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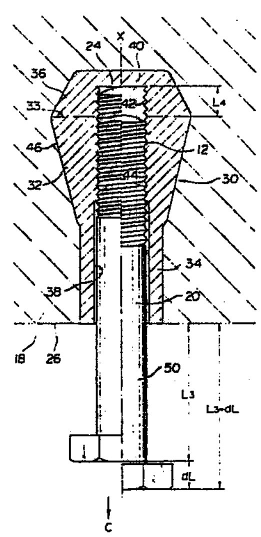
(54) Insert assembly for use in a concrete structure.

(57) There is disclosed an improved insert assembly for use in a concrete structure to mount equipments onto the concrete surface. The insert assembly includes an insert member (30) adapted to be embedded in the concrete structure (18), and a bolt member (20) threadedly matable with the insert member (30). The insert member (30) includes an insert body (32) and an end wall portion (36) integrally joined to the insert body (32). The insert body (32) has larger and smaller opposite ends and tapers from its larger end to its smaller end. Also, the insert body (32) has a threaded through hole (12), formed along its center axis, for the bolt member (20) to be screwed therein. The end wall portion (36) has a transverse outer size not larger than that of the larger end (33) of the insert body (32), and is joined to the larger end (33) of the insert body (32) to seal the larger end. This end wall portion (36) has a supplementary hole formed in its inner face. This supplementary hole (40) is aligned and communicated with the threaded hole (12) of the insert body (32) so as to receive the threaded end portion of the bolt member (20).

FIG. 2



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Description

INSERT ASSEMBLY FOR USE IN A CONCRETE STRUCTURE

BACKGROUND OF THE INVENTION

This invention relates to an improvement in an insert assembly which is used for mounting or securing various appliances or equipments onto a concrete surface.

It is not possible to weld metal members such as steel plates and brackets directly to the surface of a concrete structure such as a concrete building, bridge, dam, retaining wall, breakwater and the like. For this reason, an insert member which is threadedly matable with a bolt member, is embedded within the concrete structure in order to mount various equipments onto the concrete surface. This kind of insert member is generally made of a metal such as steel and the like, and has a configuration such that an annual ridge or a laterally expanded portion is provided to increase the contact area of the insert member which contacts the concrete, enhancing the insert member's anchoring performance to the concrete. Because this conventional insert member is made of metal, it tends to have an inconveniently heavy weight to handle, and also tends to corrode in a rather short period. The corrosion of the insert member causes the deterioration of not only the insert member itself but also of the concrete surrounding the insert member. Furthermore, when a plurality of such insert members are used at the same time for mounting different conduits, that is, for example, an electric cable conduit, a gas conduit, a water conduit and a conduit for air conditioning, coloured plastic caps and the like attachable to the insert members are required to distinguish the insert members for a particular conduit from other insert members. These plastic caps, however, are costly and are not refractory, therefore, it is preferable not to use a large number of them. Insert members made of synthetic resin may solve the cost problem, however, it is not refractory and, this time, a problem with the insert member's yield strength would arise. In particular, when the plastic insert member has a neck-like portion, the potential of a crack or rupture would be increased because of stress concentration to the neck-like portion.

To solve the problems mentioned above, the inventors have proposed an insert member made of ceramics in Japanese Patent Application No. sho 60-282465. FIG. 1 shows an example of the insert member prepared according to the disclosure of this application. This insert member 10 is of a truncated conical configuration and has a threaded hole 12 formed along the center axis of the insert member 10. Upon the embedding of the insert member 10 in the concrete structure 18, the smaller end face 14 of the insert member 10 is exposed so that a bolt member 20 can be screwed into the threaded hole 12. The bolt member 20 is, for example, a conventional bolt including a threaded distal end portion 24 and a laterally expanded head portion (not shown). The threaded hole 12 of the insert member 10 opens not only to the smaller end face 14 but also to the larger end face 16 of the insert member 10 so as to enable the bolt member 20 to be screwed in the hole 12 as far as the distal end 24 of the bolt member 20 reaches to the level of the larger end face 16. This insert member is refractory, and, because of its improved configuration, it has less potential to undergo a stress concentration than conventional insert members. However, since a lid member 22 serving as a water stop must be fitted in the opening at the larger end face 16 to prevent the water in the concrete from exuding through the hole 12, the bolt member 20 is in practice not allowed to be screwed so deeply as might be expected. In particular, when it is required to adjust the length of that portion of the bolt member 20 protruding from the concrete surface, it is not even possible to bring the distal end 24 into as deep contact as it has with the lid member 22 (see the phantom line in FIG. 1) but only to bring it halfway into the threaded hole 12. Consequently, when an axial load urging the bolt member 20 in the direction indicated by arrow B is exerted on the bolt member 20, an axial tensile stress tends to be induced in that portion of the insert member 10 near the larger end, that is, the portion where the bolt member 20 is not inserted. This occurrence of the tensile stress is not preferable for the ceramic insert member 10 of which tensile strength is not so great as its compressive strength.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an improved insert assembly in which the bolt member is allowed to be screwed in the threaded hole of the ceramic insert member deeply enough to avoid the occurrence of the tensile stress in the insert member.

