Dec. 27, 1949 J. A. VARNEY ET AL 2,492,605

HYDRAULICALLY EXPANSIBLE HOLLOW RIVET

Filed Nov. 10, 1941

Fig. 1.

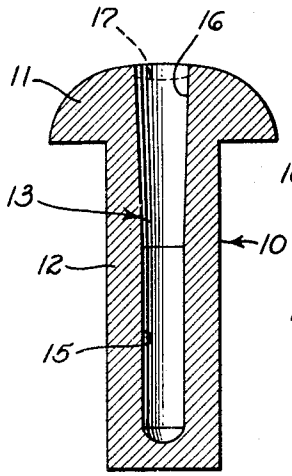


Fig. 2.

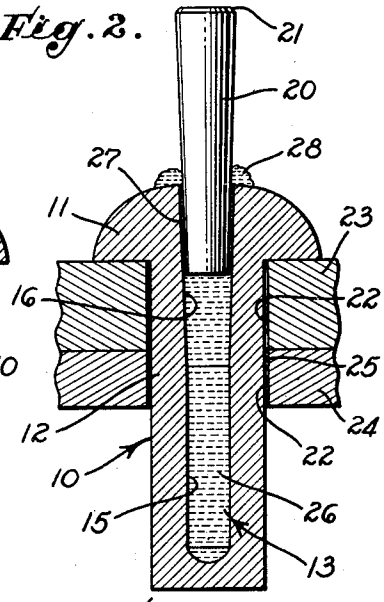


Fig. 3.

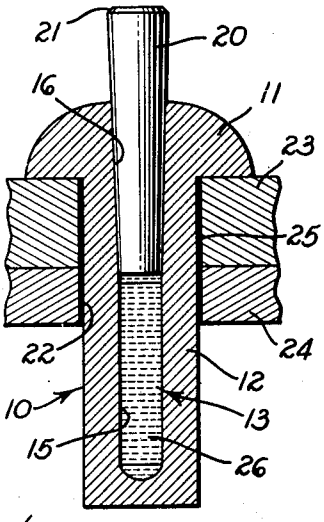


Fig. 4.

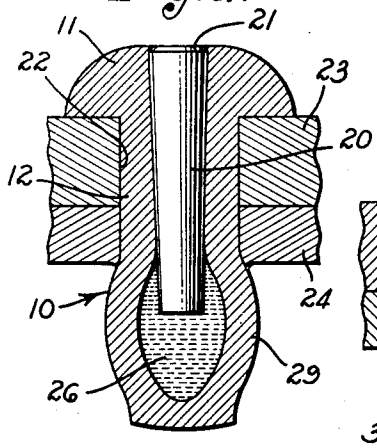


Fig. 5.

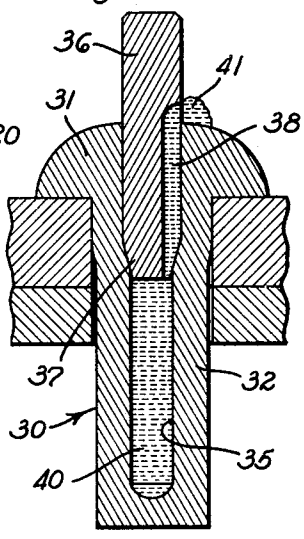


Fig. 6.

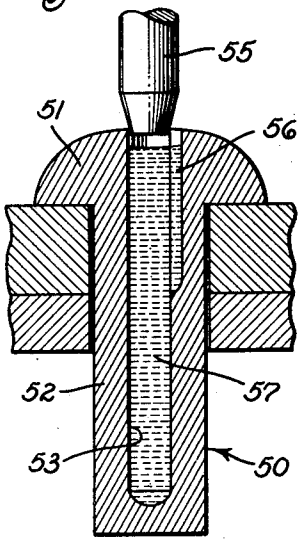
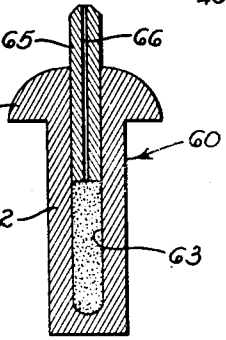


Fig. 7.



