Oct. 5, 1965 C. VOORHIES 3,209,437

METHOD OF SECURING TOGETHER TWO MEMBERS

Filed April 13, 1962 2 Sheets-Sheet 1

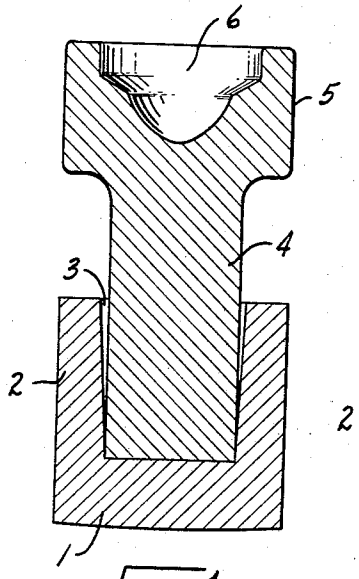


Fig. 1.

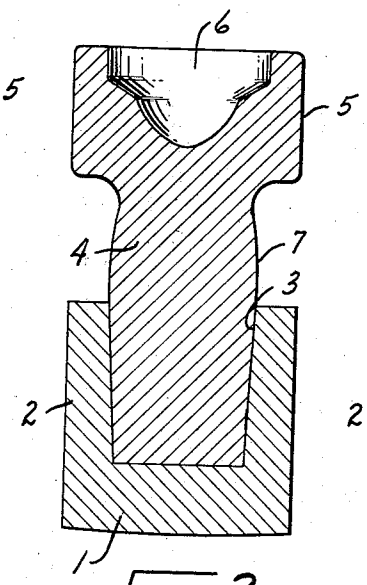


Fig. 2.

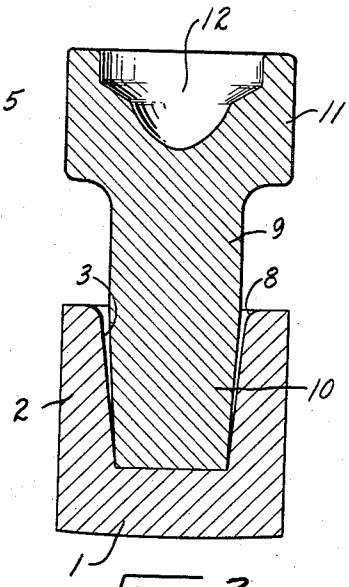


Fig. 3.

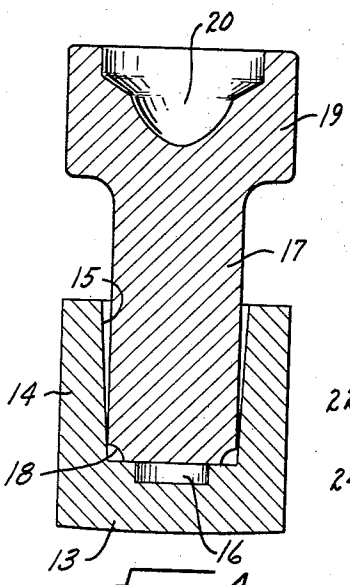


Fig. 4.

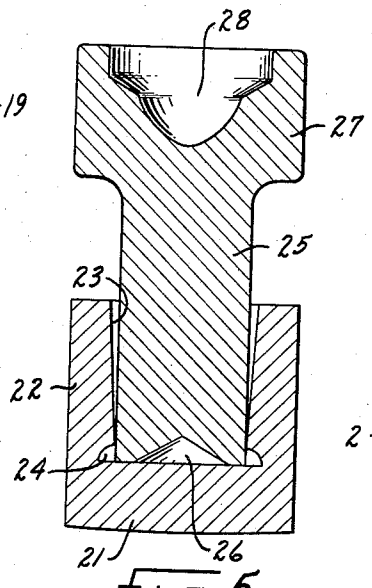


Fig. 5.

