United States Patent [19]

Allender

[11] **3,797,358**

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

[54] **BLIND FASTENER WITH PRISMATIC BODY**

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[73] Assignee: **The B. F. Goodrich Company**, New York, N.Y.

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[21] Appl. No.: **274,852**

[52] **U.S. Cl.** **85/71**

[51] **Int. Cl.** **F16b 13/04**

[58] **Field of Search** 85/71, 70, 84

[56] **References Cited**

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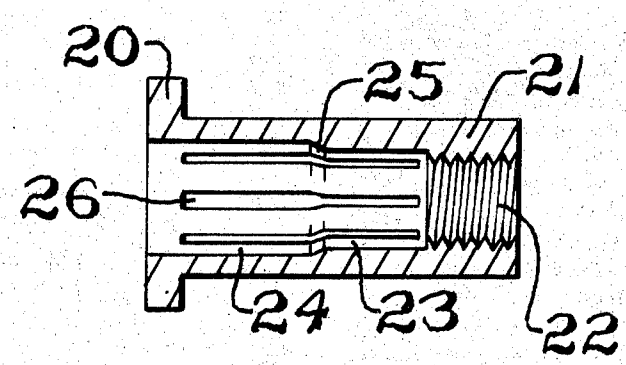
Primary Examiner—Edward C. Allen

Attorney, Agent, or Firm—W. A. Shira, Jr.; Harold S. Meyer

[57] **ABSTRACT**

A one-piece blind fastener, of the kind which serves as a nut plate, has a head to bear against the exposed face of a structural member having a hole in it, and a prismatic hollow body having preferably four to six flat faces to pass through the hole. The middle part of the body is divided longitudinally into as many strips as it has faces, and its end remote from the head is internally threaded. The bore of the fastener contains a small step or offset so that the major diameter of bore extends from the outer face of the head to the step, and a slightly smaller diameter of bore extends from the step to the threaded portion. When the fastener is shortened by a pull on a threaded draw rod, the longitudinal strips fold outward at the step and bear firmly against the back or blind face of the structure.