Another object of the present invention is to provide an insert assembly in which it is possible to adjust the length of that portion of the bolt member protruding from the concrete surface without bringing the distal end of the bolt member to a position halfway in the threaded hole.

Still another object of the present invention is to provide an insert assembly which prevents the water in the concrete from exuding through the threaded hole without employing the lid member.

With these and other objects in view, the present invention provides an insert assembly including an insert member and a bolt member. The insert member comprises an insert body and an end wall portion. The insert body has larger and smaller opposite ends and tapers from the larger end to the smaller end so that the insert body has a tapered side face inclined to the center axis thereof. A threaded through hole is formed along the center axis of the insert body in order for the bolt member to be screwed therein. The end wall portion has an inner face and is integrally joined at its inner face to the larger end of the insert body to seal the larger end of the insert body. The end wall portion has a transverse outer size not larger than that of the larger end of the insert body. A supplementary hole is formed in the inner face of the end wall portion so as to receive the threaded end portion of the bolt member. This supplementary hole is aligned and communicated with the threaded hole of the insert body. In this insert assembly, the bolt member is allowed to be screwed in the threaded hole as deeply as the distal end of the bolt member reaches or advances over the larger end of the insert body without damaging the watertightness of the insert member. Therefore, no axial tensile stress but an axial compressive stress is induced in the insert member. Accordingly, this insert member is capable of avoiding a crack or rupture due to a tensile stress, and shows a satisfactory rupture strength against the axial load applied to the bolt member.

It is preferred that the insert member is made of a ceramics such as alumina ceramics, silicon carbide ceramics and silicon nitride ceramics.

The tapered side face of the insert body in an axial cross section of the insert body may be straight, and the inclination angle of the tapered side face with respect to the center axis, preferably, is not smaller than 1° and smaller than 45°. Such a insert body may be of a truncated conical configuration, a truncated polygonal pyramidal configuration or a truncated elliptic conical configuration.

Alternatively, the tapered side face of the insert body in its axial cross section may be convexly curved.

It is also preferred that the insert body has a thickness of its tube wall at its second end, approximately four to five times thicker than the height of the thread formed inside the threaded hole thereof.

The end wall portion may taper from its inner face to its outer face.

The insert member may further comprise a tubular ceramic guide portion coaxially connected to the second end of the insert body. The hollow of the guide portion is communicated with the threaded hole of the insert body so that the bolt member is allowed to be screwed in the threaded hole through the hollow.

The supplementary hole of the end wall portion may have an internal thread formed continuously from the thread of the insert body's threaded hole.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a side-elevational view partly in section of a conventional insert member;

FIG. 2 is an axial cross-sectional view of an insert assembly according to the present invention;

FIG. 3 is a side-elevational view partly in section of an insert member in FIG. 2;

FIG. 4 is an axial cross-sectional view of a modified form of the insert member in FIG. 2;

FIG. 5 is a side-elevational view partly in section of another modified form of the insert member in FIG. 2;

FIG. 6 is a schematically side-elevational view partly in section of equipments and a concrete structure used for breaking tests given to test insert members; and

FIG. 7 is a cross-sectional view of the concrete structure in which an insert member is embedded, showing the result of the breaking tests;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 2 to 7, the same parts as those in FIG. 1 are designated by the same reference numerals, and descriptions thereof will be omitted.

FIG. 2 illustrates an insert assembly according to the present invention, in which reference numeral 30 designates a ceramic insert member adapted to be embedded in a concrete structure. This insert member 30 consists of three portions, namely, an insert body 32 of a truncated conical configuration, a hollow cylindrical guide portion 34 coaxially and integrally joined to the smaller end of the insert body 32 and an end wall portion 36 integrally joined to the larger end 33 (which is shown by the phantom line) of the insert body 32. The insert body 32 has a threaded hole 12 formed along the center axis X thereof. The hollow 38 of the guide portion 34 is aligned and communicated with the threaded hole 12 of the insert body 32 to allow a bolt member 20 to be screwed in the threaded hole 12 therethrough. The end wall portion 36 is of a truncated conical configuration of which larger end is coaxially connected to the larger end 33 of the insert body 32. The diameter of the larger end of the end wall portion 36 in FIG. 2 is generally equal to that of the insert body 32, however, the former may be smaller than the latter. The end wall portion 36 has a supplementary threaded hole 40 formed in the inner face thereof. This supplementary hole 40 is aligned and communicated with the threaded hole 12 of the insert body 32 to receive the distal end portion of the bolt member 20. The internal thread 42 of the supplementary hole 40 is continuously formed from the internal thread 44 of the threaded hole 12, that is, the major and minor diameters of the thread 42 are equal to those of the thread 44, and also the leads of the threads 42 and 44 are equal to each other.