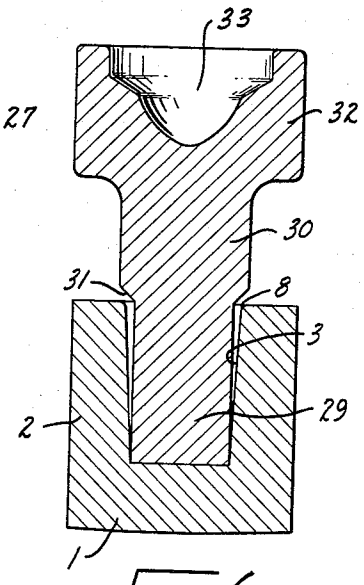


Fig. 6.

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METHOD OF SECURING TOGETHER TWO MEMBERS

Filed April 13, 1962 2 Sheets-Sheet 2

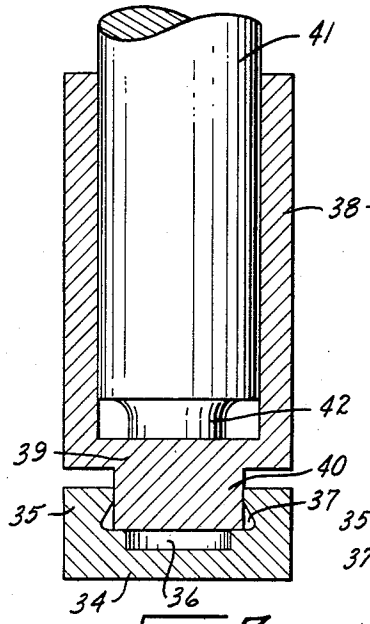


Fig. 7.

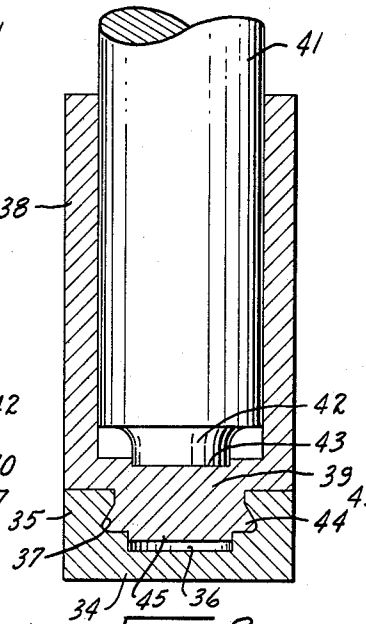


Fig. 8.

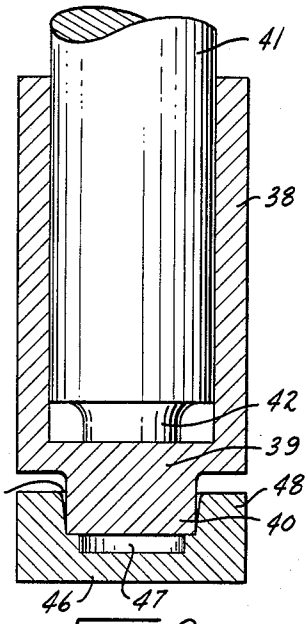


Fig. 9.

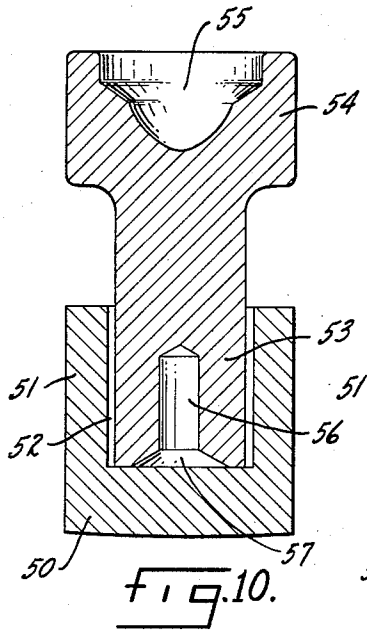


Fig. 10.

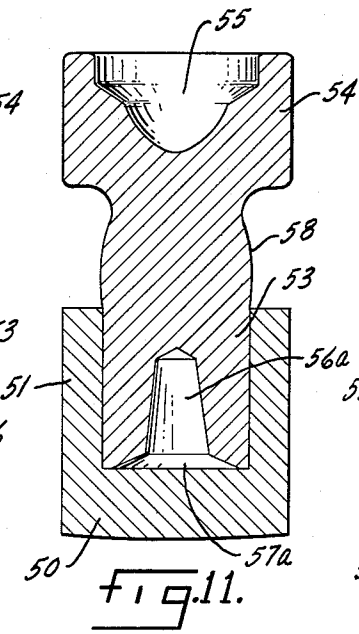


Fig. 11.