10 Claims, 18 Drawing Figures



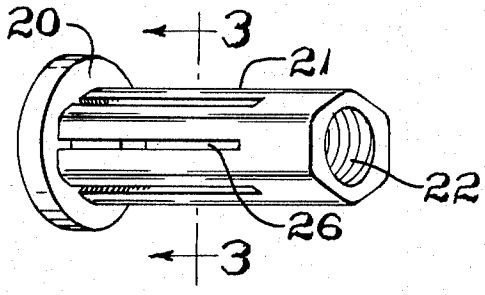


FIG. 1

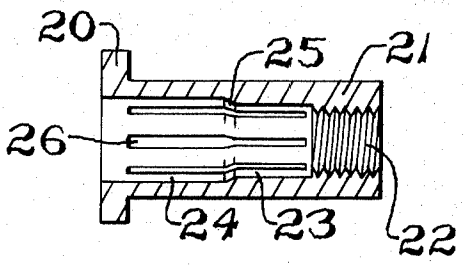


FIG. 2

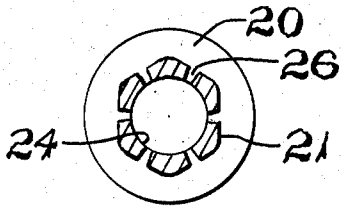


FIG. 3

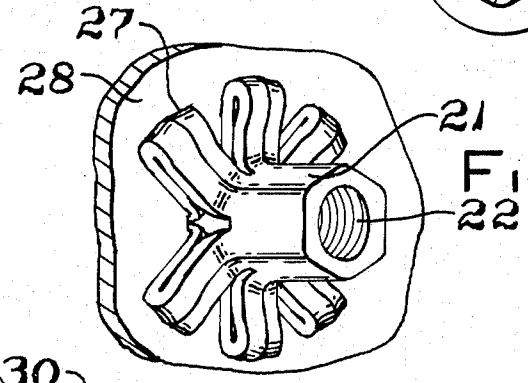


FIG. 4

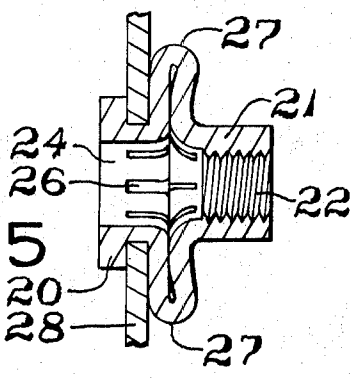


FIG. 5

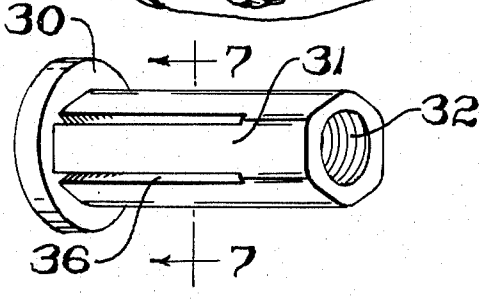


FIG. 6

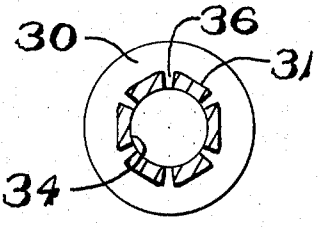


FIG. 7

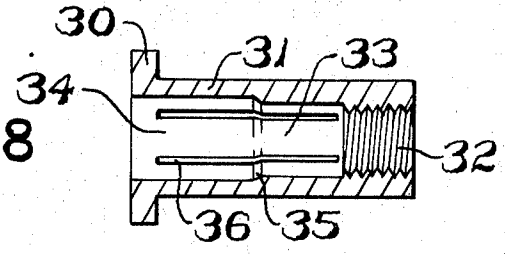


FIG. 8

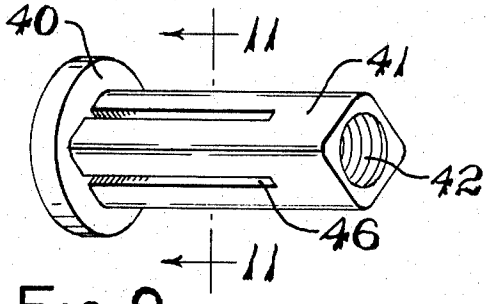


FIG. 9

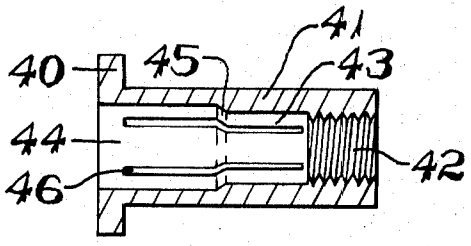


FIG. 10

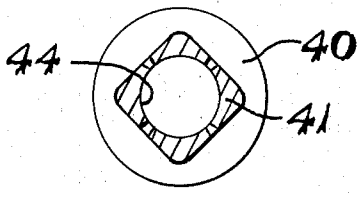


FIG. 11

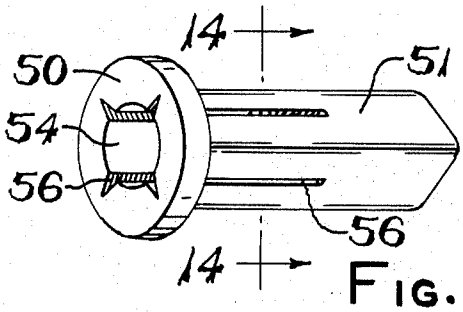


FIG. 12

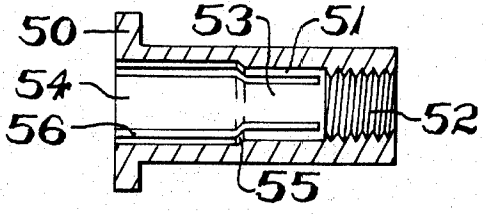


FIG. 13

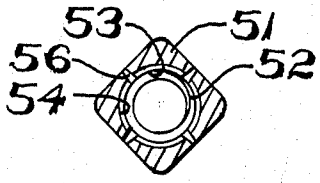


FIG. 14

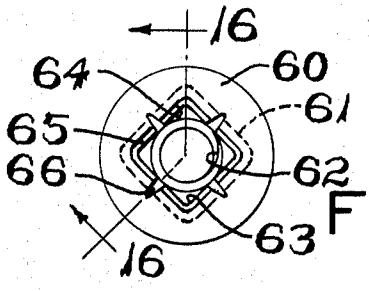


FIG. 15

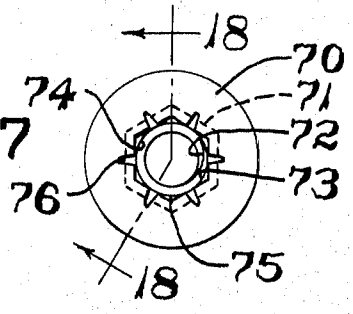


FIG. 17

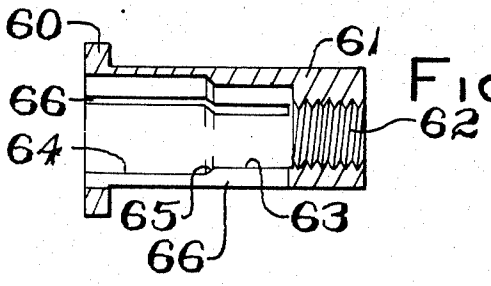


FIG. 16

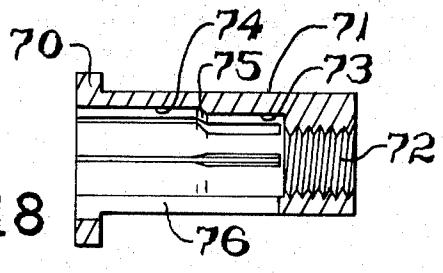


FIG. 18

BLIND FASTENER WITH PRISMATIC BODY

CROSS REFERENCE

The invention of this application is an improvement on the Blind Fastener described in the application for U.S. Pat. of James R. Shackelford, Ser. No. 95,824 filed Dec. 7, 1970.

BACKGROUND

This invention relates to blind fasteners, which means fasteners which can be installed entirely from one side of a structure, and in particular the type having an internal screw thread so that they can be used as nut plates to fasten a separate component of a product to a structure by means of screws. Such blind fasteners are extensively used where it is not convenient or practical to drill and tap the structure to receive a screw.

Heretofore, one type of blind fastener has generally been cylindrical in shape to form a circular bulge on the back or blind face of the work when it is fastened in place, although some similar fasteners have had the external shape of polygonal prisms with four to six sides, particularly where it is especially important to prevent them from turning in their seat when screws are inserted or removed. In addition, many blind fasteners have been longitudinally slotted so that the strips between the slots can fold outwardly to press against the back or blind face of the work, and in the prior Shackelford U.S. Pat. application Ser. No. 95,824 such fasteners have had a shallow internal step or offset to define the location of the folds.

