United States Patent [19]

Newton

[11] **3,772,957**

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[54] **SELF-DRILLING AND SEALING RIVET**

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[73] Assignee: **USM Corporation,** Boston, Mass.

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[21] Appl. No.: **255,392**

[52] **U.S. Cl.** **85/68,** 85/77, 85/66, 151/14.5

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

[58] **Field of Search** ..... 85/63, 66, 68, 70, 85/71, 72, 77, 78, 1 JP; 151/14.5, 41.7

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Primary Examiner—Marion Parsons, Jr.

Attorney—Carl E. Johnson et al.

[57] **ABSTRACT**

A mandrel-rivet of the pull-to-set type comprises an mandrel head either adapted, or not adapted, to form the installation hole by rotation relative to a workpiece, and its mandrel stem and/or the barrel portion of the rivet are of a configuration to provide space for holding a dormant sealant or adhesive. Rotation of the mandrel relative to the rivet after drilling may provide a melting or curing heat, and subsequent retraction of the mandrel head for rivet setting simultaneously squeezes the sealant through holes in the rivet barrel into the interface region of the joint to provide greater strength and a water-tight seal. A particularly desirable variant contemplates inclusion of a two-part epoxy initially retained in the barrel and divided by the shape of the mandrel section, for instance oval, until the mandrel rotation relative to the rivet will mix the epoxy whereupon the mandrel retraction secures the rivet while exuding activated adhesive for sealing its joint.

A drilling-pulling mandrel stem optionally useful in the fastener for attaining so-called flush break joints would be formed with multiple indentations which, though not likely to cause the stem to break under rotary drilling or straight pulling, would cause its rupture where desired when subjected by the installing tool, after rivet setting, to the tensile stress of the pulling and additionally to a tilting of the stem.