As shown in FIG. 3, the tapered side face 46 of the insert body 32 is inclined at an angle Θ with respect to the center axis X of the insert member 30. The angle Θ, i.e., the cone generating angle of the insert body 32 is not smaller than 1° and smaller than 45°, and preferably in the range of 15° to 30°. Below 1°, the resultant insert member 30 is not expected to have a satisfactory anchoring performance to the concrete structure, whereas, at 45° and above, when an axial load is applied to the bolt member 20 mated with the insert member 30, there is a potential of a tensile stress being induced in the insert body 32, particularly, in the larger end portion of the body 32. The best rupture strength of the insert body 32 is obtained when the angle Θ is 15° to 30°.

To maintain the proper rupture strength of the insert member 30, it is preferred that the tube wall of the insert body 32 at its smaller end has a thickness T defined by the following formula:

$$T = k \cdot H$$

where k is a constant in the range of 4 to 5, and H is the height of the thread 44 formed instead the hole 12.

More specifically, the tube wall's thickness T of the insert body 32 at its smaller end is preferred to be about four to five times thicker than the height H of the thread 44. According to this relationship between the thickness T and the height H as well as the length L_1 of the insert body 32 and the diameter D of the larger end 33 of the insert body 32, the inclination angle Θ is concretely determined. The entire tube wall of the guide portion 34 has a uniform thickness, and the length L_2 of the guide portion 34 is determined regarding the rupture strength of the entire insert member 30.

The process for preparing the insert member mentioned above will now be described. First, a mold made of a rubber substance and having an internal configuration which fits around the insert member 30 is prepared. Then, a threaded core member such as a bolt substantially equivalent to the bolt member 20 is coaxially fixed inside the mold. Powdery material for ceramics, such as Al_2O_3, SiC and Si_3N_4, having a particle size of about 20 to 30 μm is filled within the mold. The air is eliminated from the inside of the mold, and thereafter, hydraulic pressure of 1,000 to 3,000 t/cm^2 is applied on the mold, forming a compact out of the powdery material. The mold is removed from the resultant compact, and then the core member is unscrewed from the compact. Lastly, the compact is sintered at a temperature of about 1,700 °C, resulting in the ceramic insert member 30 shown in FIG. 2. As described above, the preparing of the insert member is simple and easy, and moreover, the inclination angle Θ of the insert body 32 which is from 1° to 45° is convenient for preventing any air spaces from being produced in the insert member during the preparation process. Accordingly, it is expected to efficiently manufacture high quality insert members with excellent dimensional accuracy.

The insert member 30 thus prepared is embedded, as shown in FIG. 2, in a concrete structure 18 to mount different equipments onto the surface 26 of the concrete structure. In order to embed the insert member 30, the insert member 30 is detachably attached to the inner surface of a form for concrete placing, and then concrete is placed inside the form. The attachment of the insert member 30 onto the form is achieved by fixing a projection member on the inner surface of the form and by firmly fitting the projection member in the hollow 38 of the guide portion 34. The removal of the form after the hardening of the concrete results in the embedding of the insert member 30 in such a manner that the free end of the guiding portion 34 is exposed. The bolt member 20 is threadedly engaged with the insert member 30 in mounting or securing an appliance, e.g., a gas conduit to the concrete surface 26, in other words, the appliance can be secured to the concrete surface 26 by means of the bolt member 20 screwed into the threaded hole 12 of the insert body 32 through the hollow 38 of the guide portion 34. Upon the engagement of the bolt member 20, since the end wall portion 36 seals the larger end 33 of the insert body 32 and also since the supplementary threaded hole 40 is provided in the end wall portion 36, the bolt member 20, as shown in FIG. 2, is allowed to be screwed in the threaded hole 12 until its distal end 24 reaches or advances over the larger end 33 of the insert body 32 without damaging the watertightness of the insert member 30.

