March 29, 1949. A. R. HAVENER 2,465,534

RIVET AND METHOD OF MAKING JOINTS THEREWITH

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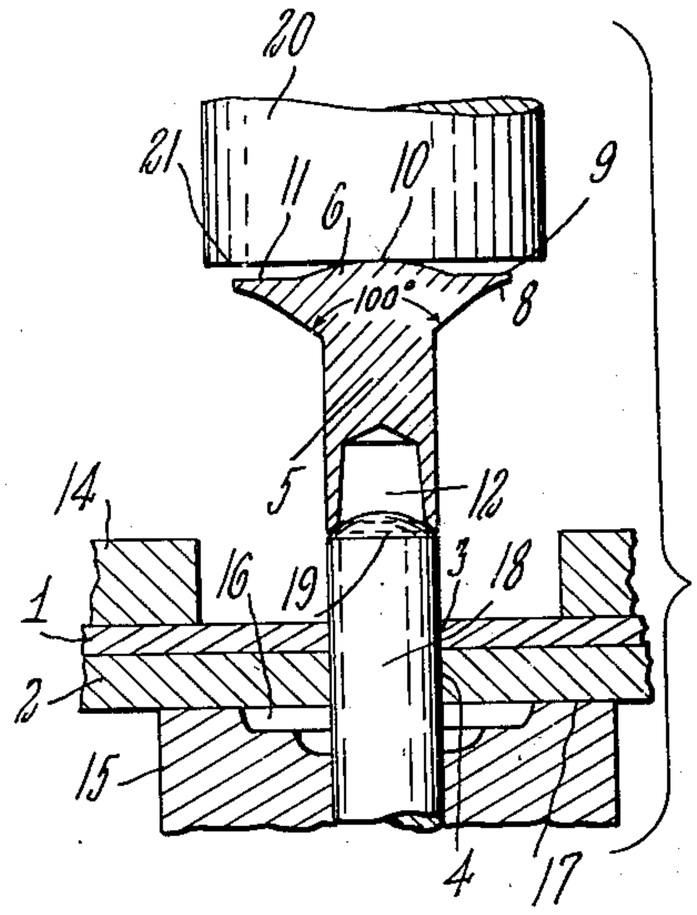

Fig. 1.

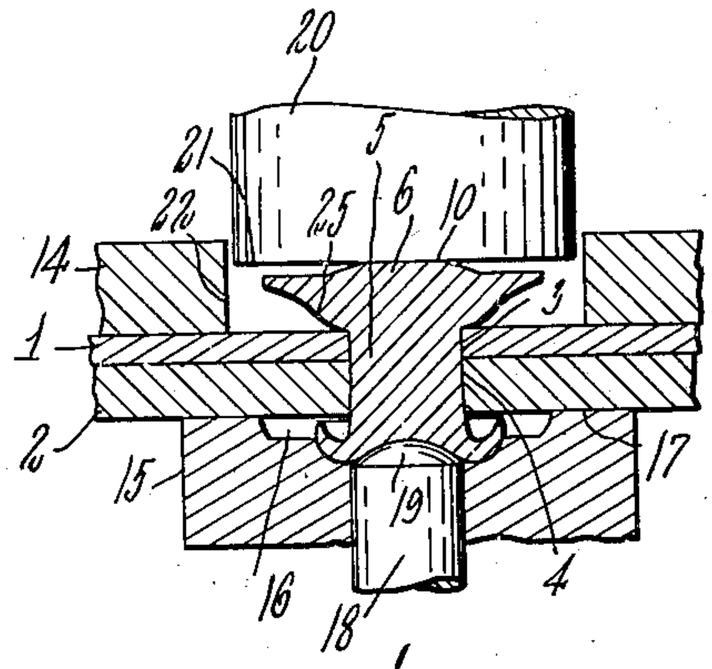

Fig. 2.