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HYDRAULICALLY EXPANSIBLE HOLLOW RIVET

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9 Claims. (Cl. 85—40)

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The present invention relates to rivets, especially self-heading rivets, and is particularly directed to such a rivet adapted to be set by hydraulic action.

In the procedure of setting a conventional rivet having a preformed head, a structurally efficient second head is formed on the leading end of the rivet by the application of a suitable impact tool and the axial compression of the rivet between the impact tool and the usual bucking bar causes the shank of the rivet to expand into snug fit with the surrounding work material. In so-called blind riveting a rivet is applied to the work from one side with no opportunity to apply a bucking bar to the rivet from the opposite side of the work and the rivet must be designed for a heading operation executed from the side of application.

Various mechanical arrangements have been employed to permit rivets to be headed from the side of application. Mechanically operated rivets of this type are usually weaker than conventional rivets, do not provide structurally efficient second heads, do not expand at their shanks into tight fit with the surrounding work material, and generally require both special tools and advanced skill.

One line of development has led to explosive rivets. An explosive rivet of the prevalent type has the disadvantage of requiring heat application by a special tool, which must be heated to an operative temperature at the beginning of a work period, and the explosion of the rivet neither produces a structurally efficient second head nor results in satisfactory expansion of the rivet shank against the surrounding work material. Since the shank of an explosive rivet does not expand, dimensions of rivet holes must be closely controlled and two holes must be separately drilled in preparation for each rivet. An explosive rivet, furthermore, is necessarily designed for a given total thickness of the two members to be riveted with very little latitude permitted. The usual tolerance in grip length is only .005 over and .015 under. Finally, great care must be exercised to have all parts in pressural contact at the moment the rivet explodes.

The general object of our invention is to provide an inexpensive self-heading rivet in which the physical properties of conventional bucked rivets are approximated if not exceeded. We propose to provide a dependable and exceptionally strong self-heading rivet that may be rapidly set by an unskilled workman without using heat and without using any special setting tool.

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More specific objects of our invention are to solve certain difficult problems in designing a rivet for hydraulic operation. These problems include the following: to trap in the rivet a suitable fluent material substantially free of air or other compressible ingredient; to trap in the rivet the precise volume of the fluent material required for a given predetermined hydraulic effect; to preclude escape of the measured volume of fluent material, a problem that is especially important because the measured volume is usually exceedingly small and is especially difficult since tremendous pressure is generated in the setting operation; to provide a rivet that is of hollow construction for hydraulic operation and yet to achieve a finished rivet as strong as, or stronger than, a conventional rivet; and to provide a self-heading hydraulic rivet that will not only expand to form a second inner head but will also expand along its shank into satisfactory pressural contact with the surrounding work material.

Our rivet, which is adapted for insertion through registered bores or rivet holes of a plurality of members for interconnecting the members, may be broadly described as comprising a rivet body with a shank and preformed head, said body having a blind bore extending longitudinally through the head into the shank, a mass of fluent material in the blind bore, and a pin or plunger adapted to be driven into the blind bore against the fluent material to displace the fluent material outwardly, thereby to radially expand the shank of the rivet in the end zone beyond said registered rivet holes into greater diameter than the registered holes.

With reference to a rivet constructed in accord with this description the specific objects of our invention include the following: to provide a pin-and-rivet combination in which the pin cooperates with the rivet to cause any excess quantity of the fluent material to be extruded automatically when the pin is inserted; to provide such a pin-and-rivet combination in which the pin functions as a valve member to cut off extrusion at precisely the point at which the fluent material is reduced to a desired predetermined volume; to provide such a combination in which fitting of the pin in the rivet effective against leakage of the fluent material under exceedingly high pressure is assured without the necessity of maintaining close fits between members of the rivet; to provide such a combination in which the pin has the dual function of a hydraulic plunger to displace the fluent material, and a mechanical wedge to expand the rivet shank; to provide such

a combination in which it is necessary merely to insert the pin and drive the pin flush with the preformed head of the rivet to insure elimination of air, extrusion of excess fluent material, effective trapping of the desired residual quantity of the fluent material; to provide such a combination in which it is necessary merely to drive the pin home; to insure the precise extent of displacement of the trapped fluent material required to expand the inner end of the rivet into an effective second head; and to provide such a combination in which the pin is permanently seated in the rivet in a manner to hydraulically lock the inner or second head of the rivet against contraction from its expanded state.