The bolt member 20 thus securing the appliance on the concrete surface, particularly when it serves as a hanging bolt, is usually subjected to an axial load which urges the bolt member 20 in a direction indicated by arrow C. This axial load is transmitted to the concrete structure 18 via the tapered side face 46 of the insert body 32, whereby the reaction force is applied uniformly to the conical side face 46 by the concrete structure 18. However, since the bolt member 20 is engaged with the insert member 30 as deeply as the distal end 24 reaches or proceeds over the larger end 33 of the insert body 32, no axial tensile stress but an axial compressive stress is induced in the insert member 30. Therefore, this ceramic insert member 30 can avoid a crack or rupture due to a tensile stress, and shows a satisfactory rupture strength against the axial load applied to the bolt member 20. Furthermore, because of the wedge-like configuration of the insert body 32, the more load the bolt member 20 is subjected to, the more firmly the insert member 30 contacts the concrete structure 18. The result is that the insert member 30 in connection with the concrete structure 18 shows an excellent anchoring performance.

When the length of that portion 50 of the bolt member 20 projecting from the concrete surface 26 must be adjusted due to a different thickness of the material such as steel plate to be secured, the bolt member 20 may be advanced or drawn back as long as the distal end 24 of the bolt member 20 is within the supplementary hole 40. That is, in this insert assembly, it is enabled, without bringing the distal end 24 of the bolt member 20 to a position halfway in the threaded hole 12, to adjust the length of the projecting portion 50 to a length of L_3 to $L_3 + dL$, where dL is equal to the length L_4 of the supplementary threaded hole 40 (see FIG. 2).

FIG. 4 illustrates a modified form of the insert member in FIG. 2, in which a cylindrical guide portion 54 is separately formed from the remainder of the insert member 52 and the guide portion 54 is detachably connected to the smaller end 56 of an insert body 58. More specifically, the threaded hole 12 is provided at its opening with an engaging section 60 having a larger inner diameter than the remainder of the threaded hole 12, and one of the opposite end sections of the guide portion 54 is fitted in the engaging section 60. In this construction, depending on the thickness of the concrete structure 18 in which the insert member 52 is to be embedded, it is possible to adjust the distance S between the concrete surface 26 and the insert body 58 by connecting the guide portions of different lengths to the insert body 58.

FIG. 5 shows another modified form of the insert member in FIG. 2, in which an insert body 62 is tapered toward a guide portion 64 in such a manner that the tapered side face 66 thereof in an axial cross section is convexly curved. Reference numeral 68 designates a recesse formed in the side face of the insert member 70 to avoid rotational movement of the insert member 70 when it is embedded in the concrete. In this construction, the reaction force to be exerted on the tapered side face 66 by the concrete structure 18 reduces gradually toward the larger end of the insert body 62 whereby, when the bolt member 20 is not screwed in the threaded hole 12 so deeply as the distal end 24 comes into the supplementary hole 40, the tensile stress to be induced in the larger end portion of the insert body 62 is considerably less than that to be induced in the insert body 32 shown in FIG. 2.

Although in the foregoing embodiments, the insert bodies 32, 58 and 62 and the end wall portion 36 are of truncated conical configurations, they may be of truncated polygonal pyramidal configurations or of truncated elliptic conical configurations. In such configurations, the insert members are enabled to prevent rotational movement when they are embedded in the concrete. Also, in place of the supplementary threaded hole 40, a supplementary hole without the internal thread may be employed. Furthermore, instead of the end wall portion 36, an end wall portion of a cylindrical configuration may be employed. This cylindrical end wall portion must have an outer diameter smaller than that of the larger end of the insert body.

In addition, the insert members in the preceding embodiments may be colored during their preparation in order to distinguish themselves from other insert members used for different purposes. More specifically, when the insert members for different conduits, that is, for instance, an electric cable conduit, a gas conduit, a water conduit and an air conduit, are colored differently, securing operation for each conduit onto the concrete surface is made efficient and effective, and mistakes in securing operation is reduced.

Breaking tests given to the insert members are now described hereunder.

Example 1

A test insert member equivalent to the foregoing first embodiment shown in FIG. 2, having 50 mm axial length and 25 mm outer diameter at the larger end portion, was prepared. This test insert member 30 was embedded in the concrete structure 18 as shown in FIG. 6. A steel tension bar 72 having a threaded end portion is threadedly engaged with the test member 30. Axial tensile load was applied to the tension bar 72 by means of a ram chair 74 and jack 76 fixed above the test member 30, and was increased until any one of the test member 30, tension bar 72 and concrete structure 18 was broken. The tensile load applied to the tension bar 72 was determined by a load cell 78 which was operatively connected to the jack 76. The result was that the concrete structure 18 was broken as shown in FIG. 7 when a tensile load of 2,390 kg was applied to the tension bar 72. This result means that the test insert member 30 was subjected mainly to a compression, and that the breaking load of the test insert member 30 is more than 2,390 kg. This value of the determined tensile load Pb, i.e., the compressive load applied to the test insert member upon the destruction of the concrete structure 18 is shown in Table 1 with the design load Pd of the insert member 30. The design load Pd is defined by the following formula:

$Pd = 2/3 \bullet \sigma sy \bullet A$

where σsy is the yield stress of steel which is about 2,400 kg/cm^2, and A is the stress area of the tension bar 72 which is about 0.58 cm^2. In addition, the major diameter of the tension bar 72 is 10 mm.