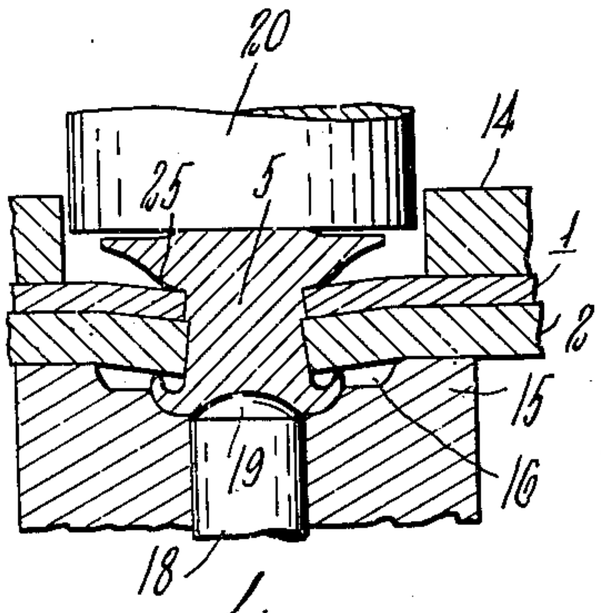

Fig. 3.

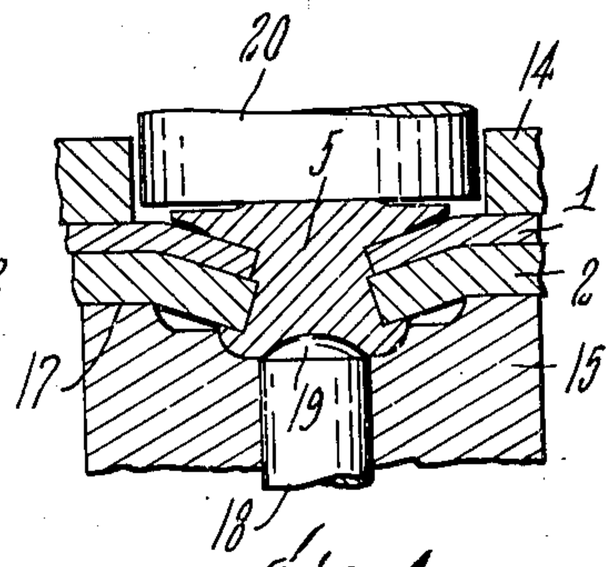

Fig. 4.

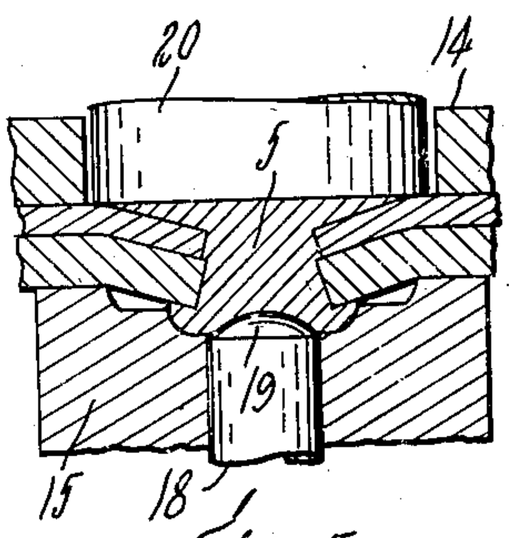

Fig. 5.

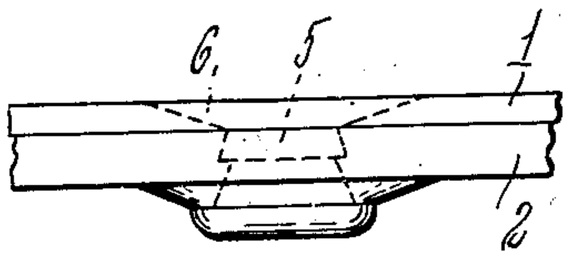

Fig. 6.

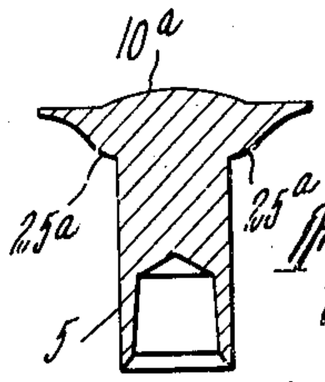

Fig. 7.

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RIVET AND METHOD OF MAKING JOINTS THEREWITH

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11 Claims. (Cl. 218—29)

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This invention relates to riveting and particularly to flush riveting in order to produce streamlining, as in aeroplane construction.

