains fixed

in the drill hole in the position which it occupied at the beginning of the bolt torqueing operation. Expansion of the expansion sleeve will be radially outwardly in perpendicular relation to the longitudinal axis of the bolt. Stated differently, the outer configuration of the expansion sleeve is cylindrical prior to expansion and remains cylindrical following expansion.

The principles of this invention are applicable to many different types and sizes of bolts. Illustrative are bolts with heads, bolts without heads, and bolts with various kinds of work-engageable elements, e.g., tie wire and rod hanger anchors.

The use of an externally conically tapered and threaded bolt in conjunction with an internally conically tapered and threaded expansion sleeve provides great shear and tensile strength which is derived from the full bolt diameter, as distinguished from the root diameter of a threaded section. Furthermore, since the length of the tapered, threaded end portion of the bolt is at least equal to the length of the tapered, threaded portion of the expansion sleeve, the act of drawing the tapered, threaded end portion of the bolt fully into the tapered, threaded portion of the expansion sleeve adds the strength of the expansion sleeve to the strength of the bolt. As a result, the present invention renders it feasible to provide a strong expansion anchor having a bolt diameter of as little as 3/16 inch, and fitting into a 3/16 inch drill hole. The shear and tensile strength of such device would be derived from the full 3/16 inch diameter of the bolt.

Under conditions of normal use there is no danger of stripping the thread between the bolt and the expansion sleeve. Compression of the anchorage wall produces a radially inwardly directed force which is balanced by the radially outwardly directed force exerted by the tapered and threaded end portion of the bolt, and these two forces lock the expansion sleeve to the bolt to prevent the stripping of thread.

The present device provides great holding power for the reasons above set forth, but also for the reason that the expansion sleeve remains embedded in the anchorage drill hole, following expansion, at precisely the same depth which it occupied prior to expansion. Normally, the position of the expansion sleeve would be substantially below or beyond the spall area, and it is important that the expansion sleeve be retained in that position. In the present case, since the bolt is drawn into the expansion sleeve, rather than the expansion sleeve being drawn over the bolt, the expansion sleeve remains fixed in its predetermined position relatively remote from the spall area of the anchorage.

The present device may be adapted to the different requirements of different installations. Thus, a conical taper having a smaller angle and an increased longitudinal dimension would be used in relatively more compressible material, for example, concrete or cinder block, brick, wood; a conical taper having an increased angle and a reduced longitudinal dimension would be used in relatively less compressible material, e.g., stone.

The present device is also adjustable to drill holes of different size. For example, if the drill hole is somewhat larger than desired, the bolt can be pre-threaded into the expansion sleeve sufficiently to expand the sleeve to the dimension of the hole. Conversely, if the drill hole happens to be somewhat smaller than desired, the expansion sleeve could be pre-squeezed to a smaller di-

ametric dimension sufficient to enable it to fit into the smaller hole.

Another feature of the present invention resides in the fact that the bolt is removable from the expansion sleeve and from the drill hole after the expansion sleeve is expanded therein. The expansion sleeve remains in the drill hole ready for subsequent use.

An important feature of the present device resides in the ease of manufacture of its component parts. The bolt is a screw machine product. The expansion sleeve may also be a screw machine product, or it may be die cast, molded, etc. Different materials may be used. Thus the bolt may be made of steel, bronze, aluminum or other materials, including alloys. The expansion sleeve may also be made of like materials or of zinc alloy, nylon or other plastics.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a view of an expansion anchor made in accordance with one preferred form of this invention, said expansion anchor being shown following insertion into an anchorage hole but before tightening of the bolt in the expansion sleeve and expansion of said sleeve.

FIG. 2 is a view similar to that of FIG. 1, except that the bolt is shown driven tightly into the expansion sleeve, expanding said expansion sleeve against the anchorage wall.

FIG. 3 is a fragmentary view of the lower end of the bolt shown in FIG. 2, including the expansion sleeve, but rotated 180° from the showing of FIG. 2.

FIG. 4 is a transverse section on the line 4—4 of FIG. 3.

FIG. 5 is a fragmentary vertical section on the line 5—5 of FIG. 1.

FIG. 6 is a fragmentary transverse section on the line 6—6 of FIG. 4.

FIG. 7 is an end view of the expansion sleeve.

FIG. 8 is an opposite end view thereof.

FIG. 9 is an exploded view showing a second embodiment of the invention, including a screw cap used to drive the bolt into the expansion sleeve.