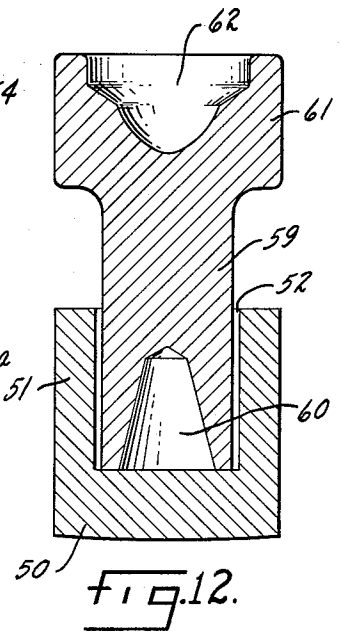


Fig. 12.

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METHOD OF SECURING TOGETHER TWO MEMBERS

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Filed Apr. 13, 1962, Ser. No. 187,237
4 Claims. (Cl. 29—156.7)

This invention relates to a method of producing a two-part member and in the particular forms shown the member is illustrated as a tappet or lash adjuster for internal combustion engines. Although it is not limited to such devices, it will as a matter of convenience be described, as shown herein, primarily in connection with tappets.

Other objects will appear from time to time throughout the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

FIG. 1 illustrates one form of the device before the two parts have been secured together;

FIG. 2 represents the same form of the device after the parts have been secured together;

FIG. 3 is a view similar to FIG. 1 illustrating a modification;

FIGS. 4, 5 and 6 are views generally similar to FIG. 1 illustrating further modifications;

FIG. 7 is a longitudinal section illustrating a hollow tappet suitable for hydraulic use embodying the present invention, the parts being shown before they have been secured together;

FIG. 8 shows the tappet of FIG. 7 after the parts have been secured together;

FIG. 9 is a view similar to FIG. 7 showing a modified form;

FIG. 10 is a longitudinal section similar to earlier figures showing a further modification with the insert fitting into the head member or cup with some clearance;

FIG. 11 is a longitudinal section showing the form of FIG. 10 with the parts expanded to retain the insert in the cup; and

FIG. 12 is a view similar to FIG. 10 showing a further modification and illustrating clearance between the head or cup and insert.

Like parts are designated by like characters throughout the specification and drawings.

Whatever the precise design of the parts, the invention includes two pices which are pressed together. It involves the solution of the problem of securing them together without brazing or welding, one member, in a typical example of the invention, being formed of hard, and possibly cast metal, and the other being formed of less hard and probably forged metal. An essential point in the invention is that one of the members is hard. It may, for example, be the face member of a tappet and the other, which may be the stem of the tappet, will be softer and more ductible than the hard face member, and the problem which the inventor has solved is to secure them together and thus to produce a method of securing them together and to produce by the method a proper article.

In the figures clearances and dimensions are somewhat exaggerated to make evident features of the invention which might not otherwise be.

In FIG. 1 there is a hollow or cup-shaped hardened member having a face **1**, side walls **2** and a tapered depression **3**. The degree of taper shown in FIGS. 1 and 2 may be considered to be exaggerated.

The stem **4** is provided with an enlargement **5** which may have a generally rounded or hemispherical depression **6** in it to serve as a suitable seat for the rounded end of a push rod. As shown in FIG. 1 the stem **4** is generally straight-sided.

When the parts are to be fastened together longitudinal

pressure is applied and because the stem **4** is ductile sufficient longitudinal pressure will deform it and will shorten it and as it is shortened will cause it to swell to assume the position shown in FIG. 2. The shape and size of the clearance **3** between the stem **4** and the inner faces of the wall **2** are such that as the stem **4** is shortened and swells it will swell from the bottom or inner end up and will progressively fill and take up the clearance **3** without at any time exerting a pressure on the hard walls **2** or on face **1** to cause fracture. One test to establish the fact that the clearance has been fully taken up and that the two parts are properly joined together is the presence of the swelling or enlargement **7** which shows outside of the member **2**. Therefore, one ready visual test which can be made to determine the proper completion of an article is by inspection in which some swelling or bowing outward of the stem **4** is noticed.