In order to flush rivet it has been usual practice to assemble the metal sheets to be riveted in lapping relation, to make rivet holes therethrough, and to depress or "dimple" the metal inwardly from the face which is to be flush in the riveted structure. Rivets are then inserted in the rivet holes and set so that the rivet heads seat in the dimple recesses and substantially fill them.

One object of the present invention is to eliminate the dimpling operation as an operation independent from the rivet setting, this being done by so forming the rivet and manipulating the parts during the setting operation that dimpling and rivet setting are done as a single operation. This not only saves the time heretofore required, both for the dimpling operation, and the handling of the work or dimpling apparatus before and after the dimpling operation, but it also obviates the necessity of special dimpling apparatus.

A further object of the invention is to so form the rivet that during the setting it dimples the work in a manner which avoids subjecting the metal to undesired deformation and stresses which might weaken the joint.

Still another object of the invention is to so support the work during the dimpling and riveting operation as to avoid undesirable distortions therein and to maintain the outer dimpled face of the work around the dimple flat.

Still another object of the invention is to so form the rivet that when it is set, its head accurately fills the dimple and presents a flush surface with the adjacent material and wherein the rivet joint is solid, tight and substantial.

In accordance with this invention, the rivet is formed with a head having its under face tapered adjacent to the shank at an obtuse angle of preferably about 100° and terminates with a gradual curve into a thin rim or flange or instead of the taper it may be formed with an ogee curve. The top face of the rivet head is upwardly domed, the dome portion being of a diameter somewhat greater than the diameter of the rivet shank, and outwardly of the dome portion the rim or flange on its upper face is flat. The rivet shank terminates preferably in a tubular end as this facilitates the setting operation and results in the formation of a stronger riveted joint.

The rivet setting mechanism includes a flat ended driver head and the setting anvil has a

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central cavity into which the sheet material is dimpled while it is supported around the dimpled area, and the anvil is provided with a central pilot portion which starts the spreading of the tubular extremity of the shank. Cooperating with the setting anvil is a hold-down which presses the work against the anvil around the dimpling recess therein and firmly clamps the parts against distortion around the dimpled area during the dimpling and setting operations.

For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figures 1 to 5, inclusive, are fragmentary cross sectional views through a rivet, the sheet material, the setting anvil and clamp, the rivet set being shown in elevation. Figure 1 shows the parts before the commencement of the setting operation, and Figures 2 to 5 show successive stages of the setting operation.

Figure 6 is a fragmentary side elevation of the work at a riveted joint, the outline of the rivet being shown in broken lines.

Figure 7 is a central longitudinal cross sectional view through a rivet having a head of a different contour from that shown in Figure 1.

Referring to the drawings, at 1 and 2 are indicated superposed plates of metal which it is desired to unite by the riveting operation. Through these plates are formed alined holes 3 and 4, as shown in Figure 1, through which the shank 5 of a rivet is inserted. This rivet has a head 6 upwardly and outwardly tapered on its lower face and preferably flaring at an angle of approximately 100° as illustrated. This outwardly flaring lower face at its outer portion merges on a gradual curve with the under face 8 of a marginal flange 9 of the rivet, which as shown, tapers toward its periphery but is much flatter than the flaring face. The top face of the rivet is upwardly domed, as shown at 10, this dome portion being of somewhat greater diameter than that of the rivet shank 5 and merging at its margin with the upper flat face 11 of the marginal flange 9. The opposite end of the rivet is shown as tubular, being formed with a central tapering hole 12 therein. During the dimpling and riveting operation, the plates 1 and 2 are clamped between the lower face of a clamping plate 14 engaging the top face of the outer plate 1 surrounding and spaced from the rivet holes 3 and 4 at a suitable distance to allow for the dimpling action entirely inwardly thereof.

During the dimpling and setting operations, the lower plate 2 is supported on an anvil 15

which has a central recess 16 on its upper face of a sufficient size to receive the dimpled portion of the work, the marginal portion 17 of the anvil being substantially opposite to the inner portion of the clamping element 14 so that these parts clamp the plates firmly together during the dimpling and setting operation.