In one practice of our invention, the material for hydraulic action is trapped in the rivet by the rivet pin before the rivet is placed in stock, and the assembled rivet is heated to make the trapped material fluent at the time of installation. One object of our invention in this particular practice is to provide for entrapment of the material and yet to permit the material to expand under heat without pushing the rivet pin outward.

The various objects and advantages of our invention including those mentioned above will be apparent in the detailed description to follow, taken with the accompanying drawing.

In the drawing, which is to be regarded as merely illustrative:

Fig. 1 is a longitudinal section of a rivet body employed in the preferred practice of our invention;

Fig. 2 is a similar view showing the rivet body provided with a tapered pin and inserted through registered bores in two sheets of work material;

Fig. 3 is a similar view showing the pin advanced into the rivet to a point to trap the fluent material therein;

Fig. 4 is a similar view showing the pin driven completely into the rivet for the purpose of setting the rivet;

Fig. 5 is a view similar to Fig. 2 showing a modified form of our rivet combination;

Fig. 6 is a similar view showing a second modification of our rivet combination; and

Fig. 7 is a similar view of a third modification of our rivet combination.

The preferred practice of our invention exemplified by Figs. 1–4 is characterized by the concept of employing a tapered pin in the above-mentioned combination, which employment accomplishes further objects and achieves further advantages of first importance.

In providing for automatic release of excess fluent material, it becomes necessary to design the pin to serve as a valve member to cut off and trap the fluent material at the instant the extrusion progresses to a predetermined point. In some practices of our invention it is feasible to provide for a simple slide-valve action to cut off extrusion and simultaneously trap the predetermined residual quantity of the fluent material. An inherent disadvantage of any simple slide-valve arrangement, however, is that it does not provide mutually contacting sealing areas of effective extent at the precise moment of cut-off and entrapment. At the dimensional tolerances that are practical in inexpensive rivets, it is difficult to avoid substantial leakage of the fluent material immediately after the fluent material is trapped and during initial displacement of the confined material.

An important object, therefore, of the preferred

form of our invention is to avoid a simple slide-valve action in favor of a more efficient mode of operation. A tapered pin in combination with a bore hole having an entrance of complementary taper permits a valve action that is distinctly different from simple slide-valve action and is especially advantageous in a hydraulic rivet. During the initial stage of insertion of the tapered pin into the tapered rivet bore, an annular passage is formed by the rivet and bore to permit the fluent material to flow freely to the entrance of the bore, but at a predetermined point in the inward progress of the pin two conical sealing surfaces of substantial axial extent come into instantaneous mutual contact and instantly a wedging action occurs to place the axially extensive sealing surfaces under uniform radial pressure of such magnitude as to preclude any further extrusion of the fluent material.

Preferably a pin that is oversize with respect to the rivet bore is employed in the various practices of our invention. Tapering the oversize pin and/or tapering the entrance to the rivet bore into which the pin is inserted provides for effectively maintaining radial sealing pressure continuously as the pin is forced progressively against the trapped material. During the inward movement of the pin the pin acts as a conical wedge to spread the bore radially and the zone of the expanding pressure lengthens progressively with the progressive longitudinal movement of the pin. If the pin is tapered the lengthening zone of radial expanding pressure may be of substantial axial extent, and a feature of our novel arrangement is that the axial diminsion of the pin taper may be, and preferably is, substantially greater than the initial axial extent of the bore hole taper so that the length of the zone of mutual contact of the two cooperating sealing surfaces increases progressively as the pin moves inward and as internal pressure of the trapped fluent material rises progressively.

The employment of an oversize pin causes the rivet shank to be expanded radially, and one object of the preferred form of our invention is to provide a pin that will cause the shank to be expanded against the surrounding work material. In this regard the invention is characterized by the concept of employing a pin having a gradual taper extending substantially through its length whereby a wedging force with radial components of tremendous magnitude may be attained.

Fig. 1 shows a rivet body generally designated 10 having a preformed head 11 and a shank 12. The rivet body 10 is provided with a blind axial bore generally designated 13, the bore being divided into an inner portion 15 of substantially uniform diameter and an outer entrance portion 16 that is of tapered or conical configuration. Various materials may be employed to fabricate such a rivet in various practices of the invention, materials such as steel, brass, copper, aluminum, and suitable alloys.