SUMMARY OF THE INVENTION

This invention is an integral seamless blind fastener with longitudinal slots so that it is fastened by outward folding of the metal between the slots to bear against the back or blind face of the structure in which it is installed. It is particularly characterized by a non-cylindrical or faceted prismatic external shape.

The non-cylindrical shape presents edges which are pressed against the walls of the hole during setting of the fastener so as to give maximum assurance against turning when a screw is subsequently inserted or removed. This security against turning is especially the case when the fastener is installed in a punched hole of the same size and shape as the body of the fastener rather than in a circular drilled hole.

In addition, it is essential for best performance and development of maximum strength against pulling out of the hole that specific dimensional relationship be maintained. First, the length of the body between the back of the structure in which the fastener is installed and the threads in the end must be such that the fastener when installed will present long bearing surfaces radiating from the fastener, this portion preferably being at least about the same length as the external diameter of the body and may be of a length up to twice its diameter or more. Second, the wall thickness must be substantial, preferably of the order of 8 to 10 percent or more of the outer diameter of the body. Finally, there must be a small step or offset in the bore, with the greater diameter extending through the head to the step and a slightly smaller diameter from the step to the reduced diameter portion containing the internal threads. This internal step defines the location of the external fold, and should be about midway between the

position of the back face of the structure and the portion of smallest internal diameter containing the internal threads.

When such a fastener is installed by shortening it, by pulling a threaded draw rod, the strips between the longitudinal slots fold outwardly, with the fold at the location of the internal step, and are pressed against the back face of the structure in a tight 180° fold with the tips of the folded strips a substantial distance from the hole in the structure.