Example 2

A test insert member equivalent to the foregoing modified form shown in FIG. 4, having 50 mm entire axial length, 25 mm outer diameter at the larger end portion and 15 mm axial length of the guide portion, was prepared. A breaking test the same as in Example 1 was given to this test insert member. The result was that the concrete structure 18 was broken in the same manner as shown in FIG. 7 when a tensile load of 2,170 kg was applied to the tension bar 72. This result means that the test insert member was subjected mainly to a compression, and that the breaking load of the test insert member is more than 2,170 kg. This value of the determined tensile load Pb, i.e., the compressive load applied to the test insert member upon the destruction of the concrete structure 18 is shown in Table 1 with the design load Pd of the insert member. The design load Pd of the test insert member is defined by the same formula given in Example 1.

Table 1

	Pb (kg)	Pd (kg)	Safety Factor (Pb/Pd)
Example 1	2,390	930	2.6
Example 2	2,170	930	2.3

As shown in Table 1, it will be understood that the breaking load of the test insert members is substantially greater than the design load thereof, that is, the insert member according to the present invention has excellent rupture strength.

Claims

1. An insert assembly for use in a concrete structure for mounting equipments onto the concrete surface, the insert assembly comprising: an insert member adapted to be embedded in the concrete structure; and a bolt member threadedly matable with the insert member and adapted to be anchored to and project from the concrete surface when the bolt member is mated with the insert member embedded in the concrete structure, the insert member comprising:

an insert body having first and second opposite ends and tapering from the first end to the second end thereof so that the insert body has a tapered side face inclined to the center axis thereof, the insert body having a threaded through hole, formed along the center axis thereof, for the bolt member to be screwed therein; and

an end wall portion having an inner face and integrally joined at its inner face to the first end of the insert body to seal the first end of the insert body, the end wall portion having a transverse outer size not larger than that of the first end of the insert body, the end wall portion having a supplementary hole, formed in the inner face thereof, for receiving the threaded end portion of the bolt member, the supplementary hole being aligned and communicated with the threaded hole of the insert body.

2. An insert assembly according to Claim 1, wherein the insert member is made of a ceramics.

3. An insert assembly according to Claim 2, wherein the tapered side face of the insert body in its axial cross section is straight.

4. An insert assembly according to Claim 3, wherein the inclination angle of the tapered side face with respect to the center axis is not smaller than 1° and smaller than 45°.

5. An insert assembly according to Claim 3, wherein the insert body is of a substantially truncated conical configuration.

6. An insert assembly according to Claim 3, wherein the insert body is of a substantially truncated polygonal pyramidal configuration.

7. An insert assembly according to Claim 3, wherein the insert body is of a substantially truncated elliptic conical configuration.

8. An insert assembly according to Claim 2, wherein the tapered side face of the insert body in its axial cross section is convexly curved.

9. An insert assembly according to Claim 3 or 8, wherein the insert body includes a tube wall having a thickness at the insert body's second end, approximately four to five times thicker than the height of the thread formed inside the threaded hole thereof.

10. An insert assembly according to Claim 3 or 8, wherein the end wall portion has an outer face opposing to the inner face thereof, the end wall portion tapering from its inner face to its outer face.

11. An insert assembly according to Claim 3 or 8, wherein the insert member further comprises a tubular ceramic guide portion coaxially connected to the second end of the insert body, the hollow of the guide portion being communicated with the threaded hole of the insert body so that the bolt member is allowed to be screwed in the threaded hole through the hollow.

12. An insert assembly according to Claim 3 or 8, wherein the supplementary hole of the end wall portion has a continuous internal thread formed on the inner face thereof from the thread of the insert body's threaded hole.

