

June 3, 1947.

O. W. ALBERT ET AL

2,421,732

TOOL FOR DIMPLING

Filed Nov. 19, 1943

FIG. 1

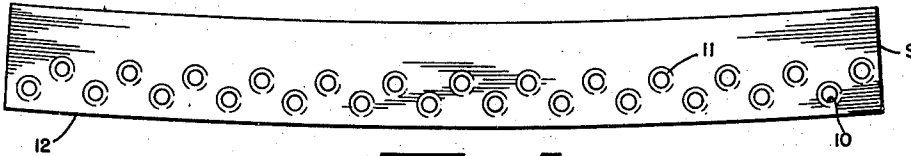


FIG. 2

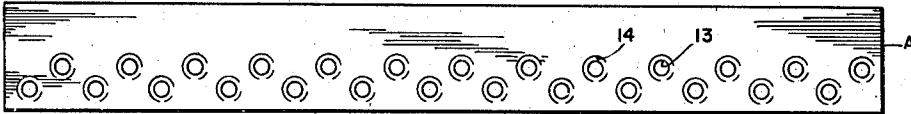
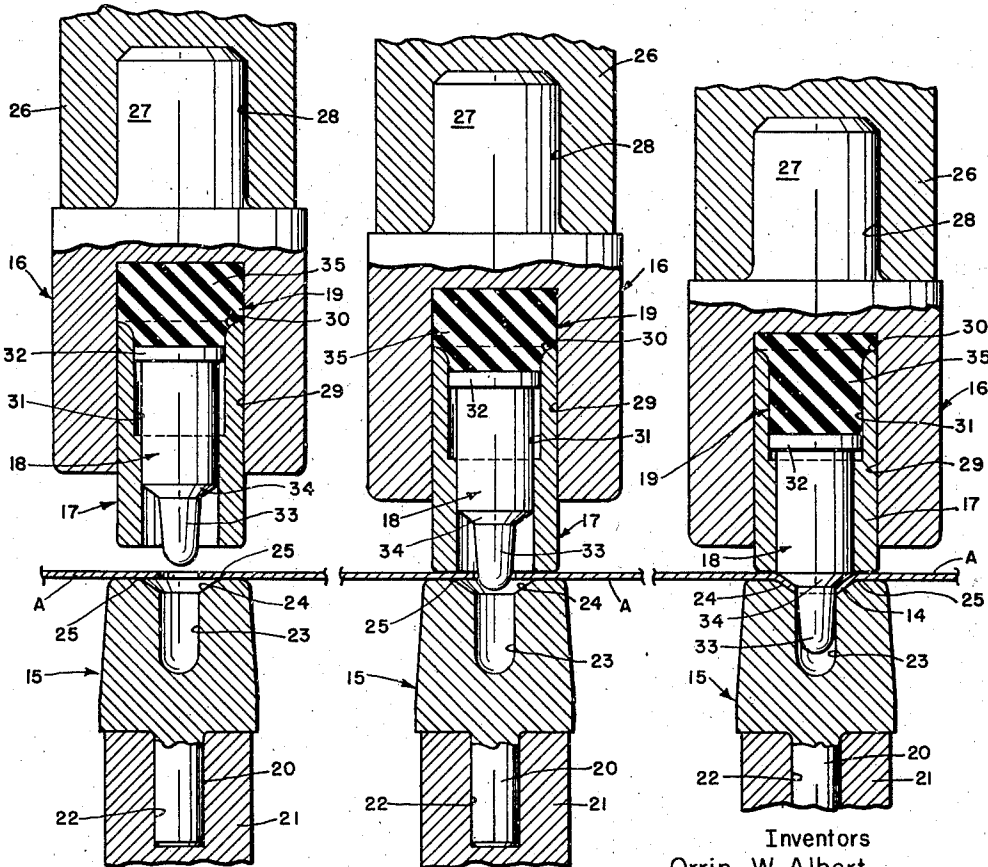


FIG. 3

FIG. 4

FIG. 5



Inventors
Orrin W. Albert
David A. Webster

By *George C. Sullivan*
Agent

UNITED STATES PATENT OFFICE

2,421,732

TOOL FOR DIMPLING

Orrin W. Albert and David A. Webster, Burbank, Calif., assignors to Lockheed Aircraft Corporation, Burbank, Calif., a corporation of California

Application November 19, 1943, Serial No. 510,978

6 Claims. (Cl. 153—21)

1

This invention relates to forming tools and methods, and relates more particularly to a means and method for forming dimples at the rivet and screw receiving openings of sheets, plates, etc.