FIG. 10 is a top view of said screw cap.

FIG. 11 is a fragmentary sectional view showing the screw cap in engagement with the bolt.

FIG. 12 is a fragmentary view showing the embodiment of FIG. 9 engaged by a nut to anchor a word piece.

FIG. 13 is a view of a third embodiment of the invention.

FIG. 14 is a top view thereof.

FIG. 15 is a fragmentary vertical section on the line 15—15 of FIG. 13, showing only the upper end of the bolt.

FIG. 16 is a view of a fourth embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to the details of the first embodiment of the invention as illustrated in FIGS. 1–8, it will be seen that expansion anchor 10 comprises a bolt 12 and an expansion sleeve 14. The bolt has a cylindrical shank 16, a bolt head 18 at the upper end of said shank, and a conically tapered and threaded lower end portion or tip 20, referred to as "bolt tip" in the claims. The included angle of the conical taper may range from about 2° to 12°. The term "included angle" as used herein is intended to define the entire conical angle, not the angle between the conical axis and the conical surface. The "included angle" is twice the angle between the axis and the surface of the cone. The angle which has been found to be best adapted to the greatest number of applications is 12°. Illustrative of the bolt dimensions to which the present invention has been applied are the following:

Bolt Diameter and Threads per Inch	Diameter of Small End of Conical Taper	Length of Conical Taper
10 – 32 (3/16")	0.091"	7/16"
1/4" – 28	0.145"	½"
⅜" – 24	0.218"	¾"
½" – 20	0.292"	1"
1" – 12	0.584"	2"

It will be observed from the foregoing table of dimensions that the longitudinal dimension of the conically tapered and threaded bolt tip is approximately twice the diameter of the bolt shank. It will also be noted that the diameter of the small end of the conically tapered and threaded bolt tip does not exceed approximately 58 percent of the diameter of the bolt shank. More particularly, in the cases of the bolt diameters ranging from ¼ of an inch to 1 inch, the diameter of the small end of the bolt tip is either precisely or approximately 58 percent of the diameter of the bolt shank. In the single instance of a bolt diameter of 3/16 of an inch, the diameter of the small end of the bolt tip is only 48 percent of the diameter of the bolt shank. These dimensions render it possible for the bolt tip to enter and threadedly engage the expansion sleeve when said sleeve is in unexpanded condition, even though its outer diameter does not exceed the diameter of the bolt shank.

Expansion sleeve 14 has a generally cylindrical outer wall 22 and a conically tapered, threaded inner wall 24. The outer diameter of the expansion sleeve (before expansion) corresponds substantially to the diameter of the shank of the bolt. The taper and threads of the inner wall correspond to the taper and threads of the conically tapered end portion 20 of the bolt, and, as shown in the drawing, the taper of these elements is substantially constant from end to end, that is, from end to end of the tapered end portion or tip of the bolt and from end to end of the expansion sleeve. Radially outwardly extending projections 26 are provided on the outer cylindrical wall of the expansion sleeve. In the forms of the invention shown in the drawing these radial projections take the form of knurling, but this is purely illustrative.

It will also be noted that expansion sleeve 14 is longitudinally slit at diametrically opposite points. Thus, on one side (shown in FIG. 1) a longitudinal slit 28 is provided, this slit extending the full length of the expansion sleeve. On the diametrically opposite side of the expansion sleeve (shown in FIG. 3) is a second longitudinal slit 30, but this slit does not extend the full length of the expansion sleeve. The two slits form, in effect, a pair of semi-cylindrical segments 14*a* and 14*b*, respectively, joined by a single narrow web 32 at one end of slit 30. This, too, is purely illustrative, since the expansion sleeve may be provided with only a single slit, to wit: slit 28, or it may be provided with a greater number of slits than two, for example, three slits forming three segments or four slits forming four segments.

What is important is that the angle of the conical taper of the expansion sleeve corresponds to the angle of the conical taper of the bolt, so that the expansion

sleeve and the bolt may operate in nut-and-bolt relationship. The length of the conically tapered and threaded end portion of the bolt is at least equal to, and preferably exceeds, the longitudinal dimension of the expansion sleeve, so that the entire expansion sleeve may be drawn up on the conically tapered and threaded end portion of the bolt. The expansion of the expansion sleeve will be perpendicular to the longitudinal axis of the bolt, so that the several segments of the expansion sleeve will remain in parallel relationship to each other. This condition is shown in FIGS. 1 and 2.