In the modified form of FIG. 3 the hard member, comprising the head **1** with the walls **2** and the clearance **3**, is the same as that shown in FIGS. 1 and 2. The hard member differs only by the fact that a beveled or rounded portion **8** appears at the upper edge of the inner face of the walls.

The stem of FIG. 3 differs from that of FIGS. 1 and 2. It is provided initially with a generally straight-sided section **9** and a generally tapered section **10**. The tapered section **10** is positioned largely within the hole or bore or cavity defined by the hard member. The stem **9** has an enlargement **11** which contains a cavity **12** of generally hemispherical shape.

In the modified form of FIG. 4 the hard member is formed of a cup **13** having integral side walls **14**, tapered as at **15**. The cup, head or base **13** is provided with a depression **16**. Within this cup is positioned a generally straight-sided stem **17** which may have its lower end rounded or reduced or beveled as at **18**. The stem provided with an integral enlargement **19** containing a rounded or hemispherical depression **20**.

In the modified form of FIG. 5 the cup is formed of a head **21** with integral walls **22** tapered as at **23**. Within the cup the walls adjacent the inner face of the head **21** may be cut away in part as at **24**.

In the form of FIG. 5 a generally straight-sided stem **25** is shown. It is provided with a depression **26** in its bottom and carries an integral enlargement **27** which has in its upper face a rounded depression **28**.

In the modified form of FIG. 6 the cup is generally the same as that shown in FIG. 3 and carries the same reference numeral. The stem of the form of FIG. 6 is generally straight-sided and shaped with two diameters. The lesser diameter is indicated at **29** and is generally coextensive in length with the hole or cavity formed within the walls **2**. The stem portion of larger diameter is indicated at **30**. The portions **29** and **30** are joined by an inclined or beveled portion or area **31** which initially is located outside of the cavity within the head. An integral enlargement **32** is provided with a rounded depression **33**.

Without describing in detail the operation of completing the tappets of FIGS. 3–6, inclusive, it is here sufficient to say that upon the application of longitudinal pressure the stem swells progressively from its inner or bottom end upwardly and takes up the initial clearance between it and the cup to assume generally the appearance of FIG. 2. When this has occurred the two parts are firmly secured together. A further slight additional application of endwise pressure will cause some swelling of that portion of the stem which then lies exteriorly of the hard cup. This furnishes the ready means for visual identification of proper formation, as above described.

In the form of FIG. 4 the cut away portion **18** may or may not be omitted. Whether it is or it not omitted,

experience has shown that the cavity **16** will first be filled by the application of longitudinal pressure which causes distortion of the stem. Thereafter the swelling of the stem, above mentioned, will occur and the stem will assume generally the outward appearance of FIG.2.

In the completion of the forms shown in FIG. 5 longitudinal pressure will initially cause distortion of the lower end of the stem **25**. The clearance portion or space **26** will wholly or largely disappear and the metal of the stem **25** will flow into the cavities **24**. Thereafter swelling of the stem due to the further application of longitudinal pressure on it will cause the taking up of the clearance **23** and finally some outward bulging or enlarging of the stem itself.

The operation of the form of FIG. 6 is substantially the same as that of FIGS. 1 and 2.

The forms of FIGS. 7, 8 and 9 relate to hollow tappets. In FIGS. 7 and 8 the structural parts are the same. There is in these figures a hard head member comprising a bottom face portion **34** which is provided with integral walls **35**. A cavity **36** is formed on the inner face of the member **34** and the walls may be cut away in part as at **37**.

The more ductile member comprises a tubular portion **38** and provided with a downwardly extending reduced portion **40**. In completing the device of FIGS. 7 and 8 a punch **41**, which fits relatively snugly within the tubular portion **38**, is inserted. It is reduced at its lower end as at **42**.