A quantity of suitable fluent material is placed in the rivet bore 13 either at the time the rivet is manufactured for stock or at the time the rivet is actually used, and the rivet bore may be filled with the fluent material to any suitable level, for example, the level indicated by the dotted line 17 in Fig. 1. The term fluent material as used in this disclosure covers any material that is sufficiently fluent to permit displacement and to achieve the required hydraulic effect under the temperature and pressure prevailing inside the rivet when the rivet-setting operation is per-

formed. At one extreme a light liquid such as thin oil or water may be employed and at the other extreme a normally solid material, for example, a soft metal alloy, may be employed providing that the normally solid material becomes fluent to an operative extent under the pressure created by a heavy impact tool and/or at the temperature at which the rivet is set. In one practice the rivet may be filled with a normally solid material such as lead or a suitable salt, and in preparation for the rivet-setting operation, the rivet body may be heated to make its content molten and to temporarily make the rivet body itself more ductile. For most riveting operations, we prefer to employ a non-corrosive liquid or semi-liquid which may be introduced into the rivet bore and then retained by insertion of the pin. Other deformable plastic material, such as white lead, may be used, the material being molded into slugs and then rammed into the rivet bore and tamped free of air.

The pin or plunger that is to be driven into the rivet bore hole may be of any suitable material and configuration. The pin should be harder than the rivet body 10 but may be of the same material if given additional hardening treatment. The particular pin 20 shown in Fig. 2 is formed with a chamfer or inclined shoulder 21 at its outer end and is tapered throughout its length at the same taper as the entrance portion 16 of the rivet bore.

Fig. 2 shows the rivet 10 initially seated in the registered rivet holes 22 of a pair of members 23 and 24. It will be noted that the rivet body fits into the registered rivet holes 22 with a liberal clearance 25. One of the features of our invention is that the dimensions of this clearance are not critical, since the shank of the rivet will expand during the setting operation to conform with surrounding rivet holes of various diameters.

Fig. 2 shows the pin 20 in the initial stage of the insertion of the pin in the rivet body 10, the rivet body having been previously filled with suitable fluent material 26 to approximately the level indicated in Fig. 1. As the pin moves initially into the rivet, displacing the fluent material, the annular clearance 27 between the rivet and the surrounding rivet bore constitutes a relief passage through which the fluent material is extruded to accumulate in a mass 28 on the head of the rivet. The annular clearance 27 progressively narrows and the first stage of the inward movement of the pin terminates when the tapered periphery of the pin makes intimate contact with the surrounding tapered portion of the rivet bore. Since the pin and the entrance portion 16 of the rivet bore have substantially the same taper, the closing contact of the pin with the surrounding rivet occurs substantially simultaneously throughout the entire length of the tapered portion of the bore hole. Even if the pin 20 is moved into the rivet in a very gradual manner by a steadily applied force, the trapping of the fluent material in the blind end of the bore is decisive and is followed immediately by a rapid rise in the sealing pressure exerted between the pin and the surrounding rivet. In the preferred practice of our invention the pin is driven into the rivet by closely successive blows delivered by an impact tool, in which procedure the sealing contact of the pin with the rivet bore is instantaneous and is instantaneously followed by a sharp rise in sealing pressure.

In one practice of the invention the rivet is placed in stock after the initial stage of the insertion of the pin 20 has been carried out, the pin being driven beyond the sealing point sufficiently to create an effective seal and to prevent subsequent accidental withdrawal of the pin. One advantage of such a practice is that the protruding pin provides a finger grip by means of which the rivet may be conveniently lifted and applied to work material.