In the use of the foregoing device, expansion sleeve 14 is threaded onto the tapered, threaded end portion 20 of the bolt, but without expanding the sleeve. This is shown in FIG. 1. A hole 34 is drilled into the proposed anchorage 36, which, in the illustration shown in the drawing, is a concrete mass such as a concrete floor, wall or ceiling. The diameter of the drill hole corresponds, substantially, to the diameter of bolt shank 16 and unexpanded sleeve 14, exclusive of knurled ridges 26, with sufficient clearance for insertion of the assembled device into the hole. A workpiece 38, e.g., a metal plate with a pre-formed hole, is placed upon anchorage 36, the hole of said workpiece in registration with hole 34 of the anchorage. A washer 40 may be placed on the workpiece 38. Bolt 12 with expansion sleeve 14 mounted thereon is then inserted through the washer and the workpiece into drill hole 34. It may be necessary to drive the bolt into the drill hole by means of a hammer, since the knurled ridges 26 extend slightly beyond the diameter of expansion sleeve 14 and the shank of bolt 12.

The expansion anchor will now occupy the position shown in FIG. 1. Bolt head 18 will be engaged by means of a torque tool, such as a wrench, and the bolt will be caused to thread its way deeper into expansion sleeve 14. The knurled ridges 26 of the expansion sleeve, engaging the drill hole wall, will prevent the expansion sleeve from rotating during the initial stages of this operation. Expansion of the expansion sleeve will continue until the bolt is firmly anchored in the expansion sleeve and the expansion sleeve is firmly anchored in the drill hole. The expansion of the sleeve is shown in FIG. 2, and it will be noted that the segments of the expansion sleeve have expanded in parallel relation to each other, perpendicular to the longitudinal axis of the bolt.

The head of the bolt also performs an additional function, namely, that of engaging and holding the workpiece. This too is shown in FIG. 2, and it will therefore be understood that in this particular embodiment of the invention the head of the bolt performs the dual functions of engaging a torque tool and engaging the work.

Turning now to the second form of this invention as illustrated in FIGS. 10–12, it will be understood that expansion anchor 50 corresponds to expansion anchor 10 in that both consist of a bolt with a conically tapered and threaded end portion and an internally conically tapered and threaded expansion sleeve. Thus, expansion anchor 50 comprises a bolt 52 having a shank with a conically tapered and threaded lower end and an expansion sleeve 54 threaded thereon. The upper end 60 of the shank of bolt 52 is also threaded, but unlike the lower end, it is not tapered.

Bolt 52 has no head corresponding to bolt head 18 of the first form of the invention. Hence it must be provided with means for engaging a torque tool and means for engaging the work. The means for engaging a torque tool is screw cap 56 which has internal screw threads 62 for engagement with threaded upper end 60 of the bolt. This is shown in FIG. 11. Screw cap 56 may be tapped with a hammer to drive the assembly (bolt 52 plus expansion sleeve 54) into a drill hole 64 in anchorage 66. After the assembly is driven into the drill hole the screw cap is engaged by means of a torque tool and the bolt is thereby screwed deeper into the expansion sleeve to expand it into anchoring engagement with the wall of the drill hole. The screw cap is now removed from the bolt and the bolt is ready for its intended use.

The work engaging means is a conventional nut 58. The work, such as plate 68, and a washer 70 are placed over the bolt and nut 58 is then threaded to the threaded end portion 60 of said bolt. A torque tool is used to tighten the nut on the bolt and thereby to secure plate 68 to anchorage 66.

The third form of the invention is illustrated in FIGS. 13–15 of the drawing, and once again, the expansion anchor depicted therein comprises a bolt and an expansion sleeve. More particularly, expansion anchor 80 comprises a bolt 82 having a conically tapered and threaded end portion at the lower end of the shank, and an internally conically tapered and threaded expansion sleeve 84 threaded to said tapered end portion of the bolt. In all important respects, expansion anchor 80 corresponds to expansion anchor 50. However, instead of being provided with a screw cap 56 for torque tool engaging purposes, bolt 82 is provided with an extension piece 88 of torque tool engaging configuration, e.g., hexagonal shape in top view. See FIG. 14 of the drawing. This extension piece projects upwardly from threaded upper end portion 86 of the bolt, integrally therewith. The cross-sectional dimensions of the extension piece are smaller than the root diameter of the threaded upper end portion 86 of the bolt so that a nut 90 may pass over it.