In the completed condition of the form of FIGS. 7 and 8 longitudinal pressure has been applied by the punch and some deformation of the part **39** has occurred. The punch has forced itself into this part to a degree sufficient to form a depression **43**. Also, the extension **40** of the member **39** has been deformed and distorted so that parts of it have extended into the cavities **37** to form outward projections **44** and to some degree it has been forced into the depression **36** to form a downward extension **45**. Under certain conditions the space **36** will have been entirely taken up by the extension **45**. Under other conditions it will not be the case.

In the modification of FIG. 9 the hollow member **38** is the same as that shown in FIGS. 7 and 8. The head or cup-shaped member is modified somewhat. It is the hard member of the combination and it is provided with a bottom face portion **46** which has a depression **47** in it. It has integral walls **48** which are inwardly tapered to provide a clearance **49**. When the form of FIG. 9 is completed the lower end of the member **38** is in tight contact with the upper face of the member **48**. The clearance **49** is taken up completely by the swelling of the extension **40** and the depression **47** in the member **46** is largely or wholly filled in by metal which has flowed from the extension **40**.

The modified forms of FIGS. 10, 11 and 12 show still further modifications of the general idea in which there is a hard cup or head member into which a relatively softer insert is positioned with clearance between the two, and in which when pressure is exerted longitudinally the softer insert is caused to expand laterally until its expansion is limited by contact with the cup and the two are thus held together by contact and friction. As shown in FIGS. 10, 11 and 12, **50** is a cup similar to the cups shown in the first six figures. These cups of FIGS. 10, 11 and 12 include a bottom portion **50**, as stated, and sides **51**. A hollow or cavity **52** is formed within the cup and the cup is preferably straight-sided internally and externally so that it is without taper internally in particular.

An insert **53** of relatively softer material is used and it is inserted into the cup as shown in FIGS. 10 and 11. It may be enlarged as at **54** and provided with a hollow or cavity **55** into which a push rod is positioned when the device is assembled in an engine. The insert member **53**

is provided with a bore **56** and with a laterally and downwardly tapered enlargement **57**.

When the insert is put into the cup or head as shown in FIG. 10 and pressure is exerted longitudinally against the insert and the head, the insert, being softer than the head, tends to be shortened and to swell laterally. As the pressure is continued long enough it will swell into contact with the inner straight face of the bore or cavity **52**. It is shown in that condition in FIG. 11. Further compression longitudinally will tend to cause the exposed portion **58** of the insert **53** to swell laterally as shown in FIG. 11. When that occurs an operator has visual indication that the insert and cup art in tight contact with each other within the cup and further compression endwise or longitudinally is unnecessary.

As the swelling of the portion of the insert within the cup takes place, the perforation **56** will be enlarged in diameter and this enlarged condition is shown at **56*a*** in FIG. 11. Correspondingly, the flared portion **57** will be enlarged laterally and this enlarged condition is shown at **57*a*** in FIG. 11.

In FIG. 12 the head or cup member is the same as shown in FIGS. 10 and 11 and the same reference numerals have been applied to it in FIG. 12. The insert differs somewhat from that shown in the earlier figures and its shape is somewhat different. Thus in FIG. 12 there is an insert **59** which is straight-sided, as is the insert **53** of FIG. 10. The insert **59** is provided with a flared and outwardly enlarged bore or cavity **60**. The insert **59** may be laterally enlarged as at **61** and provided with a depression or space **62** into which a push rod may extend and within which one end of the push rod may be seated when the device is assembled in an engine.

When endwise or longitudinal pressure is exerted upon the device in the form shown in FIG. 12, the insert **59** will be expanded into frictional engaging contact with the inner face of the straight-sided cavity **52** within the head or cup **51**.

All of the forms of the invention illustrated have in common at least one feature, namely that the relatively softer insert is positioned within a cavity in a relatively harder cup or head. The dimensions of the insert and the cavity in the cup are such that the parts may be freely put together without any substantial effort. There is nothing like a "drive fit" when the parts are initially assembled. Thus a substantial clearance remains between the insert and the inner walls of the head or cup no matter what the shape of the head or cup may be and no matter what the shape of the insert may be. When the insert has been freely positioned within the cup or head, longitudinal pressure is exerted upon the device and since the insert is the softer of the two members it will tend to be somewhat shortened and will swell, as shown for example in FIGS. 2, 8 and 11. The same swelling will occur in the manufacture of all of the forms of the device and since in the forms of FIGS. 1–6, inclusive, and 10–12, inclusive, the insert comprises a substantial portion which is not within the cup, when the application of pressure has been carried out sufficiently to bring the insert and the inner face of the head into frictional sealing contact a relatively slight further continuation of the longitudinal pressure will cause expansion of the exposed portion of the insert. This expansion is shown in FIGS. 2 and 11. When this occurs an operator has visual indication that the pressure which has caused the swelling or enlarging of that portion of the insert which lies within the cup or head has been carried out sufficiently and he may thereupon discontinue it. He has thus external visual indication of the conditions within the head or cup.