In the second stage of insertion of the pin 20, the pin progressively displaces the fluent material with what may be termed a hydraulic effect inasmuch as the tremendous pressure created by the displacement is exerted substantially equally in all directions. During this second stage of insertion, terminating when the pin reaches its ultimate position, for example the ultimate position shown in Fig. 4, the following important effects occur concurrently:

(1) The frictional and fluid-pressure resistance to the inward movement of the pin causes the rivet body, fluid and pin to act when the pin is struck as a single solid element and thus causes the preformed head 11 of the rivet to be pressed strongly against the outermost member 23;

(2) While the outer or preformed head 11 of the rivet is pressed against the outer member 23, the inner end of the rivet is expanded hydraulically to form the inner head (Fig. 4), which inner head engages the inner member 24 and cooperates with the preformed head 11 to clamp the two members 23 and 24 together;

(3) The tapered pin 20 progressively expands the shank 12 of the rivet against the surrounding rivet holes 22 in the members 23 and 24;

(4) Over a relatively long axial dimension, the tapered pin continuously engages the material of the surrounding rivet with a wedging action that insures the maintenance of effective sealing pressure between the pin and the surrounding rivet;

(5) The axial dimension of the rivet bore along which sealing pressure is exerted increases as the pin is driven home;

(6) The pin becomes unitary with the rivet to serve as a hard core giving the rivet shank greater strength than the shank of a conventional rivet of the same dimension, especially strength to withstand shearing stress.

When the pin 20 is driven flush with the preformed head 11 of the rivet, the same impact tool that is employed to drive the rivet may be used to peen the material of the rivet head over the chamfer or shoulder 21 as shown in Fig. 4. It is apparent that by virtue of such peening, the rivet body engages the pin 20 in a positive manner to lock the pin in place and the pin in turn hydraulically locks the inner end of the rivet in the expanded configuration represented by the inner head designated 29. Instead of, or in addition to, peening the material of the rivet body over the end of the pin we may employ the expedient of roughening or serrating a portion of the pin surface to encourage engagement of the pin by the surrounding metal of the rivet, but it is to be noted that in the absence of any such expedient the tremendous pressure with which the rivet body embraces the pin effectively holds the pin against retreat notwithstanding the tapered configuration of the pin. Friction between the pin and the surrounding rivet may alone be depended upon to retain the pin and thereby hydraulically lock the expanded rivet against contraction. Explosive rivets and many mechanically expanded rivets offer no more resistance to withdrawal from rivet holes than is

afforded by resistance to deformation inherent in the bent or deformed metal of the rivet, whereas our hydraulically locked rivet offers positive resistance to any such withdrawal.

The exact point in the progressive insertion of the pin at which the pin traps the fluent material may be readily controlled and predetermined in designing the rivet combination and likewise the volume of the fluent material that is trapped at the end of the first stage of insertion may be easily controlled and predetermined. In addition, the extent to which the fluent material is displaced to expand the inner end of the rivet in the final stage of the pin, insertion may be controlled and determined in advance. All these factors may be computed on the drafting board to arrive at a design of the rivet body and pin suitable for a given riveting task.

Various empirical procedures may also be employed to arrive at satisfactory designs. For example, a rivet body of the general configuration shown in Fig. 1 may be dimensioned for a given rivet hole in work material and then the proper dimensions of the pin may be determined experimentally. The experimental pins used in such a design procedure may be relatively long to permit the experimental pins to be shortened at either or both ends as the experiments may indicate. Cutting off the smaller end of the tapered pin correspondingly increases the volume of the fluent material that is trapped when the pin reaches the sealing position at the end of the first stage of the insertion. If the pin is to be driven flush with the preformed head of the rivet as indicated in Fig. 4, cutting off the larger end of the pin decreases the extent to which the pin is driven into the rivet bore and correspondingly decreases the extent to which the trapped fluent material is displaced in the final stage of pin insertion.

Fig. 5 illustrates a second practice of our invention in which a slide-valve action is employed to cut off extrusion of the fluent material in the course of the rivet-setting procedure. In Fig. 5 a rivet generally designates **30** has a preformed head **31**, a shank **32**, and an axial bore **35** which bore may be initially of substantially uniform diameter. A suitable pin **36** of uniform diameter but preferably formed with a tapered nose **37** may be oversize with respect to the axial bore **35** so that the pin may function as a conical wedge to enlarge the axial bore and thereby expand the shank **32** into intimate contact with the surrounding work material. A longitudinal recess **38** is cut in a leading portion of the pin **36** to permit fluent material **40** in the rivet bore to be extruded as indicated at **41** until the trailing end of the recess is cut off by the axial movement of the pin, whereby the residual volume of the fluent material is trapped. Upon further movement of the pin the trapped fluent material is displaced to expand the hydraulic rivet in the manner previously described.