FIG. 1

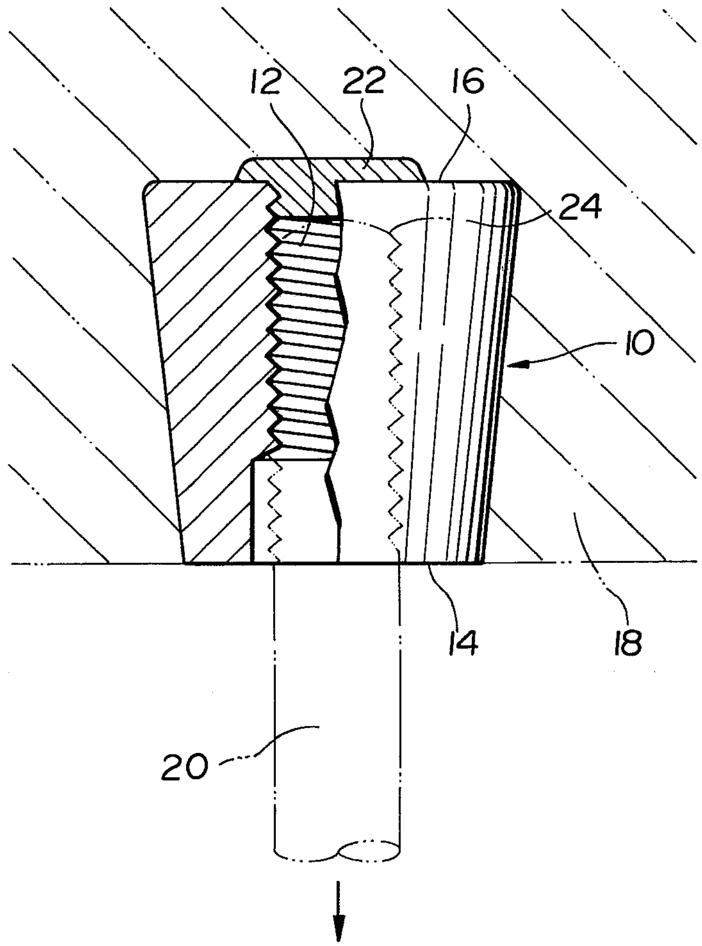

FIG. 3

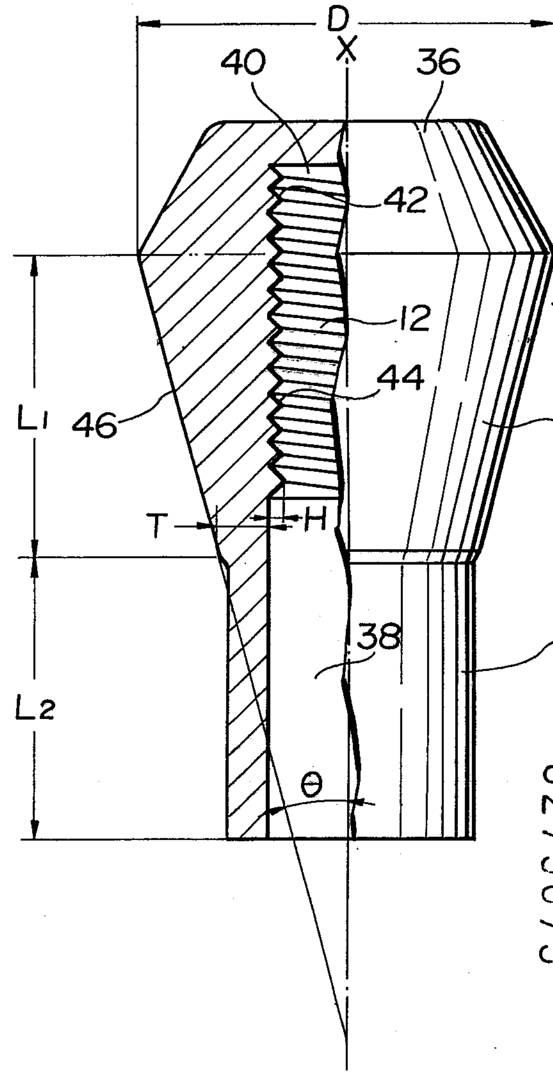

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