April 12, 1949. L. C. HUCK 2,466,811

METHOD OF RIVETING

Filed April 30, 1945 2 Sheets-Sheet 1

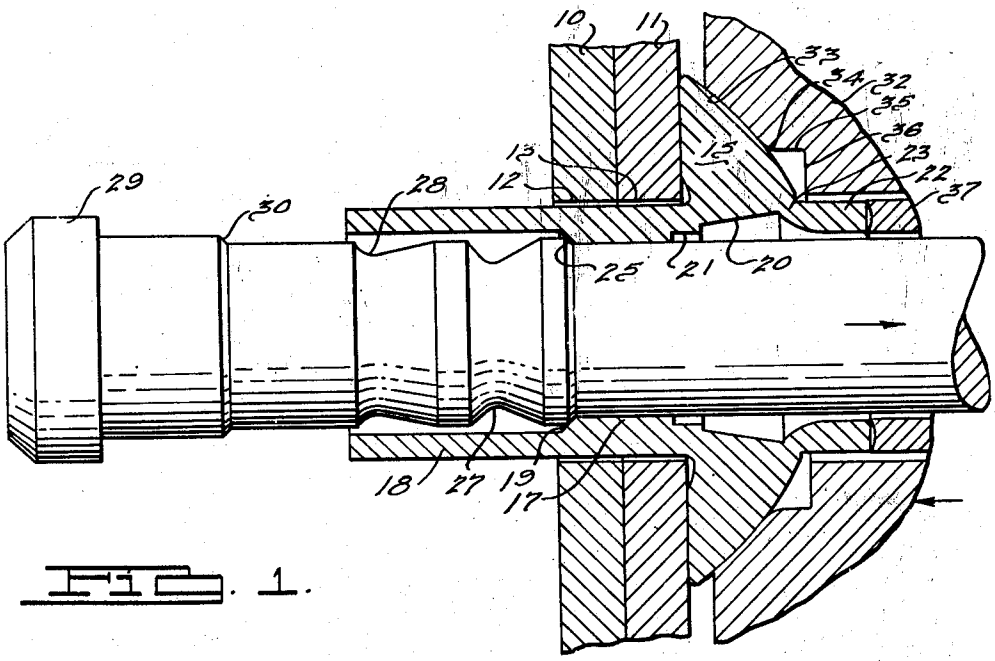

Fig. 1.

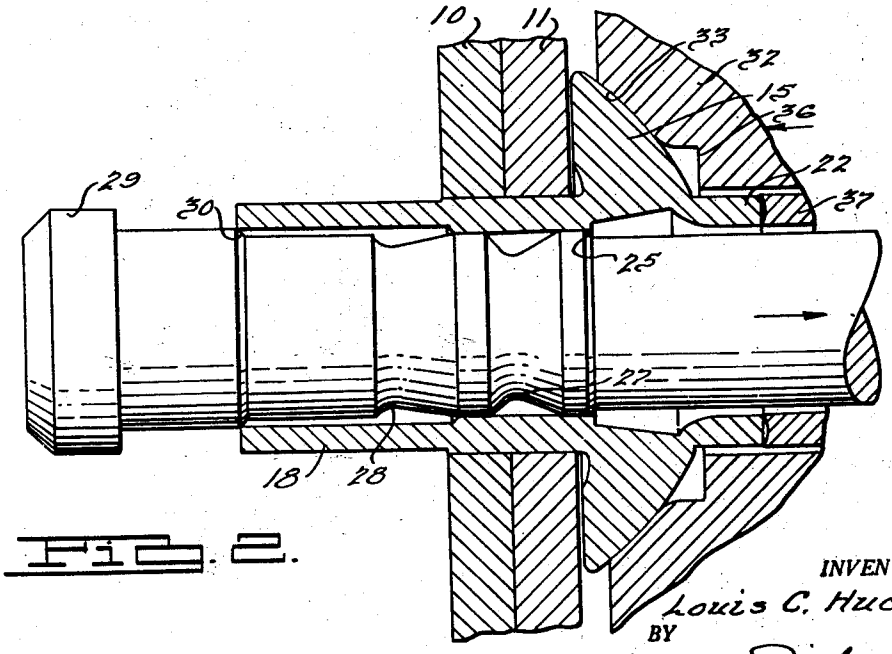

Fig. 2.