Fig. 6 shows another embodiment of our invention in which a slide-valve action occurs in the rivet-setting procedure. The rivet generally designated **50** has a preformed head **51**, a shank **52**,and an axial bore **53** that may be initially of uniform diameter. To set the rivet, an oversize pin **55** of the same configuration as the previously described pin **36** is driven into the axial bore **53**. In this particular construction provision for escape of excess fluent material is made by forming a relief channel in the rivet body, for example, a groove **56** extending from the entrance of the axial bore **53** to a suitable intermediate point of the bore. When the oversize pin **55** is driven into the axial bore **53** fluent material **57** in the bore escapes along the groove **56** until the groove is cut off by the leading end of the pin, whereupon the residual fluent material is trapped for hydraulic expansion of the rivet.

It is apparent that in the embodiment shown in Fig. 6, as well as in the embodiment shown in Fig. 5, the extent to which the rivet is expanded hydraulically by driving the pin flush with the preformed head of the rivet may be varied simply by varying the lengths of the channels provided for initial extrusion of the trapped fluent material.

In one practice of our invention for which the construction shown in Figs. 5 and 6 is admirably adapted the material for hydraulic action is trapped in the rivet at the time of manufacture and the whole rivet is heated to make the trapped material suitably fluent at the time of installation. Such a practice requires that the pin effectively retain the mass of material inside the rivet over an extended period of time and requires some provision to permit the entrapped material to expand under heat without dislodging or loosening the rivet pin. In this practice of the invention the required material, for example melted solder, is placed inside the rivet shown in Fig. 5 or the rivet shown in Fig. 6, and then the corresponding pin is forced into the rivet in the usual manner to trap the material. The inward movement of the rivet is stopped with escape for the material almost but not quite cut off, the avenue of egress being sufficiently restricted to retain the material and yet being adequate to permit escape of the material as may be required to compensate for expansion when the rivet is heated. Only a slight inward movement of the pin is necessary to completely cut off egress of the fluent material when the rivet is finally used.

In this last practice of our invention we may employ a rivet such as shown in Fig. 7. The rivet body **60** in Fig. 7 has the usual preformed head **61**, shank **62**, and blind axial bore **63**, the bore in this construction being of substantially uniform diameter. A pin **65** is dimensioned for a driving fit in the bore **63** and is provided with an axial passage **66** of small cross-sectional dimension. The inner end of the rivet bore **63** may be filled with a normally solid material such as solder. When the pin **65** is driven into the rivet the axial passage **66** permits the escape of air from the interior of the rivet and permits the inner end of the pin to make intimate contact with the entrapped material. When the rivet is taken out of stock and heated, the axial passage **66** permits sufficient egress of the fluent material to compensate for heat expansion of the material. Even if the trapped material is oil, the axial passage **66** through the pin may be dimensioned to effectively retain the material in the rivet and yet serve as a vent to permit expansion of the material without causing axial movement of the pin. When the pin **65** is driven into the rivet to set the rivet, the impact tool striking the outer end of the pin cuts off the axial passage at each blow and the deformation of the material of the pin around the outer end of the axial passage **66** under repeated blows by the impact tool permanently seals the axial passage.

The disclosure herein in specific detail of preferred practices and embodiments of our inven-

tion will readily suggest various substitutions and changes within the scope under our inventive concept, and we reserve the right to all such departures that lie within the scope of our appended claims.

We claim as our invention:

1. In a rivet for insertion through and beyond registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a head and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of fluent material in said blind bore; and a tapered pin adapted to be driven into said blind bore against said fluent material to displace the fluent material outwardly by hydraulic action, thereby to radially expand the shank of the rivet in the zone beyond said registered holes into greater dimension than the registered holes, a portion of said blind bore at the entrance end thereof being tapered to permit extrusion of said fluent material until said pin is inserted to a predetermined point of sealing with said tapered bore portion whereby an excess volume of the fluent material may be placed in the bore and be reduced automatically to a predetermined volume by insertion of the pin.

2. In a rivet for insertion through and beyond registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a head and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of fluent material in said blind bore; and a plunger adapted to be driven into said blind bore against said fluent material to displace the fluent material outwardly, thereby to radially expand the shank of the rivet in the zone beyond said registered holes into greater diameter than the registered holes, there being a channel formed in said rivet body providing communication between the exterior thereof and a point in said blind bore to permit escape of said fluent material from the blind bore until said plunger is inserted past said point whereby any excess fluent material is extruded automatically by insertion of the plunger, leaving a predetermined quantity of the fluent material trapped in the blind bore.