FIG.2

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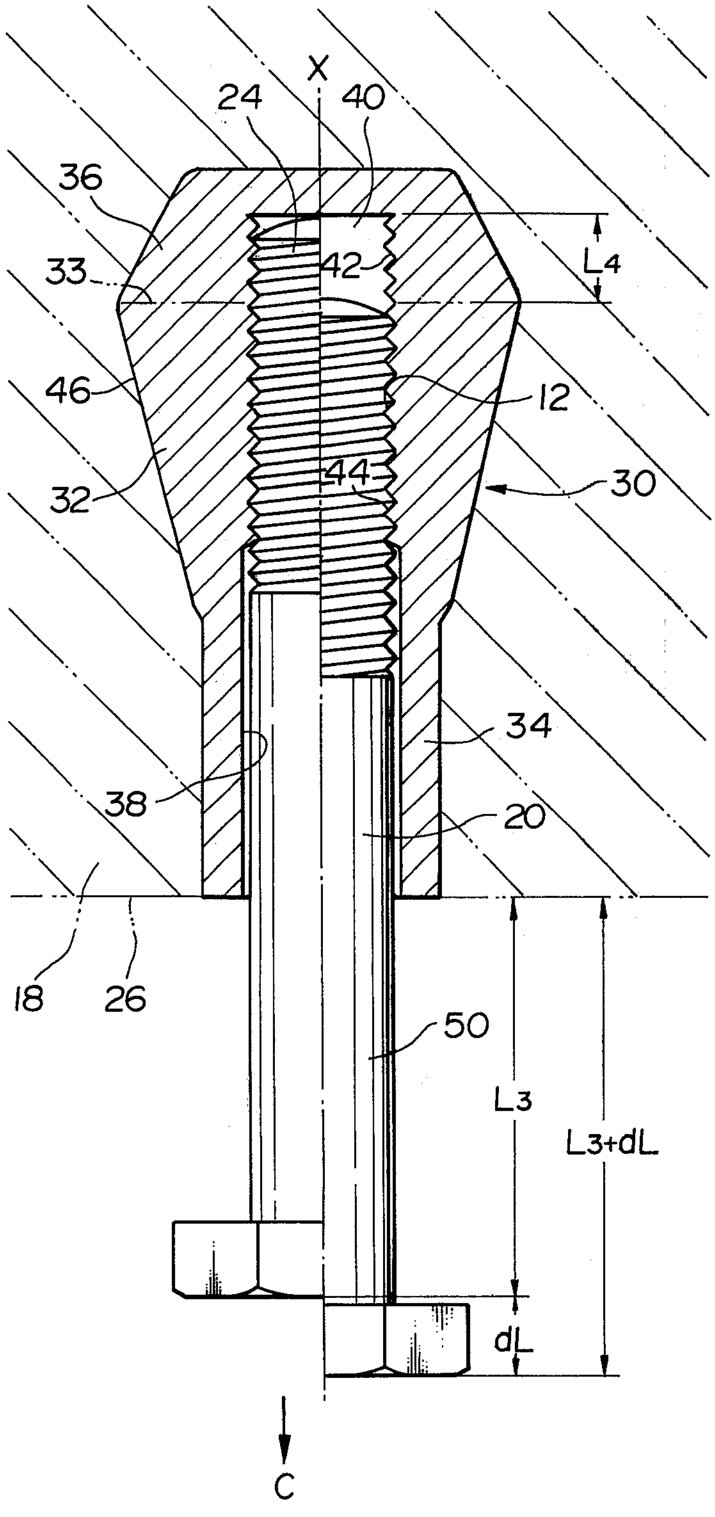