In the fabrication of airplane components it is common practice to dimple the rivet receiving openings so that the rivets may be flush set or countersunk. Where rows of closely spaced openings are located adjacent the edges of the aluminum alloy sheets and are dimpled by means of the conventional dimpling punches and dies, the sheets are warped and deformed. The warping of the sheet material is the result of stretching and/or shrinking of the sheet along its edge portion where the openings are dimpled. The stretching and/or shrinking is caused by straining of the material beyond the limits of the dimples, and where there are one or more rows of closely spaced dimpled openings adjacent the edge of a sheet the warping is often substantial. The warping occurs in a direction parallel to the plane of the sheet, and usually also in a plane perpendicular to the plane of the sheet. The last named form of warping may be easily remedied, but the curvature or warping in the plane of the sheet is practically impossible to correct. This irremediable deformation of the sheet is the major cause of the misalignment of the dimpled openings with openings in the substructure and also results in poor mating of the skin sheets and irregularities in the assembled sheets.

It is an important object of the present invention to provide a rapid, effective and commercially practical method for dimpling openings in sheets and plates, which method completely avoids warping and deformation of the sheets and plates.

Another object of the invention is to provide a method for dimpling openings in sheets and the like, which confines the shaping and straining of the sheet material to the dimples themselves and prevents straining of the contiguous areas of the sheets. In accordance with the method of the invention, the material is confined and securely held in an annular area spaced around the opening during the dimpling operation to preclude the possibility of straining the material beyond the dimple. The only portion of the sheet that is shaped and strained is that portion which constitutes the dimple.

Another and important object of the invention is to provide a double action dimpling punch operable in conjunction with a die to form dimples at or around openings in a sheet without straining the surrounding sheet material adjacent the dimple, thereby preventing warping and deformation of the sheet.

Another object of the invention is to provide a double action dimpling punch embodying a

2

clamping or confining sleeve which contacts the sheet immediately around the area to be dimpled and clamps the sheet against an opposing surface of the die prior to and during the engagement of the dimpling punch with the sheet, thereby preventing straining and deforming of the sheet beyond the dimple.

Another object of the invention is to provide a double action dimpling punch embodying a simple yet very effective means for first transmitting movement and pressure to the clamping sleeve and subsequently operable to transmit movement and pressure to the dimpling punch while maintaining the clamping pressure on the sleeve.

A further object of the invention is to provide dimpling dies and punches of the character referred to that are operable to rapidly and effectively form dimples without cracking or warping the sheet. The punches and dies of the invention may serve to form one or more rows of closely spaced dimples in the edge portion of a sheet without warping or cracking the sheet.

A further object of the invention is to provide a simple and compactly constructed double acting dimpling punch adapted to be used in conjunction with a conventional type die and in a conventional punch press embodying a clamping sleeve adapted to clamp the sheet immediately surrounding the punch with a force proportional to the punching force.

A still further object of the invention is to provide a simple unitary double acting dimpling punch embodying a clamping sleeve adapted to clamp the sheet immediately surrounding the punch with a high force without employing complicated and bulky mechanical apparatus, linkages and the like.

Other objects and features of the invention will be readily understood from the following detailed description of a typical preferred form of the invention throughout which reference will be made to the accompanying drawings in which:

Figure 1 is a plan view of a plate or sheet having a multiplicity of openings that have been dimpled by means of conventional dies, illustrating the manner in which the sheet is deformed or warped by the dimpling operation;

Figure 2 is a view similar to Figure 1 showing a plate or sheet in which the dimples have been formed by the method and tool of the invention;

Figure 3 is a longitudinal detailed sectional view of the die and punch of the invention showing the sheet in position on the die;

Figure 4 is a view similar to Figure 3 showing the clamping sleeve in engagement with the sheet; and,

Figure 5 is a view similar to Figure 3 showing the punch in its final dimple forming position.

The dimpling dies and punches of the invention are adapted to dimple openings in sheets

and plates of different materials and of different configurations. In the drawings we have shown a simple form of the invention employed to dimple rows of staggered openings in the edge portion of a sheet of aluminum alloy of the type employed in airplane skins. It is to be understood that the invention is not to be construed as limited or restricted to the specific form or application herein described, but is to be considered broadly as including any features or modifications that may fall within the scope of the claims.