3. In a rivet for insertion through and beyond registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a head and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of fluent material in said blind bore; and a plunger adapted to be driven into said blind bore against said fluent material to displace the fluent material outwardly by hydraulic action, thereby to radially expand the shank of the rivet in the zone beyond said registered holes into greater diameter than the registered holes, a leading portion of said plunger being recessed to a point intermediate its forward and rear ends to permit escape of said fluent material from the blind bore until said plunger is inserted to an extent sufficient to close the rear end of the recess, whereby an excess volume of the fluent material may be placed in the bore and then be reduced automatically to a predetermined volume by insertion of the plunger.

4. In a rivet for insertion through and beyond registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a head and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of fluent material in said blind bore; and a pin adapted to be driven into said blind bore against said fluent material to displace the fluent material outwardly by hydraulic action, thereby to radially expand the shank of the rivet in the zone beyond said registered holes into greater diameter than the registered holes, there being a passage in one of said rivet body and pin elements effective for escape of said fluent material from said bore until said passage is closed by overlap of the other of said elements when said pin reaches a predetermined point in the blind bore, whereby any excess volume of the fluent material in the blind bore is reduced automatically to a predetermined volume by insertion of the pin, said pin being of a length to produce a desired extent of displacement of said predetermined volume of the fluent material when the pin is driven substantially completely into the rivet body.

5. In a rivet for insertion through and beyond registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a head and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of fluent material in said blind bore; and a plunger adapted to be driven into said blind bore against said fluent material to displace the fluent material outwardly by hydraulic action, thereby to radially expand the shank of the rivet in the zone beyond said registered holes into greater diameter than the registered holes, said plunger being oversize with respect to the blind bore to move in the blind bore with a wedging action, thereby to create sealing pressure to minimize leakage of the fluent material past the plunger as well as to expand the blind bore and increase the diameter of said shank within said registered holes.

6. In a rivet for insertion through registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a head and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of fluent material in said blind bore; and a plunger adapted to be driven into said blind bore against said fluent material to displace the fluent material outwardly by hydraulic action, thereby to radially expand the closed end of the shank of the rivet into greater circumference than the remainder of said shank can attain when confined by said registered holes having such diameter that said shank initially bears a normal fitting relation thereto, at least a portion of said blind bore extending to the entrance thereof being tapered and at least a portion of said plunger extending to the leading end thereof being of the same taper, whereby in the course of insertion of the plunger the plunger initially forms with the blind bore a passage for escape of the fluent material and then forms with the blind bore an annular seal of substantial axial extent against leakage of fluent material from the blind bore.

7. A combination as set forth in claim 6 in which said tapered portion of the plunger is of greater axial extent than said tapered portion of the blind bore, whereby the axial extent of said annular seal increases as the plunger continues to move into the blind bore.

8. In a rivet for insertion through and beyond registered rivet holes of a plurality of members

for interconnecting the members, the combination of: a rivet body forming a body and a shank, said body having a blind bore extending longitudinally through said head into said shank; a mass of material in said blind bore adapted to be heated to fluency at the time the rivet is installed; and a pin partially inserted in said bore, thereby retaining said material while the rivet is in stock prior to installation, there being a relatively small vent passage from the interior of the rivet effective while the pin is thus partially inserted to permit expansion of said material under heat prior to installation without dislodging the pin, said partially inserted pin being adapted to be driven further into said bore thereby to cut off said vent passage and displace the fluent material to radially expand the shank of the rivet in the zone beyond said registered holes into greater dimension than the registered holes.

9. In a rivet for insertion through registered rivet holes of a plurality of members for interconnecting the members, the combination of: a rivet body forming a shank of deformable metal and a head, said body having a blind bore extending longitudinally through said head into said shank; a mass of substantially incompressible fluent material in said blind bore; and

a plunger adapted to be driven into said blind bore against said fluent material to displace the fluent material by hydraulic action, said plunger being oversize with respect to said blind bore and of harder metal than said body, whereby said shank is reinforced by said plunger against deformation.

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