2 Claims, 9 Drawing Figures

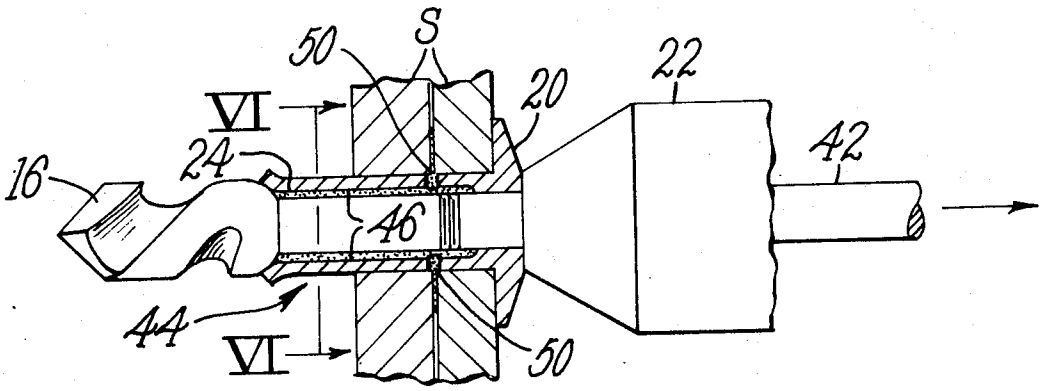


Fig. 1

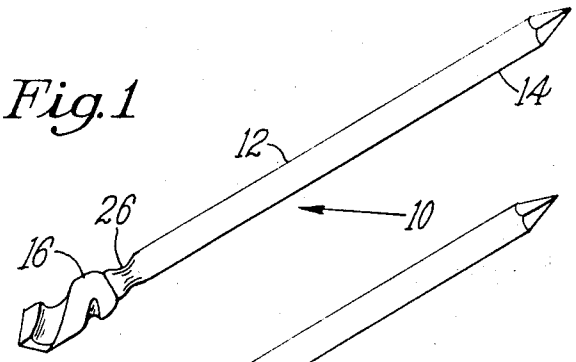


Fig. 2

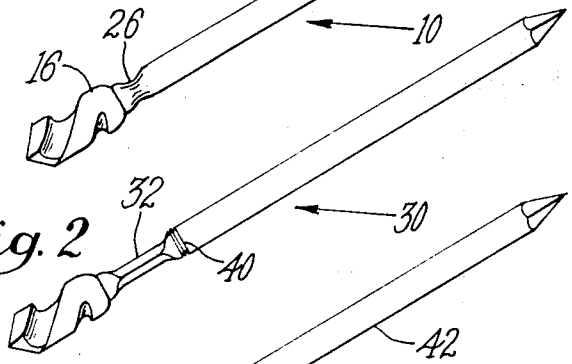


Fig. 3

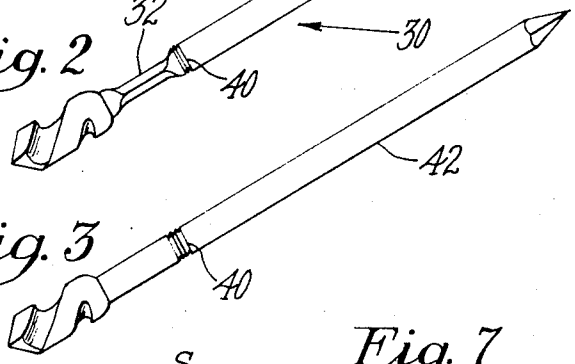


Fig. 4

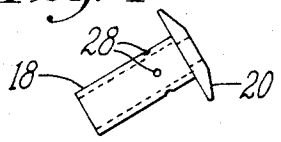


Fig. 5

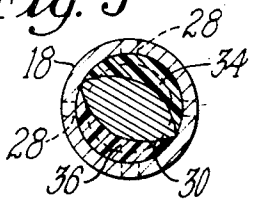


Fig. 6

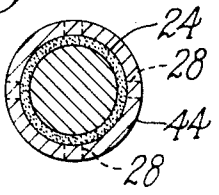


Fig. 7

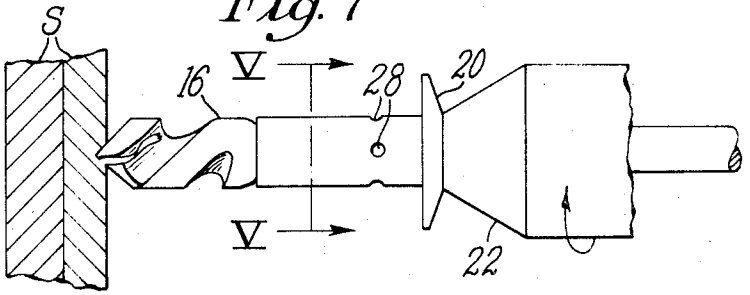


Fig. 8

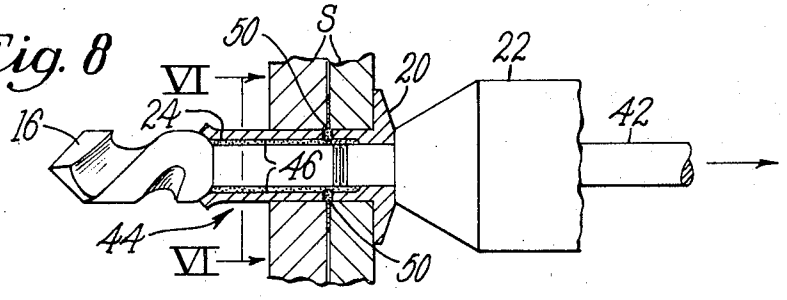
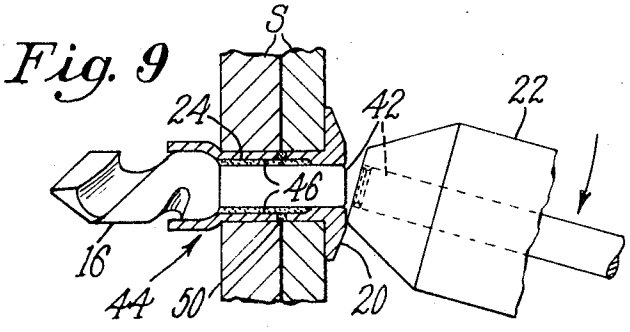


Fig. 9



SELF-DRILLING AND SEALING RIVET

BACKGROUND OF THE INVENTION

U.S. Pat. No. 3,512,224 issued May 19, 1970, upon an application filed in my name, discloses a two-part grommet, one part of which has an orifice to allow expulsion of adhesive for bonding the grommet upon setting the assembly in a structure.

The present invention relates to blind fasteners of the pull-to-set type. More especially this invention pertains to novel mandrel-rivets adapted both to drill the holes into which they are to be installed and to release and apply, during their installation, a sealant or adhesive contained in the respective rivet barrels whereby strong, sealed joints are produced. Tools suitable for blind riveting and for mandrel drilling have hitherto been known; also, self-drilling mandrel rivets have hitherto been disclosed. So far as I am aware, however, no self-drilling, self-sealing blind fastener has previously been available, and hence the marked advantages of combining in one fastener its own hole-making means and joint sealant activation have not hitherto been attained.

SUMMARY OF THE INVENTION

In view of the foregoing it is a primary object of this invention to provide an improved pull-to-set fastener incorporating its own joint sealant exudable upon fastener installation.

Another object of the invention is to provide an improved mandrel-rivet having the dual capabilities of forming its own mounting hole in a structure, and then, upon relative setting movement of the mandrel and the rivet, exuding adhesive to produce a fluid-tight joint.