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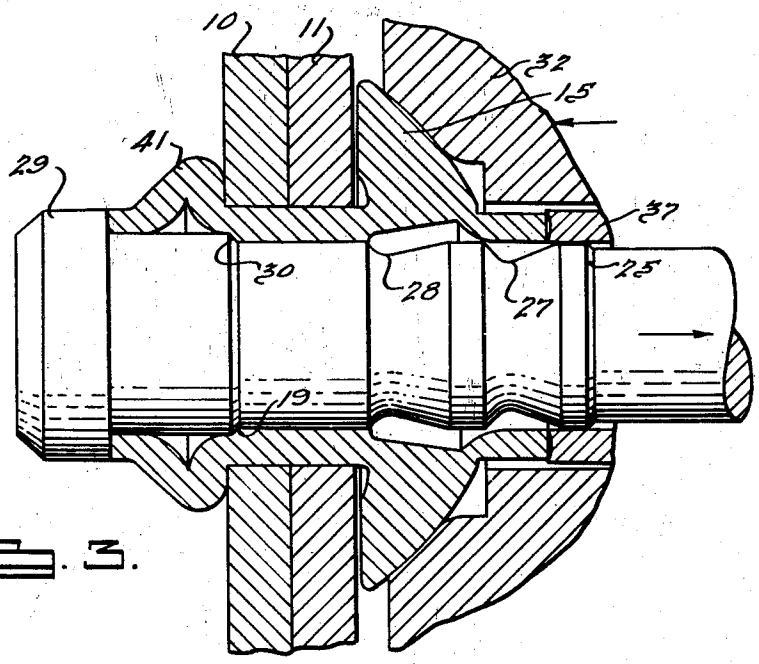

Fig. 3.

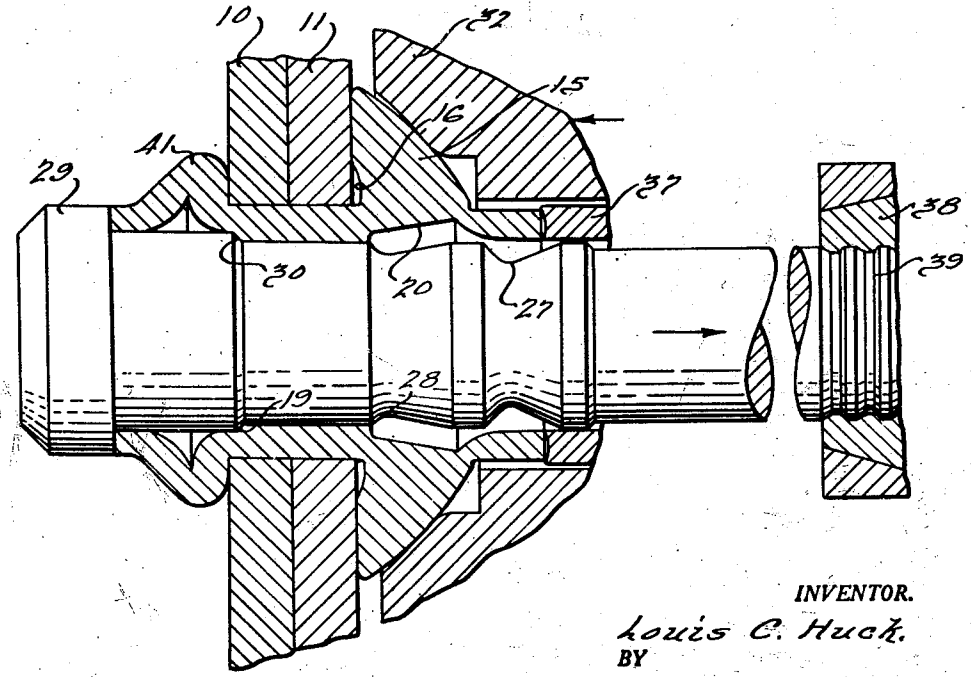

Fig. 4.