In Figure 1 we have illustrated a strip S of sheet stock having two rows of openings 10 extending along one longitudinal edge. The openings 10 of the individual rows are relatively close together and the outer row is in close relation to the edge of the strip. Annular tapering recesses or dimples 11 are provided in the strip S around the openings 10. The dimples 11 have been formed by typical or conventional dimpling punches and dies. The conventional dimpling devices have strained the material in areas beyond the dimples. As a result of this, an edge portion of the sheet S has been stretched longitudinally. The longitudinal stretching of the edge portion of the sheet has given the sheet a permanent set or warp so that its longitudinal edge 12 is convexly curved. The warping in the plane of the sheet S makes it difficult if not impossible to accurately mate the sheet with a companion sheet and displaces the openings 10 to positions where they will not register with openings in the substructure or other parts.

Figure 2 illustrates a similar sheet A having openings 13 in the same relationship as the openings 11. The openings 13 of the sheet A have been provided with dimples 14 in accordance with the method and by the tools of the invention. The sheet A remains in its original rectangular configuration without warping in its plane or the perpendicular plane. Accordingly, the sheet A may be mated with companion sheets and its openings 13 will register with openings in the substructure or other parts.

The dimpling tool of the invention may be said to comprise generally a die 15, a punch holder 16, a clamping sleeve 17 in the holder 16, a punch 18 in the sleeve 17, and elastic means 19 for transmitting pressure and movement from the holder 16 to the sleeve 17 and punch 18. In the drawings we have shown the die 15 as being the lower unit of the set. In practice the tool may be inverted so that the die forms the upper element and the invention is not to be considered as limited to the relationship of the parts shown in the drawings.

The die 15 may be a simple, one-piece member. It may be a substantially conventional die element. As illustrated, the die 15 comprises a head or body portion, and a reduced shank 20. The body of the die 15 bears on the end of the die support 21 and the shank 20 is received in an opening 22 in the support. A central vertical opening 23 enters the die 15 from its upper end and is provided to receive a part of the punch 18. A tapered bore or recess 24 is formed in the mouth of the opening 23 to assist in shaping the dimples. The recess 24 is annular and has a downwardly and inwardly sloping wall. The upper end of the die 15 presents a flat annular surface surrounding the depression or recess 24. It is preferred to provide a slight radius or curvature 25 at the junction of the recess 24 with the end of the die to facili-

tate drawing of the material into the die and to slightly increase the area of the material over which the strain is distributed.

The punch holder 16 may be a simple one-piece socket member. The holder 16 is arranged against the lower end of its carrier 26 and has a reduced shank 27 extending upwardly into an opening 28 in the carrier. A central vertical socket 29 enters the holder 16 from its lower end and serves to receive or house the sleeve 17, the punch 18 and the means 19.

The ring or sleeve 17 is an elongate tubular element which slidably engages in the socket 29. The sleeve 17 has a plain cylindrical exterior and a flat horizontal lower end. The lower end of the sleeve 17 directly opposes the end face of the die 15 and is adapted to contact the sheet A to clamp it against the die. The internal diameter of the sleeve 17 is substantially the same as the largest diameter of the die recess 24. The sleeve 17 extends a considerable distance into the socket 29 to be adequately guided thereby. The upper internal corner 30 of the sleeve 17 is rounded off. The upper portion of the sleeve 17 is enlarged in internal diameter as at 31 to provide the sleeve with an upwardly facing internal shoulder spaced some distance below the upper end of the sleeve.

The punch 18 is arranged within the sleeve 17 for longitudinal movement with respect thereto. The punch 18 is an elongate member whose major portion is cylindrical to slidably engage in the opening of the sleeve 17. An annular flange or head 32 is provided on the upper end of the punch 18 and slidably fits the enlarged upper portion 31 of the sleeve opening. The head 32 is engageable with the shoulder at the lower end of the enlarged portion 31 of the opening to limit the downward movement of punch. A tapered stem or pilot 33 of reduced diameter projects from the lower end of the punch 18. The shoulder 34 which occurs at the root of the pilot 33 is the dimple forming surface of the punch. The shoulder or surface 34 is annular and slopes downwardly and inwardly at substantially the same angle as the wall of the die recess 24.

The means 19 for transmitting movement from the holder 16 to the sleeve 17 and punch 18 comprises a body 35 of elastic, flowable material arranged in the socket 29 above the sleeve and the punch. The material 35 is such that it flows under pressure and is resilient or elastic to return to its original shape and proportions upon being relieved of pressure. It is desirable to employ a material having good flow characteristics and which will not break down with extended use. Raw latex has good flow characteristics and is durable but has a poor recovery upon being relieved of pressure. We have found that cured rubber of about 40 Shore hardness rating is well suited for use in the tool. The body of elastic material 35 is shaped to completely occupy the socket 29 above the sleeve 17 and punch 18 and serves to normally hold these parts in the positions illustrated in Figure 3.