To these ends, and in accordance with a feature of the invention, the configuration of a mandrel shank portion and/or the surrounding rivet barrel portion provide storage for an exudable sealant. In one variant a self-drilling mandrel rivet has a mandrel head swedged to form a drill tip, and that portion of the mandrel stem within the rivet barrel is reduced to enable an adhesive or sealant to be accommodated therein. The sealant may be of a "one-part" type that will become thermoplastic under the heat and/or squeezing forces generated during the installation, or which would cure upon the exclusion of air by formation of the rivet joint. Alternatively, the sealant may be of the two-part epoxy type. In the latter case the mandrel stem within the barrel defines predetermined storage volumes for the resin and its activator, holding them separately until the hole forming, whereupon their admixture is effected by relative rotation of the rivet and the drilling mandrel, and the adhesive mixture is caused to be exuded for sealing by the relative mandrel retraction to axially compress and set the rivet.

It will be understood that, although the variant form of the novel fastener employing a self-drilling mandrel head is presently preferred, the invention is not necessarily thus limited but may well also reside in a pull-to-set mandrel rivet initially insertable into a preformed hole and having a non-drilling mandrel head, and a reduced mandrel shank which may relatively rotate and or be simply relatively retractive to exude a sealant retained within the unset rivet barrel.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other feature of the invention will

now be more particularly described in connection with an illustrative embodiment, and with reference to the accompanying drawings thereof, in which:

FIG. 1 is a view in side elevation of a self-drilling mandrel having a reduced shank portion formed to accommodate an adhesive;

FIG. 2 is a view similar to FIG. 1 but having its shank portion of oval cross section;

FIG. 3 is a view in side elevation of a self-drilling rivet-mandrel, the shank of which is cylindrical and formed with flush break grooves;

FIG. 4 is a view in side elevation of a tubular rivet having sealant orifices and assemblable with either of the mandrels of FIGS. 1–3;

FIG. 5 is a transverse section taken on the line V—V of FIG. 7;

FIG. 6 is a transverse section taken on the line VI—VI of FIG. 8;

FIG. 7 is a view in side elevation showing the beginning of installation by a tool of a mandrel-rivet including, for example, the mandrel of FIG. 2 and a two-part epoxy shown in FIG. 5;

FIG. 8 is a longitudinal section showing the mandrel of FIG. 3 assembled on a rivet having an enlarged bore portion providing a chamber or pocket for an adhesive deposit, the mandrel having bored a mounting hole by operation of a tool which is starting mandrel retraction to set the rivet; and

FIG. 9 is a longitudinal section showing the mandrel-rivet of FIG. 8 after installation is completed.

DESCRIPTION OF PREFERRED EMBODIMENTS

The following description will be predicated on the assumption that the self-drilling mandrel is employed in the several mandrel assemblages to be explained by way of illustration. It will be understood, however, that where the structure in which the fastener is to be secured already has been provided with an appropriate receiving hole, and the heat due to drilling is not required for conditioning of the adhesive, the mandrel may merely have a conventional enlarged head devoid of drilling configurations but employing one or another of the other novel features associated with the mandrel shank as will hereinafter be described.

In FIG. 1 a self-drilling mandrel generally designated **10** has an elongated shank **12** provided with a pulling end **14** (which may be formed with a gripping means such as grooves not shown), and an opposite extremity having an enlarged head **16** with a drilling configuration adapted to bore a receiving hole for a tubular rivet barrel **18** (FIG. 4) in a structure S (FIGS. 7–9). It will be understood that the mandrel **10** will telescopically receive the rivet barrel **18** as shown in FIG. 7, a preformed flanged end **20** of the rivet being remote from the head **16** and adapted to engage the structure S when in abutting relation with an anvil or nosepiece **22** (FIGS. 7 and 8) of an installing tool. The latter, when the self-drilling head **16** is employed, is of a type adapted to rotate the mandrel **10** about its axis and relatively to both the structure S and the inserted rivet held against rotation by the nosepiece **22**, and thereafter axially retract the mandrel relative to the rivet as will be described.

In accordance with this invention either a portion of the mandrel shank **12** and/or the rivet barrel **18** have a configuration to provide therebetween a space or pocket for the storage of a deposit of adhesive or seal-

ant 24. This may be a thermoplastic or thermoset type of adhesive which would be heatable to fluid state by the friction generated during rotation of the mandrel within the rivet. For annularly accommodating the deposit 24 the mandrel shank 12 is of reduced section as shown at 26 (FIG. 1) and axially spaced to communicate, during rivet upsetting, with at least one radial aperture 28 formed in the barrel 18. It will be understood that, as indicated in FIGS. 8 and 9, the axial position of the barrel apertures 28 preferably corresponds with interfaces of the structure S in which the fastener assembly is to be secured and to which the adhesive or sealant is to be exuded.