Such fasteners have an extremely high resistance to pulling through the holes, and also maximum resistance to turning in the holes.

DRAWINGS

In the accompanying drawings, FIG. **1** is a perspective view of a fastener with a six-sided prismatic body and a cylindrical bore, with slots in the middle of the six faces, FIG. **2** is a longitudinal section and FIG. **3** is a transverse section.

FIG. **4** shows in perspective the fastener of FIG. **1** after installation in a hole in a structure as seen from the back or blind face, and FIG. **5** is a longitudinal section of the same installation.

FIG. **6** is a perspective view of a six-sided fastener differing from the previous one in having slots at the edges between the six faces, FIG. **7** is a transverse section and FIG. **8** is a longitudinal section.

FIG. **9** is a perspective view of a four-sided prismatic fastener, FIG. **10** is a longitudinal section of the fastener, and FIG. **11** is a transverse sectional view of it.

FIG. **12** is a perspective view of a slightly different form, FIG. **13** is a longitudinal sectional view, and FIG. **14** is a transverse sectional view of that form.

FIG. **15** is a view from the head end of a fastener having both a prismatic outer surface and a prismatic inner surface so that the part of the hollow body which is to form the folds is of uniform thickness circumferentially, and FIG. **16** is a broken longitudinal section of the same fastener.

FIG. **17** is a view from the head end of a fastener having a bore, part of which is prismatic and part of which is cylindrical, and FIG. **18** is a broken longitudinal section of that fastener.

DETAILED DESCRIPTION

Referring to FIGS. **1** to **3**, a fastener is shown having a head **20** and a hollow body **21** having the shape of a hexagonal prism of such a size that it will just fit easily through a hole in a sheet of metal or the like forming part of a structure. The body **21** has a longitudinal bore made up of three sections of different diameter.

The end farthest from the head has a bore of smallest diameter **22** and is internally threaded to receive a threaded draw rod for installation, and to receive a screw if the fastener is to be used as a nut plate.

The central part of the length has a larger bore **23** which will just permit the draw rod or screw to pass through and enter the internal threads in the far end **22**. The length of this section in the embodiment shown is nearly as great as the maximum outside diameter of the body.

The remainder of the fastener including the head has a bore **24** of a diameter slightly greater than that of the central section **23**. These two sections are accordingly

on either side of a shallow step **25** or offset in diameter.

In each flat face of the body **21** is a longitudinal narrow slot **26**, the length of which is such that it extends at least from about the juncture of the threaded section of bore **22** and the central section of bore **23** at one end to the back face of the structure in which it is installed at the other end. The length just mentioned is the length of the portion of the fastener which folds to grip the back face of the structure in which the fastener is installed, and must be great enough that the strips between the slots will ultimately have a large bearing area on the structure and bear against the structure at a substantial distance from the hole.

In addition, the step **25**, which defines the location of the beginning of the fold in each strip when the fastener is installed, should be about midway between the back face of the structure and the threaded far end, so that the folded strip will project at about a right angle from the axis of the fastener and lie against the back face of the structure. Consequently, the bore **24** at the head end should have a length about equal to that of the central section of bore **23** plus the thickness of the structure plus the thickness of the head.

The fastener is installed by use of conventional tools which are available in a number of designs for manual or power operation, for exertion of a strong pull on a threaded draw rod against the reaction of an anvil engaging the head of the fastener. The fastener is screwed on to the tip of the draw rod, inserted in the hole in the structure, and fastened in place by pulling up the draw rod to shorten the fastener. The draw rod is then unscrewed to disconnect the tool from the fastener.

The shortening of the fastener causes each of the strips between slots **26** to commence bending outward at the location of the step **25**. As the shortening continues, the strips form tight 180° folds and are pressed firmly against the back face of the structure in a flower petal shape as shown in FIGS. **4** and **5**, with the folded strips **27** lying against the back face of a structural member **28**.

The prismatic shape of the fastener body is found to have a number of unanticipated benefits, in addition to the obvious fact that it provides maximum resistance against turning, particularly when installed in a polygonal hole of the same size and shape as the outside of the fastener body. This can be extremely important, as when used to receive screws fastening automobile seat belts to floor panels. When belts need replacing, after a year or two of use, it is most helpful to be able to remove the screws without having to grip the fastener, even though the screws may be rusted in place.