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FIG.4

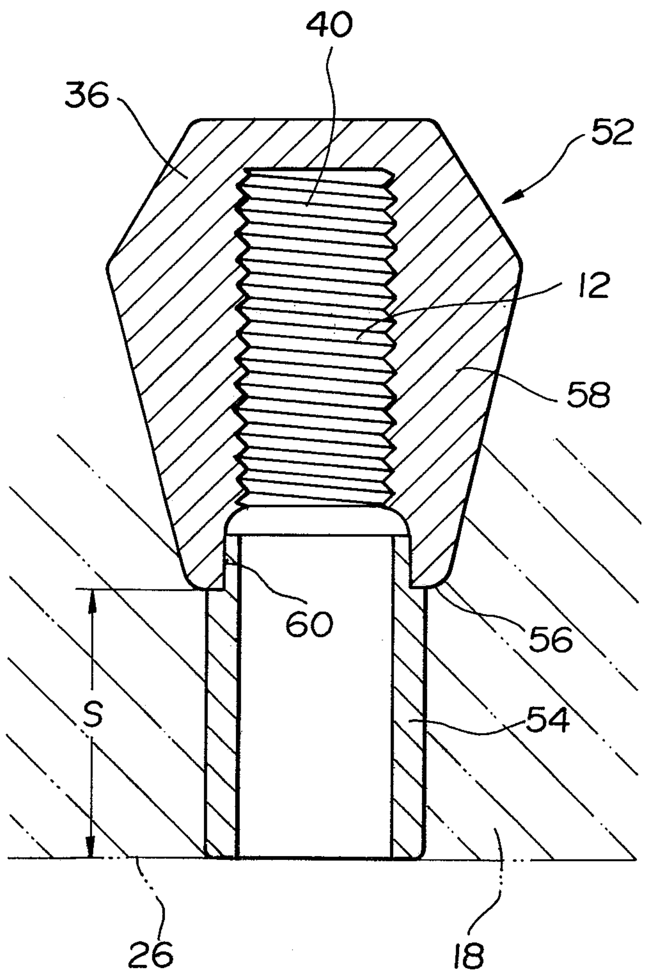

FIG.5

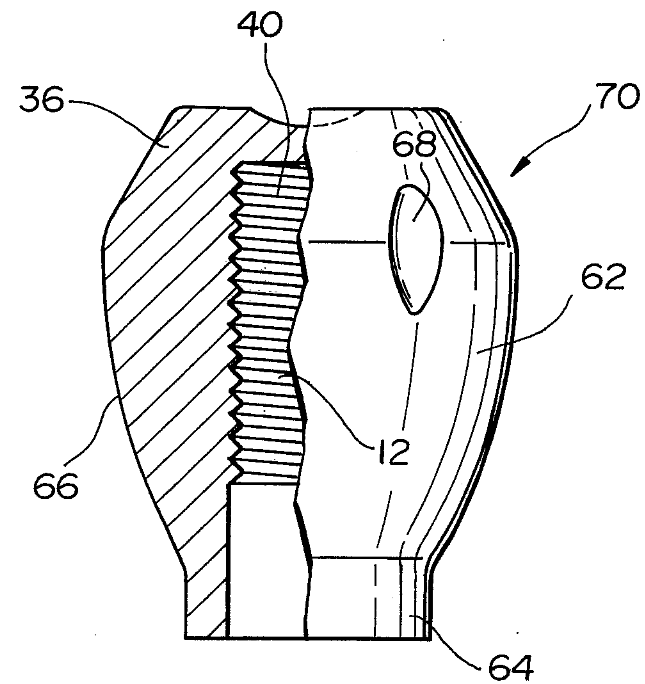

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FIG. 6

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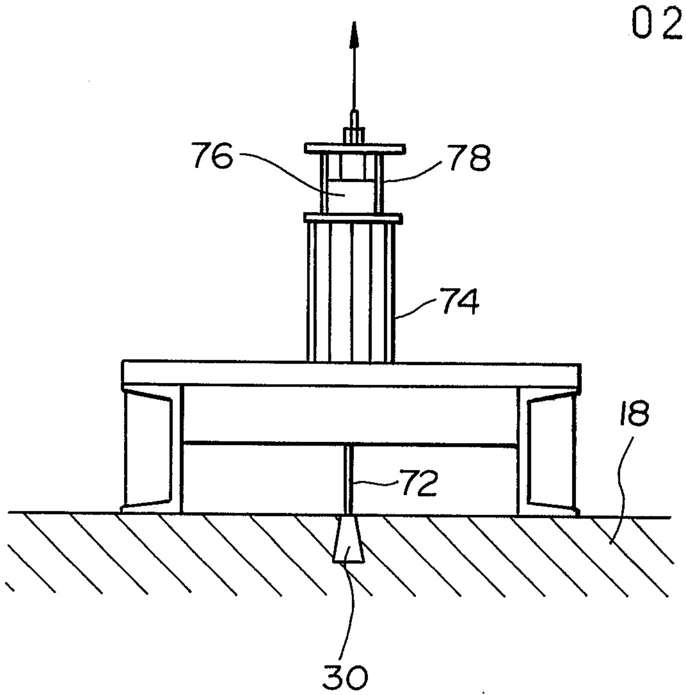
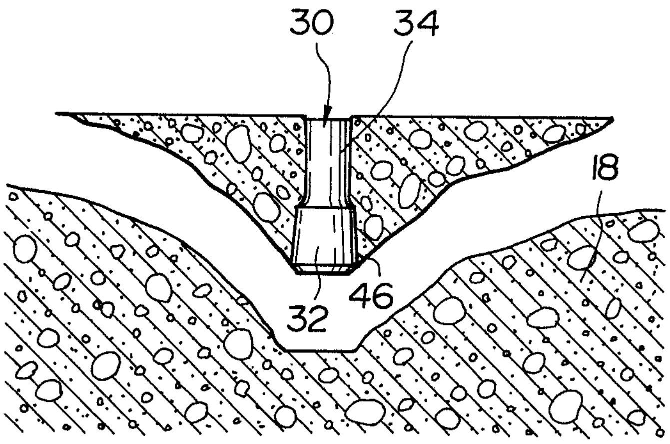


FIG. 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 30 1377

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A-1 561 627 (AACKERSBERG MORTENSEN) * Page 3, line 29 - page 4, line 23; figure 4 *	1	E 04 B 1/41
A		3,4,5,8,9,11,12	
A	US-A-3 418 781 (PENOTE) * Column 1, line 54 - column 2, line 22; figures *	1	
A	GB-A-2 060 806 (SANYO) * Page 1, line 68 - page 2, line 69; figures *	1,3,4,5	
A	US-A-3 982 363 (DORRIS)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

E 04 B
E 04 G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-04-1988	LAUE F.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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