In FIG. 2 a self-drilling mandrel generally designated 30 differs from that shown in FIG. 1 in that its shank has a reduced portion 32 which is oval in cross section, the major axis diameter corresponding substantially to the internal diameter of the barrel 18. In this way, as indicated in FIG. 5, two substantially equal pockets are provided for the reception and storage of a two-part epoxy 34–36. The resin component and its activator are kept apart in the fastener assembly until the mandrel is relatively rotated during drilling of the installation hole, when mixing of the epoxy will occur, and relative mandrel retraction thereafter to set the rivet forces the mixture through the orifices 28. Thus crevices and voids in the joint, barrel and mandrel are filled to provide a water-tight, high temperature resistant seal. It will be appreciated that the mandrel temperature may appropriately rise during the drilling, due to heat generated at the drill tip and by reason of high speed rotation of the mandrel, and the heat transmitted by conduction can decrease viscosity of the epoxy and accelerate curing. Also, if desired the nosepiece 22 may itself be heated by means not illustrated.

The mandrels of FIGS. 1 and 2 may, but need not, employ so called "flush break" grooves of the type shown at 40 at FIGS. 2 and 3. The mandrel 42 of FIGS. 3, 8, and 9 next to be described is unlike those of FIGS. 1 and 2 in that it has no reduced shank portion for accommodating an adhesive deposit, but is formed with the peripheral grooves 40, or closely arranged indentations (as in knurling) providing a locality of stress concentration. The grooves 40, nicks, or indentations do not weaken the mandrel to the extent that it breaks during rotation or straight retractive pulling to set the rivet, but they do produce a localized stress in the mandrel such that, whn the tool not only is exerting retractive pulling stress but is also tilted after the rivet has been set, the mandrel will, due to tensile and bending stress break off at the desired point, usually even with the rivet flange end 20 as shown in FIG. 9.

The mandrel 42 is especially adapted for use with a tubular rivet 44 (FIGS. 8 and 9) which differs from that shown in FIG. 4 in that an enlarged bore portion 46 of the barrel is adapted to retain adhesive or sealant 48 (FIGS. 6, 8 and 9) until at least partly squeezed out of orifice 50 during rivet setting by relative mandrel retraction.

Though not herein illustrated, it will be understood that a two-part epoxy may be employed in the rivet 44, a mandrel of the type shown in FIG. 2 then being employed and having, at its ovalized shank section, a major axis substantially equal to the internal diameter of the enlarged bore 46.

Installation of the self-drilling and sealing rivet will now be briefly reviewed, the procedure being essentially the same for any of the several combinations mentioned. With the rivet telescoped on one of the mandrels in the manner shown in FIG. 7, the installing tool will (by mechanism not herein shown) grip the mandrel with the nosepiece 22 bearing on the rivet flange 20. The mandrel is then rotated by the tool, when positioned by the operator, to cause the drilling head 16 to bore a hole in the structure S for receiving the barrel 18. With the nosepiece 22 holding the rivet flange in structure-abutting relation and thus preventing rivet rotation, the relative mandrel rotation heats and/or mixes the adhesive. Next the operator causes the tool to retract the head 16 for setting the rivet. The blind end of the rivet barrel is accordingly radially expanded by the head 16, and the adhesive or sealant entrappd between the rivet barrel and the mandrel is exuded through the aperture 28 or 50 to tightly seal the rivet joint.

If the installed rivet had a flush break groove 40 or equivalent stress concentration locality in its mandrel shank the tool would now be tilted to add a bending stress to the pulling stress on the mandrel whereby it is broken off where desired. The installed rivet thus remains plugged as well as sealed. A strong joint is afforded by the novel blind fastener which can be quickly and conveniently completed.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A pull-to-set mandrel-rivet comprising, in telescoping relation, a tubular rivet having a barrel formed with a flange on one end and a radial orifice spaced therefrom, a mandrel provided with a head remote from the flange and having a shank extending through the barrel, that portion of the shank within the barrel having a roughly oval cross section to provide two storage spaces bounded by the inner wall of the barrel, and an epoxy resin and its activator respectively occupying said spaces, said orifice enabling the resin and the activator, upon relative upsetting movement of the mandrel and rivet, to flow and mix to form a sealant for the rivet.

2. A mandrel-rivet as in claim 1 wherein the mandrel is formed with a drill tip, and operation of the drill tip in forming a work hole for the reception of the mandrel-rivet facilitates the subsequent admixture of the resin and its activator by supplying heat due to friction.

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