The anvil, as shown, is provided with a retractible pilot 18, which in its projected position as shown in Figure 1, is in position for its rounded upper end 19 to engage within the outer end of the hole 12 of the rivet, and as the clamp 14 and the anvil 15 are brought toward each other, this pilot retracts under spring pressure, as is well known in the art, until it reaches its final seated position shown in Figures 2 to 5, inclusive. The rivet is set and is caused to dimple the work by a driver 20 having a flat driving end 21, the driver being of a diameter to pass within the opening 22 of the clamp 14.

The first portion of the driving action, as shown in Figure 2, causes the dome 10 of the rivet head to become somewhat flattened and the under face of the rivet head adjacent to the shank 5 to bulge outwardly as shown at 25, while the action of the anvil with its pilot is to spread the tubular end portion of the rivet outwardly and upwardly toward the lower face of the work plate 2.

Succeeding steps in the setting operation, which it is to be understood are performed without pause between them, cause the bulged portion 25 of the rivet engaging the upper plate 2 around the margin of its rivet receiving hole to force the portions of the sheet materials around the margin of the rivet holes downwardly into the recess 16 of the anvil until the condition of Figure 5 is reached where the dimpling operation has been completed, the rivet material at the tubular end has been set and forced firmly against the lower face of the plate 2 closely adjacent to the rivet hole, and the head of the rivet, the outer margin of which remains substantially in its original condition and without substantial enlargement of the head area, has been forced downwardly into the dimple formed in the upper face of the upper sheet 1 and has been caused to be conformed to the upper face of the sheet 2 and to fill the dimple therein with its top face quite flush with the top face of the plate 1 outwardly of the dimpled area. The pressure exerted by the flat faced driver 20 on the rivet is at first concentrated on the domed portion of the rivet head, so that after this is flattened, the stock forming it being largely displaced into the rivet shank which flows outwardly and around the edge portions of the work pieces at the holes displaced by the dimpling action, the force of the driver is insufficient to materially expand the flange portion of the rivet head which it merely conforms to the contour of the outer portion of the dimple, leaving the top face of the rivet head so nearly flush with the work that an excellent stream lining of the surface is produced. The use of the clamping plate 14 is of great importance in this connection as without it the sheet material buckles upwardly, surrounding the dimpled area, and produces an undesirable bulge in the outer surface of the joint which it is very difficult to flatten out.

In Figure 7 is shown a rivet of a shape somewhat modified from that of Figure 1. In this modified shape the lower face of the rivet head is formed initially with a taper provided with an ogee curve, the convex portion 25*a* of which is adjacent to the rivet shank, this lower face being

substantially of the contour shown in Figure 2 of the partially set rivet initially of the contour shown in Figure 1. This ogee formation is found to be of substantial advantage in facilitating the setting of the rivet, making the operation of setting easier. This is possibly due to the initial presentation against the margins of the work at the holes of a wider zone of contact with the rivet head having the ogee construction, this facilitating the initiation of the dimpling action and avoiding nearly perpendicular presentation against the face of the rivet head of relatively sharp edges of the work at the hole which tend to cut the rivet head rather than to bend the work. This construction produces a riveted joint of increased strength. Dome 10*a* of the rivet head of Figure 7 may be slightly smaller than the dome 10 of the rivet of Figure 1, since less distortion of the rivet head during the dimpling and setting operations is then necessary.

In the final riveted condition of the joint, the rivet and the sheets riveted together are tightly bonded, there being no space therebetween at any point, while the material of the shank is firmly forced against the edges of the dimpled sheets in the rivet holes. Thus a very secure and tight riveted joint is produced and with the rivet presenting a head very accurately flush with the face of the work. Of course, it is to be understood that the amount of dimpling permitted by the configurations of the anvil and the amount of material of the rivet are accurately proportioned so that the head of the rivet contains the correct amount of metal to accurately fill the dimple of the work. In an automatic rivet setting machine the area of the driver head cannot greatly exceed the area of the rivet head before it is driven and still properly operate the holder to release the rivet. By terminating the doming of the rivet head sufficiently inwardly of its margin, the flattening of this head has substantially no effect to increase the area of the head when the rivet is set over its area before setting, nor to change the configuration of its perimeter. Should the head area be spread during the setting beyond the perimeter of the driver head, the driver head would produce an indentation of the rivet head surrounded by an upstanding ridge. This would damage the air foil surface of the work which it is so important to preserve in aircraft construction.