The method of the invention will be described in connection with the operation of the die and punch set described above. The sheet A, previously provided with the openings 13, is arranged between the die 15 and the punch means. It is to be understood that the die and punch means may be employed in individual sets or in gangs. In the latter case, the plurality of sets may be operable to simultaneously dimple the several openings 13. With the die and punch in their original or idle positions, the sleeve 17 and the punch pilot

33 are spaced above the die so that the sheet A may be readily arranged in position on the die. The sheet is positioned to flatly bear on the upper end of the die 15 and to have its opening 13 aligned with the die opening 23. When the sheet has been properly positioned, the mechanism with which the die and punch means are associated is operated to produce relative movement between the die and punch elements.

It will be assumed that the punch unit is moved downwardly with respect to the die 15. When the punch means is in its idle or original position, the elastic material 35 holds the sleeve 17 in an extended position where its active lower end is adjacent the plane occupied by the lower extremity of the pilot 33. The initial phase of the downward movement of the punch holder 16 brings the lower end of the sleeve 17 into engagement with the sheet A. This engagement limits the downward travel of the sleeve, and as the holder 16 continues to move downwardly, the material 35 is compressed between the downwardly moving upper wall of the socket 29 and the upper ends of the relatively stationary sleeve 17 and punch 18. Thus the material 35 transmits downward pressure from the holder 16 to the sleeve 17 and the sleeve is tightly forced against the sheet A. An annular area or zone of the sheet A spaced around the opening 13 is confined or clamped between the end face of the sleeve 17 and the end face of the die 15. Figure 4 of the drawings shows the sleeve 17 in its work clamping position. The holder 16 continues to move downwardly and the compressive force exerted on the annular zone of the sheet is increased until the zone is under a high compression.

The material 35 is compressed during the actuation of the clamping sleeve 17, as above described, and is displaced from between the upper end of the sleeve and the upper wall socket 29 to flow downwardly into the sleeve. It is preferred to proportion the parts so that there is always a substantial body of the material 35 between the upper end of the sleeve 17 and the top wall of the socket 29 even with the parts in their fully actuated positions. The material 35 displaced or compressed into the sleeve 17 forces the punch 18 downwardly relative to the sleeve which is held against further downward movement by reason of its engagement with the sheet A. Thus as the holder 16 continues its downward travel, the punch 18 is forcibly moved downwardly within the sleeve. During the first portion of this downward movement of the punch its pilot 33 passes downwardly through the opening 13 into the opening 23. During the final portion of downward travel of the punch 18 the dimpling surface 34 engages the sheet A around the opening 13 and presses it downwardly against the wall 24 of the die 15 to form the dimple. This shaping or forming of the dimple occurs while a surrounding annular section of the sheet A is compressed between the sleeve 17 and the end of the die 15.

The confining or clamping, under pressure, of the annular zone of the sheet A around the dimple area prevents straining of the sheet beyond the dimple itself. In this connection it is to be noted that the compressive force on the annular zone of the sheet A surrounding the dimple is at its maximum when the dimple is formed. In actual practice, it has been found that the confining or compressing of the sheet between the annular dimple surrounding faces of the die 15 and sleeve 17 positively restricts all straining of the sheet

to the actual dimple and no part of the sheet beyond the dimple is strained or stressed. Accordingly, the sheet A is not deformed or warped in any way even in instances where closely spaced openings adjacent an edge of an elongate sheet are dimpled.

Attempts have been made to accomplish a similar result by employing springs or spring actuated clamping devices. Such attempts have not been successful because the springs necessary to obtain the required pressure must be excessively large in relation to the size of the punch. Furthermore, a tool employing a spring is not perfectly adaptable for dimpling sheets of different thickness. In the tool of the present invention the use of springs is completely avoided and the hold down pressure is always proportional to the dimple-forming pressure irrespective of the sheet thickness and other factors.

At the completion of the dimple forming action the holder 16 moves upwardly, withdrawing the pilot 33 from the opening 13 and disengaging the punch and the sleeve 17 from the sheet A, freeing the sheet for removal. Upon such upward movement of the holder 16 the elastic material 35 returns to its original configuration and restores the sleeve 17 and the punch 18 to their normal idle positions. Thus the die unit is automatically conditioned for the next operation.

From the above description of operation of the tool it will be seen that the method of the invention for forming a dimple in a piece of work comprises generally the steps of confining or clamping the work around the area to be dimpled and the shaping or forming of the dimple while maintaining the clamping pressure around the area to prevent straining and deforming of the work beyond the dimple.