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UNITED STATES PATENT OFFICE

2,466,811

METHOD OF RIVETING

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Application April 30, 1945, Serial No. 591,052

1 Claim. (Cl. 218—29)

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The invention relates to riveting mechanisms, and it has particular relation to a method of setting a two-part rivet.

In setting a blind rivet, as for instance the brazier head type disclosed in my copending application for patent, Serial No. 454,211, filed August 10, 1942, now Patent Number 2,397,111, granted March 26, 1946, the pin is pulled by gripping means and the reaction to the pull is applied by a primary anvil to the brazier head. In the first part of the riveting operation a shoulder on the pin radially expands that part of the tubular member within the opening or hole in the structure being riveted, and this creates forces and factors which tend to extrude the tubular member axially ahead of the shoulder particularly if more metal is ahead of the shoulder than that needed to fill the opening or hole. This extrusion when it occurs may cause an extrusion rise of the brazier head so as to leave a space between the head and structure, or if the plate next to the head moves with the extrusion and hence, moves with the head, the plates may separate to some extent.

After the movement of the shoulder to fill the opening or hole, a head on the pin moves against the end of the tubular member opposite the brazier head and forms the blind head. Thereafter increased pull on the pin causes a secondary anvil to force a locking collar on the brazier head into a recess in the latter and a recess in the pin, so as to lock the pin and tubular member together. Then continued increase in pull on the pin causes it to break under tension.

Another object of the invention is to provide a method of riveting which will effect return of the radially outer part of the head on the tubular member in the event of an extrusion rise thereof as mentioned.

Other objects of the invention will become apparent from the following specification, from the drawings relating thereto, and from the claims hereinafter set forth.

For a better understanding of the invention reference may be had to the drawings wherein:

Figure 1 is a cross-sectional view illustrating a rivet in its unset condition association with a riveting mechanism constructed according to one form of the invention; and,

Figs. 2, 3, and 4 are similar views showing the rivet in intermediate stages of the riveting operation.

Referring to Fig. 1, the rivet is shown in connection with a structure comprising plates 10 and 11 having openings 12 and 13 for receiving the rivet. The rivet comprises a tubular member

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extending through the openings 12 and 13 and having a preformed or manufactured head 15 engaging the outer side of plate 11, and the underside of this head has a recess 16 adapted to allow for any burrs around the plate opening. Within the openings 12 and 13, the tubular body is of smaller internal diameter as indicated at 17 and at the outer side of plate 10, a projecting portion 18 of larger internal diameter is provided. The junction of the two portions 17 and 18 is formed with an annular, conical shoulder 19.

The head 15 shown is of the brazier type and is provided with a central, conical recess 20 which joins a smaller counterbore or recess 21 at its inner end. An annular locking collar 22 axially aligned with the recess 20 is initially joined to the head 15 by means of a web 23, and this collar before the rivet is set, projects axially outwardly from the surface of the head.

The second part of the rivet comprises a pin having a conical shoulder 25 which engages the shoulder 19 in the tubular member, and when the pin is pulled through the tubular body, the shoulder 25 causes radial expansion of the portion 17 of the body so as to fill the openings 12 and 13. It might be noted that the largest diameter of the shoulder 25 is approximately equal to or slightly less than the diameter of counterbore 21, and also that it is less than the inside diameter of the body portion 18 so that a portion of the shoulder 19 remains after the shoulder 25 has been pulled through the body. The pin also includes an annular relatively deep breakneck or groove 27 which is the weakest part of the pin and a second groove 28 of slightly larger diameter which is adapted to receive the collar 22 in a later part of the riveting operation.

A head 29 on the end of the pin is adapted to engage and move the end of the body portion 18 so as to cause the latter to bulb outwardly and form what is known as the blind head. It might be mentioned here that the outer end of the body portion 18 is inherently stronger so as to cause it to remain in unexpanded condition and thereby assure bulbing of the portion 18 between the plate 10 and such strengthened end, and the manner in which the end of the body portion 18 is strengthened is more particularly set forth in the copending application for patent previously identified. The pin also includes a shoulder 30 which is adapted to engage that remaining part of shoulder 19 in the final stage of forming the blind or bulbed head from the body portion 18 so as to cooperate in limiting further movement of the pin through the body.