An important benefit results from the fact that the thickness of wall of the body of the fastener in the center of each face of the body **21** is considerably less than would be the case if the same amount of metal were used in a cylindrical body. This permits slots **26** to be cut more easily and quickly, because less metal needs to be removed, if the slots are sawed, or a smaller force is required, if the slots are pierced.

Another unanticipated benefit is that the fastener after installation is stiffer and has an increased resistance to pull-through for the same amount of metal, because the rib corresponding to each of the edges between faces of the prism gives a greater dimension in the direction transverse to bending stresses than if it had a uniform wall thickness.

The embodiment shown in FIGS. **6** to **8** has the same external and internal shape as that of FIG. **1**. Similarly it has a head **30**, body **31**, threaded bore **32** at the far end of the body, a central section of bore **33** of intermediate diameter and a head end bore **34** of slightly greater diameter separated from bore **33** by a step **35**. It differs in that its longitudinal slots **36**, instead of being in the middle of the faces, are located at the edges between the several faces.

This embodiment is somewhat more difficult to manufacture because of the necessity for producing the slots where the metal is thickest, and also at an edge where precise and rigid support of a tool may be required. In other respects it exhibits as good or better properties than that of FIG. **1**.

In particular, in this embodiment the folds are formed in strips having the shape of a shallow channel, with the ends folded toward the channel side. This produces a box-like shape with a maximum of the material at its surfaces to produce the greatest stiffness and resistance to pull-through failures.

The fastener shown in FIGS. **9** to **11** is essentially the same as that of FIG. **1**, except that its body has four sides instead of six. It similarly has a head **40**, and a body **41** which in this instance has the shape of a square prism. The body at its far end has an internally threaded bore **42** of relatively small diameter, an intermediate section of bore **43** of greater diameter, and a head end bore **44** of still slightly greater diameter separated from bore **43** by a shallow step **45**. Like fastener Like the FIG. **1**, it has a longitudinal slot **46** in each face of the body **41**, but since it is a square prism, there are only four slots instead of six.

The fastener of FIG. **9** exhibits all the advantages and benefits of that of FIG. **1**, but to a more pronounced extent, because it exhibits a considerably greater difference in wall thickness between the edges of the longitudinal strips formed by slots **46** and the middle zone of the strips.

This fastener is installed exactly like all the other fasteners of this invention, by tension on a threaded draw rod after insertion in a hole of the proper size.

The fastener shown in FIGS. **12** to **14**, like that of FIG. **9**, has a square body. It has a head **50**, a four-sided prismatic body **51** with an internally threaded bore **52** of minimum diameter at the far end of the body, a central section of bore **53** of greater diameter, and a head end bore **54** of still slightly greater diameter separated from central bore **53** by a small step **55**. It also has a longitudinal slot **56** in the center of each face of the body **51** but of somewhat different shape than the slots **46** of FIG. **9**.

In FIG. **9** the slots **46** are shown as extending lengthwise from (but not through) the head **40** to the threaded part of the bore **42**, and as being tapered in width with the greatest width outside and smallest width inside. Such slots can be formed, for example, by piercing the walls with longitudinal blades, preferably before drilling or finish reaming of central bore **43** and head end bore **44**.

In FIG. **12** the slots **56** are shown with the reverse taper, being of greatest width inside and smallest width outside. Moreover, they extend completely through the head **50**. Such slots can be made, for example, by driving a ribbed punch into the fastener from the head end, to gouge or squeeze slots **56** the entire length of the head end bore **54** and central bore **53** but not into

threaded bore 52. Such slots extending completely to an end of the fastener (in this case the head end) do not affect the integrity or performance of the fastener as long as a sufficient ring of metal remains at the end to prevent splitting of the end during the installation.

As shown in FIGS. 15 and 16, it is not essential that the fasteners have a circular bore. Thus a slug of metal of the proper size can be headed at one end and can then be partially pierced from the head end by a square pin having a shallow step intermediate its length. Thereafter, the closed end of the body is drilled and tapped, and slots are cut through the head into the remaining part of the length by means of a ribbed punch as described above with respect to FIG. 12.