From the foregoing description of the method and apparatus, the rivet, and the joint produced thereby, it should be evident to those skilled in the art that various changes and modifications might be made without departing from the spirit or scope of this invention.

I claim:

1. A rivet comprising a shank, a head on one end of said shank having its under face outwardly and upwardly tapered at approximately 100° and merging with a laterally extended marginal flange tapering in thickness toward its periphery, the under face of said flange being substantially flatter than said tapered face.

2. A rivet comprising a shank, a head on one end of said shank having its under face outwardly and upwardly tapered at approximately 100° and merging with a laterally extended marginal flange tapering in thickness toward its periphery, the under face of said flange being substantially flatter than said tapered face, the free end of said shank being tubular.

3. A rivet comprising a shank, a head on one end of said shank having its under face outwardly

and upwardly tapered at approximately 100° and merging with a laterally extended marginal flange tapering in thickness toward its periphery, the under face of said flange being substantially flatter than said tapered face, the top face of said head inwardly of said flange being upwardly domed.

4. A rivet comprising a shank, a head on one end of said shank having its under face outwardly and upwardly tapered at approximately 100° and merging with a laterally extended marginal flange tapering in thickness toward its periphery, the under face of said flange being substantially flatter than said tapered face, the free end of said shank being tubular, and the top face of said head inwardly of said flange being upwardly domed.

5. A rivet comprising a shank and a head on one end of said shank having its under face of ogee contour with its convex portion adjacent to said shank and outwardly and upwardly tapered throughout the length of the ogee curve and merging with a laterally extending marginal flange.

6. A rivet comprising a shank, a head on one end of said shank having its under face outwardly and upwardly tapered in ogee contour with its convex portion adjacent to said shank and merging with a laterally extended marginal flange, the free end of said shank being tubular.

7. A rivet comprising a shank, a head on one end of said shank having its under face outwardly and upwardly tapered in ogee contour with its convex portion adjacent to said shank and merging with a laterally extended marginal flange, the top face of said head inwardly of said flange being upwardly domed.

8. A rivet comprising a shank, a head on one end of said shank having its under face outwardly and upwardly tapered in ogee contour with its convex portion adjacent to said shank and merging with a laterally extended marginal flange, the top face of said head inwardly of said flange being upwardly domed and the free end of said shank being tubular.

9. The method of making a riveted joint, which comprises inserting through registering holes in sheet material, the shank of a rivet having a head upwardly and outwardly tapered on its lower face and merging with a lateral marginal flange and having an upwardly domed top face surrounded by a flat margin of said flange, and while supporting the opposite faces of the sheet material spaced from the margins of said rivet holes while leaving the material unsupported adjacent to said holes, forcing the rivet head against the work with a flat ended driver engaging the upper face of said rivet head to set the rivet, thereby dimpling said sheet material away from said head around said holes and flattening the top face of and forcing said head into and filling said dimple.

10. The method of making a riveted joint, which comprises inserting through registering holes in

sheet material plates the shank of a rivet having a head upwardly tapered on its lower face in ogee contour with its convex portion adjacent to said shank and engaging one of said plates adjacent to said holes, said rivet having a head provided with an upwardly domed top face surrounded by a flat margin, and while holding said sheet material plates clamped together from the opposite sides spaced around the peripheries of said holes and unsupported adjacent to said peripheries, setting the rivet with a flat ended driver engaging the upper face of said rivet head and of a diameter at least as great as the maximum diameter of said head, thereby dimpling said sheet material plates downwardly around said holes and flattening and forcing said head into said dimple without substantial enlargement of the maximum diameter of said head.

11. The method of making a riveted joint, which comprises inserting through registering holes in sheet material plates the shank of a rivet having a head upwardly tapered on its lower face in ogee contour with its convex portion adjacent to said shank and engaging one of said plates adjacent to said holes, said rivet having a head provided with an upwardly domed top face surrounded by a flat margin, the free end of said shank being tubular, and while holding said sheet material plates clamped together from the opposite sides spaced around the peripheries of said holes and unsupported adjacent to said peripheries, setting the rivet with a flat ended driver engaging the upper face of said rivet head and of a diameter at least as great as the maximum diameter of said head, thereby dimpling said sheet material plates downwardly around said holes and flattening and forcing said head into said dimple without substantial enlargement of the maximum diameter of said head.

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