The rivet is adapted to be set by a rivet setting mechanism which includes a primary anvil 32 having a concave surface 33 for engaging the radially outer portion of the brazier head 15, but towards its center the anvil is relieved by a reversely curved face 34 and a counterbore formed by an axial wall 35 and a radial wall 36. The purpose of this relief in the anvil and the wall or bottom 36 of the counterbore will be presently considered.

The secondary anvil is indicated at 37 and is adapted to force the collar 22 into the recess 20 in a later part of the riveting operation. The riveting mechanism also includes jaws 38 shown by Fig. 4 for gripping the outer grooved end of the pin indicated at 39 and pulling it in the direction of the arrow as shown on the pin, and the reaction to this pull is applied successively to the anvils 32 and 37 in the opposite direction, as also shown by arrows. Details of a gun or riveting mechanism having two anvils are mentioned in the copending application for patent.

In setting the rivet the pin is gripped and pulled in the direction of the arrow on the pin, and this causes the shoulder 25 initially to expand the body portion 17 so as to fill the openings in the structure, and while this is occurring, the reaction force is applied by the anvil 32 to the head 15. As the shoulder 25 advances through the thicker wall portion 17 of the tubular body, it forces the metal outwardly to fill the openings, and it is desirable that there be sufficient metal to fill the openings. In order to assure obtaining this result even though initial hole clearance around the rivet may vary, the wall portion 17 is made thick enough to provide sufficient hole filling metal for the larger clearances which may occur in the usual range of variations in hole clearance. It follows from this that there may usually be a surplus of metal over and above that required to fill the hole. Hence, it will be found where there is surplus metal that the shoulder 25 in moving through the tubular body portion 17 actually will cause the body portion ahead of the shoulder to flow, and this will cause a rise of head 15 in the same direction as the shoulder is moving so as to move it slightly away from the plate 11 as shown in Fig. 2. This extrusion rise of head 15 will occur even though the anvil 32 is applying the reaction force to the head. In other words as the conical shoulder expands the hole filling portion of the body, the hole is first filled, and then during further movement of the shoulder its tapered or conical surface will apply powerful expanding forces to the inside wall of the body due to the powerful force effective through the tapered engagement. With the hole filled this force acts with sufficient power to elongate the body ahead of the shoulder and to cause the head 15 to rise above the plate 11 and to move the anvil with it. The shoulder 25 may finally carry a small amount of metal with it into the counterbore 21 but such metal will be ironed out against the wall of the counterbore. Thus, the counterbore provides a space for such metal and prevents its movement into the locking recess 20.

The present invention is particularly concerned with returning or bending the radially outer part of the head 15 into contact with the plate 11 after such elongation rise, and also bringing the plates together if they have been separated by the elongation. However, due to the fact the blind head yet must be formed, it is necessary that the tubular body be held against movement in the openings in the plates as the head 29 on

the pin applies axial forces to the end of the tubular body. The point and extent of engagement between the anvil and head must then be so related to the thickness of the head and the deformability of the metal of the head, that is, to the inherent resistance to bending of the head as related to the resistance to collapse by the tubular portion as not to move the head relative to the tubular body during the blind head forming operation. In other words, with a thicker head or with a less ductile metal in the head, the metal and dimensions in the shank remaining the same the counterbore or wall 36 in the anvil must be increased in diameter to provide a greater moment arm, and with a thinner head or more ductile metal in the head, the counterbore and wall 36 must be reduced in diameter. From another point of view, the engagement between the anvil and head must be so related to the thickness of head and deformability of the metal of the head relative to the collapsability of the shank as to prevent bending of the radially outer part of the head towards the plate 11 prior to formation of the blind head because if the head bends before the blind head is formed, its pushing against the plate might push them along the shank toward the head 29 and, of course, prevention of such movement relative to the body is important.