After expansion anchor 80 is placed in drill hole 92 in anchorage 94, a hammer may be used to tap extension piece 88 to securely seat the device in said hole. Workpiece 96 and washer 98 are then placed over the outwardly projecting threaded upper end portion 86 and nut 90 is then applied to said threaded upper end portion and tightened thereon by means of a wrench or other torque tool.

Referring now to the fourth form of the invention as illustrated in FIG. 16, it will be seen that expansion anchor 100 comprises a bolt 102 having a conically tapered and threaded lower end portion, and an internally conically tapered and threaded expansion sleeve 104 threaded thereto. The upper end of the bolt shank has a torque tool and work engaging formation 106 formed thereon, integrally therewith. In this case, formation 106 is a flattened end piece having a hole formed therein for engagement with a tie wire or the like. The flattened configuration of end piece 106 adapts it for engagement with a torque tool. This makes it possible to screw the bolt tightly into the expansion sleeve and to securely attach both the bolt and the expansion sleeve to the anchorage.

The foregoing is illustrative of preferred forms of the invention and it will be understood that these forms may be modified and other forms may be provided

within the broad spirit of the invention and the broad scope of the claims.

I claim:

1. An expansion anchor comprising:
   a. a bolt having an elongated, cylindrical shank with a conically tapered and threaded tip at one end thereof and torque tool engageable means at the opposite end thereof, and
   b. an expansion sleeve having an internal portion which is conically tapered and threaded to receive said conically tapered and threaded bolt tip in screw-threaded engagement therewith,
   c. said expansion sleeve having a generally cylindrical external configuration,
   d. the outer diameter of the expansion sleeve corresponding, substantially, to the diameter of the cylindrical shank of the bolt, when said sleeve is unexpanded,
   e. said conically tapered and threaded bolt tip defining a substantially constant taper, the taper and the threading extending substantially the full length of the bolt tip,
   f. said conically tapered and threaded internal portion of the expansion sleeve defining a substantially constant taper, the taper and the threading extending substantially the full length of the expansion sleeve,
   g. the longitudinal dimension of the conically tapered and threaded bolt tip being at least equal to the longitudinal dimension of the expansion sleeve, and
   h. said expansion sleeve being slit substantially from end to end, in longitudinal direction, to enable it to expand radially outwardly when the conically tapered and threaded bolt tip is screwed therein,
   i. the conically tapered and threaded bolt tip and the conically tapered and threaded internal portion of the expansion sleeve being correspondingly tapered at an included angle in the range of about 2° to 12°.

2. An expansion anchor in accordance with claim 1, wherein:
   the torque tool engageable means is a bolt head which is integral with the shank.

3. An expansion anchor in accordance with claim 1, wherein:
   a. the torque tool engageable means is a removable screw cap with wrench-engageable configuration,
   b. the shank of the bolt being threaded for screw-threaded engagement with said screw cap for torqueing the bolt, and with a nut for engaging the work.

4. An expansion anchor in accordance with claim 1, wherein:
   a. the torque tool engageable means is formed coaxially with the shank of the bolt, integrally therewith,
   b. the greatest cross-sectional dimension of said torque tool engageable means being no greater than the diameter of the shank of the bolt,
   c. said shank being threaded adjacent said torque tool engageable means for screw-threaded engagement with a work-engageable nut.

5. An expansion anchor in accordance with claim 1, wherein:
   a. the torque tool engageable means is an eye which is integral with the upper end of the shank,
   b. said torque tool engageable means being also adapted to function as a tie wire fastening element.

6. An expansion anchor in accordance with claim 1, wherein:
   the longitudinal dimension of the conically tapered and threaded bolt tip is sufficient to reduce the diameter of its small end to the extent necessary to enable said bolt tip to enter and threadedly engage the expansion sleeve when said sleeve is in unexpanded condition and its outer diameter corresponds to the diameter of the shank of the bolt.

7. An expansion anchor in accordance with claim 6, wherein:
   the longitudinal dimension of the conically tapered and threaded bolt tip is approximately twice the diameter of the bolt shank.

8. An expansion anchor in accordance with claim 6, wherein:
   the diameter of the small end of the conically tapered and threaded bolt tip does not exceed approximately 58 percent of the diameter of the bolt shank.

9. An expansion anchor in accordance with claim 1, wherein:
   anchorage-engageable projections are formed on the external cylindrical surface of the expansion sleeve.

* * * * *