Having described only a typical form of the invention, we do not wish to be limited to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

We claim:

1. A tool for providing a recess in a sheet comprising a die having a concave die surface and a face surrounding the die surface, a holder, the die and holder being related for relative movement, a punch axially movable in the holder and having a convex surface opposing the die surface, a pressure sleeve around the punch axially movable with respect to the holder and punch and having a face opposing the die face for engaging the sheet, and a single element arranged between the holder and the sleeve and punch for transmitting movement from the holder to the sleeve so that the sheet is clamped between said faces, upon movement of the holder toward the die, and for transmitting movement from the holder to the punch during continued movement of the holder toward the die so that the punch and die surfaces form the recess in the sheet.

2. A tool for providing a recess in a sheet comprising a die having a concave die surface and a face surrounding the die surface and adapted to engage a surface of the sheet, a holder having a socket and movable toward the die, a movable sleeve in the socket projecting from the holder to have a face opposing the face of the die, a punch movable in the sleeve and having a convex surface opposing the die surface, and means in the socket operable to transmit movement to the sleeve, upon movement of the holder toward the die, to bring the face of the sleeve against the sheet so

7

that the sheet is clamped between said faces and then operable to transmit movement from the holder to the punch to bring the punch into active engagement with the sheet.

3. A sheet dimpling tool for use with a die having a concave die surface and a face surrounding the die surface and adapted to engage a surface of the sheet, the tool comprising a holder having a socket and movable toward the die, a movable sleeve in the socket projecting from the holder to have a face opposing the face of the die, a punch movable in the sleeve and having a convex surface opposing the die surface, and a body of elastic flowable material in the socket for transmitting movement from the holder to the sleeve to bring the face of the sleeve into engagement with the sheet so that the sheet is clamped between said faces during the initial portion of movement of the holder and adapted to flow into the sleeve during continuing movement of the holder to move the punch against the sheet to form the recess while the sheet is clamped between said faces.

4. A dimpling tool for use with a die having a surface with a die recess therein, the tool comprising a holder movable toward the die and having a socket with an end wall facing toward said die surface, a sleeve slidable in the socket and projecting from the holder to engage a sheet on the die, a punch movable in the sleeve and having a convex face opposing the recess of the die, and a body of elastic flowable material engaged between said end wall of the socket and the inner end of the sleeve for transmitting movement from the holder to the sleeve, during initial movement of the holder toward the die, to bring the sleeve against the sheet so that the sheet is clamped between the surface of the die and the sleeve and adapted to flow into the sleeve upon continued movement of the holder to move the punch against the sheet to form the dimple.

5. A dimpling tool for use with a die having a die surface and an abutment surface around the die surface, the tool comprising a holder movable toward the die, the holder having a socket presenting an end wall which faces toward the die, a sleeve slidable in the socket and projecting from the socket to have its outer end engageable with

8

a sheet on the die, a punch slidable in the sleeve and having a forming surface on its outer end, and a body of elastic flowable material in the socket between said end wall and the inner ends of the sleeve and punch operable during the initial movement of the holder to transmit movement to the sleeve so that the sheet is clamped between the outer end of the sleeve and the abutment surface of the die and operable during continuing movement of the holder to maintain the sleeve in clamping engagement with the sheet and to flow into the sleeve and move the punch against the sheet to form a dimple therein.

6. A dimpling tool for use with a die having an end surface adapted to engage a work piece comprising a holder, a sleeve movably carried by the holder and having a work engaging surface opposing said surface of the die, a body of flowable material between the holder and sleeve for transmitting movement from the holder to the sleeve, and a dimpling element movable in the sleeve and contacted by said flowable material to be actuated by pressure transmitted from the holder through said flowable material when movement of the sleeve is prevented by engagement of the sleeve with the work piece.

ORRIN W. ALBERT.
DAVID A. WEBSTER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,394,506	Giles	Oct. 18, 1921
2,338,736	Peterson et al.	Jan. 11, 1944
1,612,156	Small	Dec. 28, 1926
2,168,377	Wales	Aug. 8, 1939
2,268,787	Wales	Jan. 6, 1942
2,265,331	Wales	Dec. 9, 1941
2,328,919	Merriman	Sept. 7, 1943
2,288,378	Veit	June 30, 1942

FOREIGN PATENTS

Number	Country	Date
253,975	Italy	July 9, 1927
511,106	Great Britain	Aug. 14, 1939