The resulting fastener, seen from the head end in FIG. 15 and in broken longitudinal section in FIG. 16, has a head 60 and a square prismatic body 61, the far end of which has a bore of smallest diameter with internal threads 62. A central section has a square bore 63 so that the body of the fastener in this section has an approximately uniform wall thickness around its circumference. The remainder of the bore 64 extending through the head, is also square but with a slightly greater dimension so that there is a small step 65 between it and the central section of bore 63. Each of the four faces has a longitudinal slot 66 which in this case extends through the head 60 and the entire length of both square sections of the bore.

This particular fastener has a strength nearly as great as the form with a circular bore because the angular shape of the strips at their junction with the threaded far end 62 of the body produces a pronounced stiffness against any further deformation of the installed fastener, and therefore strongly resists bending back of the folded strips toward the far end of the fastener and pulling through the hole.

A still further variation is shown in FIGS. 17 and 18, in which the fastener has a head 70, and a six-sided prismatic body 71 having an internally threaded far end 72. In this form the central section 73 of the bore has a cylindrical shape, and only the portion of the bore 74 at the head end has a six-sided prismatic shape like that of the outside of body 71. Also in this form the dimension from one internal face of the prismatic bore 74 to the opposite face does not need to be greater than the diameter of the central cylindrical section 73 of the bore. The step 75 forming the transition between the central section 73 of the bore and the head end bore 74 consequently exists principally in the corners of the head end bore 74. This form accordingly provides a lateral support of a screw inserted in the installed fastener, against lateral displacement or shear deformation, without requiring use of a non-standard screw having its threaded tip of a smaller diameter than the remainder of its shank. Finally, this form, like all the others, has a longitudinal slot 76 in each face of the prismatic body 71, for installation in the same manner as all the other forms of the invention described herein, and for folding of the resulting strips against the back face of the structure, for maximum strength against pull through the hole in the structure.

Manifestly, many minor variations in structure are possible without departing from the scope of the invention. Thus the shape of the head may be modified to suit various particular needs, such as the conical shape of a "flat head" to fit a conically countersunk hole.

It is not essential that the fastener body be of exactly the same size and shape from end to end, although it is preferred that the external shape of the portion which is to form the folds on the back side of the structure be essentially uniform.

The longitudinal slots in the fastener body have been shown as extending completely through the body between the outside and inside, but it is well known that they function in the same manner if they extend almost through since a remaining very small thickness of metal will separate during the installation of the fastener.

Moreover, the number of faces of the prismatic body can be varied, with any of the forms whether shown as having four or six faces having a different number of faces. However numbers smaller than four or greater than six are not presently preferred.

I claim:

1. A one-piece blind fastener comprising a head and a prism shaped body integral with the head, the fastener having a longitudinal bore extending through the head and the body and having three sections, the bore of the section farthest from the head being of smallest diameter and being internally threaded, the bore of the central section being of a greater diameter to clear the tips of threads of a screw fitting the internal threads, the bore of the other section being of slightly greater maximum diameter and slightly smaller wall thickness along its length than the central section, in at least several circumferential locations, with an abrupt internal shallow step or offset between it and the central section in the same circumferential locations, the last mentioned section extending from the step to and through the head, the portion of the body capable of passing completely through a hole in a structure in which it is to be installed but not including the internally threaded section farthest from the head being of essentially uniform external size and shape and of a length at least approximately as great as its maximum external diameter, and longitudinal slots in the said portion dividing it into strips.

2. A fastener as in claim 1, in which the numbers of slots is the same as the number of faces of the prismatic body.

3. A fastener as in claim 2, in which the longitudinal slots are in the center of the faces.

4. A fastener as in claim 1, in which the prismatic body has not less than four nor more than six faces.

5. A fastener as in claim 1, in which the prismatic body has four faces.

6. A fastener as in claim 1, in which each section of the bore other than the threaded section is cylindrical.

7. A fastener as in claim 1, in which the section of the bore from the step to the head is prism shaped and the wall of the body in that section has an approximately uniform thickness.

8. A fastener as in claim 7, in which the central section of the bore, from the internally threaded end to the step, is cylindrical.

9. A fastener as in claim 1, in which the step is approximately midway between the location of the back face of the structure and the internally threaded end section.

10. A fastener as in claim 7, in which the prismatic body has six faces, the longitudinal slots are in the centers of the faces, and the step is approximately midway between the location of the back face of the structure and the internally threaded end section.

* * * * *