With the anvil 32 now holding the head 15 as seen in Fig. 2, the head 29 on the pin moves against the end of body portion 18 and forms a blind head indicated at 41 in Fig. 3. During the final stage of this blind head forming operation the shoulder 30 on the pin engages the shoulder 19 on the tubular member and this engagement in conjunction with the engagement between the head 29 on the pin and the blind head effectively stops further movement of the pin, at least to any appreciable extent. With this increase in resistance to pin movement, the pull on the pin increases and consequently the reaction against anvil 32 increases. It follows that more and more pressure is applied against the radially outer portion of head 15 and until the anvil bends or moves the radially outer part of the head towards the structure as seen in Fig. 4. This brings the plates together and also closes any gap between the head and plate 11 except for the recess 16 which remains and which in fact is slightly deeper due to the extrusion rise of head 15.

Following this bending or movement of the radially outer part of head 15, further increase in pull on the pin, and the reaction applied against head 15 by anvil 32 will automatically cause the reaction to the pull on the pin to shift to the secondary anvil 37, and this anvil then forces the collar 22 into the recess 20 in head 15. At the time the collar is thus forced into the recess 20, the groove 28 is radially aligned with recess 20 and the collar is forced into the locking groove also, and thus, the pin and tubular member are locked together within the head 15. After this lock is obtained tension on the pin will further increase until it is sufficient to break the pin at the breakneck 27. It may be noted here that the pin pulling forces progressively increase through the hole filling, blind head forming, head bending, collar locking and pin breaking operations.

The wall or bottom 36 in the counterbore in the anvil 32 is provided so as to limit or stop any extrusion of the inner part of the head 15 into the counterbore in the event such movement should occur under certain circumstances. For example, in view of manufacturing tolerances and

variations in the metal or other variables, the condition may at some time occur where the head 15 after the hole filling operation would bend over against the plate 11, before the blind head forms In that case, the tubular body might be pulled with the pin by the engagement of the head 30 on the pin with the end of the tubular member but if this occurs the wall 36 of the counterbore would positively limit the movement. This insures that the projecting portion 18 of the body will not be appreciably shortened and that continued pull on the pin will form a blind head Particularly where the thickness of the plates approaches the maximum of the range of thickness for any given length of tubular member it is important that the projecting body portion 18 not be shortened appreciably since sufficient length of projection must be maintained in order to form a satisfactory blind head.

Normally therefore, where there is surplus metal ahead of the hole filling shoulder 25, an extrusion rise of head 15 may occur and the head will carry the anvil with it due to the extrusion forces. Then when the head 30 on the pin begins to move the end of body portion 18, the relation between the anvil and head 15 is such as to prevent movement of the tubular member through the structure, and the head is not bent by the anvil until the blind head is formed. Normally then, it is only after the blind head forming operation that the forces applied by the anvil become sufficient to bend the head against the structure. It should be understood that the hole filling operation does not require a pin pulling force and reaction on the anvil sufficient to bend the head, although the hole filling operation does cause an elongation rise of the head and movement of the anvil away from the structure.

Although only one form of the invention has been illustrated and described in detail, it will be apparent to those skilled in the art that various modifications may be made without departing from the scope of the claim.

What is claimed is:

The method of setting a rivet of a type including a tubular member having a centrally opened preformed head at one end, an intermediate body portion and an opposite end portion of larger inside diameter than the inside diameter of said intermediate portion and a pin extending through the tubular member and having a shoulder engaging the intermediate body and having means on one end initially spaced from but designed for engaging said end portion of the tubular member, which comprises inserting the assembled rivet and pin into openings in a structure to be riveted with the intermediate portion in said openings, with the preformed head abutting one face of the structure and with said opposite end portion protruding beyond the structure, pulling the pin and applying the reaction force to the preformed head so as to form a blind head on the opposite end of the rivet, and then applying a substantially entirely axially directed force to an annular area extending radially outwardly from substantially the mid point between the outer surface of the stem and the outer annular edge of the head to force the radially outer portion only of the head towards and against the structure.

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