In all forms of the invention the clearance between the insert and the cup is such that the insert may be moved freely into the cup and whatever the shape of the insert or the shape of the cavity within the cup, the expansion which takes place when pressure is exerted causes the

insert to assume the shape, and very largely the size, of the depression or cavity in the cup. If the parts were initially so tight that a common press fit were required to fit them together, longitudinal pressure in any substantial quantity exerted thereafter would in all probability burst the hardened head or cup within which the insert is seated.

The dimension of the holes or perforations or cavities **56** and **60** in the forms of FIGS. 10 and 12, respectively, is preferably large enough to make the section of the insert less than that of the unbored portion of the insert. It is for that reason that the initial swelling and enlarging will occur at the points or along the area where the bore or perforation exists.

The device in all its forms is completely suitable for use as a tappet in an internal combustion engine or for any comparable use without the addition of any brazing or welding. If a customer unused to this type of construction and assembly should still insist upon the addition of brazing or welding, that can be done without much detriment because a relatively small quantity of brazing material could be inserted within the cup or head before the pressure is applied to cause the insert to expand into contact with the inner face of the perforation or cavity in the head or cup. Such brazing is not required or recommended, but if insisted upon it can be carried out in addition to all of the steps above mentioned without any appreciable detriment to the manufacture of the device or to its use.

Although an operative form of the device has been shown, the invention is not limited to the particular details shown. Many changes may be made in the form, shape and arrangement of parts without departing from the spirit of the invention.

I claim:

1. The method of securing together two members, one of relatively hard material, and the other of relatively softer material which includes the following steps: forming a generally cup-shaped member of relatively hard material with a cavity, forming a generally softer member adapted to penetrate loosely within said cavity, placing said relatively softer member within said cavity and thereafter exerting pressure upon the two members while they are substantially unheated and thereby expanding the softer member progressively outward with respect to the cup-shaped member, and continuing such pressure until that part of the softer member not enclosed has been laterally expanded.

2. The method of securing together two members, one of relatively hard material, and the other of relatively softer material which includes the following steps: forming a generally cup-shaped member of relatively hard material with a cavity, forming a generally softer member adapted to penetrate loosely within said cavity, placing said relatively softer member within said cavity and

thereafter exerting pressure upon the two members while they are substantially unheated and thereby expanding the softer member progressively outward with respect to the cup-shaped member, and continuing such pressure until that part of the softer member not enclosed has been laterally expanded to a predetermined amount.

3. The method of securing together two members, one of relatively hard material, and the other of relatively softer material which includes the following steps: forming a generally cup-shaped member of relatively hard material with a cavity, forming a generally softer member adapted to penetrate loosely within said cavity and conforming in diameter at least at one point to a diameter of said cavity, placing said relatively softer member within said cavity and thereafter exerting axial pressure upon the two members and thereby while they are substantially unheated expanding the softer member progressively outward with respect to the cup-shaped member, and continuing such pressure until that part of the softer member not enclosed has been laterally expanded.

4. The method of securing together two members, one of relatively hard material, and the other of relatively softer material which includes the following steps: forming a generally cup-shaped member of relatively hard material with a cavity, forming a generally softer member adapted to penetrate loosely within said cavity and conforming in diameter at least at one point to a diameter of said cavity, placing said relatively softer member within said cavity and thereafter exerting axial pressure upon the two members and thereby while they are substantially unheated expanding the softer member progressively outward with respect to the cup-shaped member, and continuing such pressure until that part of the softer member not enclosed has been laterally expanded to a predetermined amount.

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