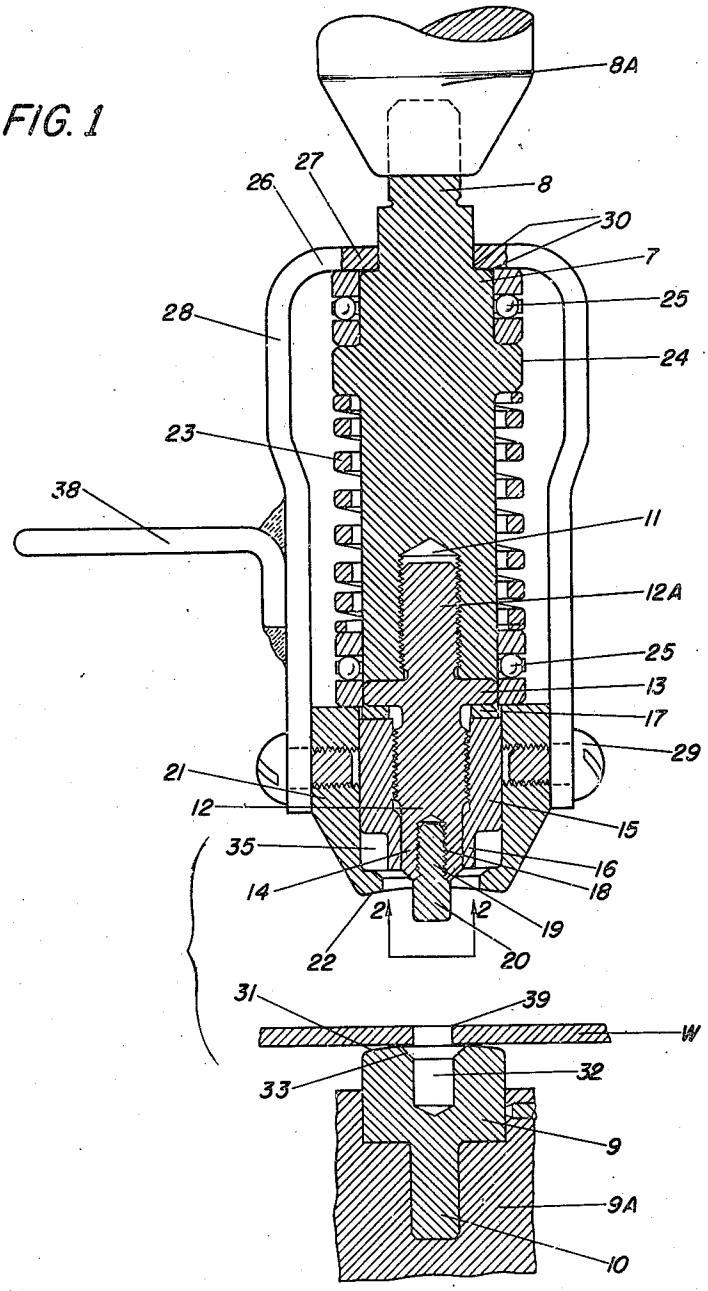
Oct. 4, 1949. H. E. VEIT 2,483,798

APPARATUS FOR THE DIMPLING OF HARD METAL ALLOYS

Filed Aug. 4, 1944 2 Sheets-Sheet 1

FIG. 1



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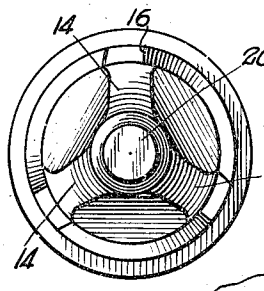

FIG. 2

FIG. 3

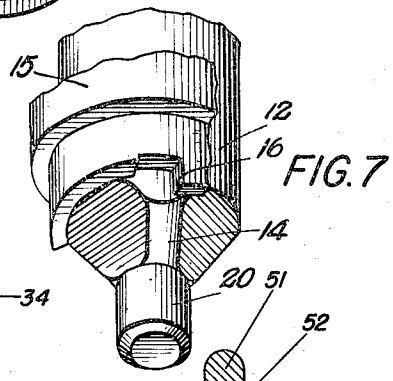

FIG. 7

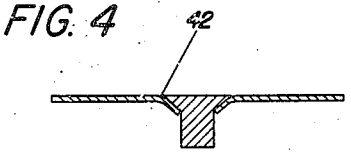

FIG. 4

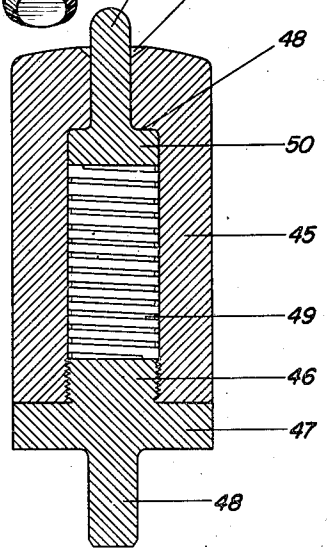

FIG. 6

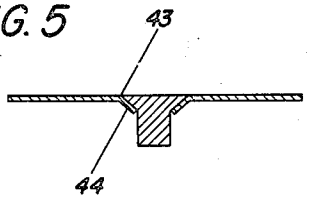

FIG. 5

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APPARATUS FOR THE DIMPLING OF HARD METAL ALLOYS

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Application August 4, 1944, Serial No. 548,073

5 Claims. (Cl. 153—21)

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My invention is directed to a method and apparatus for forming dimples; and, more particularly, to a method and apparatus for the dimpling of hard metals and hard metal alloys.

It is customary, in the construction of aircraft, and of other items of manufacture where the riveting of metal is required, to employ the art of flush riveting. In the aircraft industry this practice is essential for the attainment of aerodynamic smoothness of the exterior surface, a factor vitally affecting the speed and maneuverability of the plane.

The conventional method of flush riveting is to dimple the sheets of material about each rivet hole. This operation places a dimple or depression around a hole for the reception of the head of the rivet so that the top of the rivet head will be flush with the surface of the sheet.

In the dimpling of most sheet metals, the tool of my earlier Patent No. 2,288,378 has been found satisfactory. Certain alloys, however, of aluminum and of magnesium which have been found to be very advantageous for aircraft in that they present the desired qualifications in respect to weight and tensile strength, are presently of limited utility only because of the difficulty of dimpling the material. Thus, those high strength aluminum alloys which are more brittle than a heat-treated, rolled sheet of an alloy of 4.5% copper, 0.6% manganese, 1.5% magnesium and 93.4% aluminum—a currently standard structural alloy, denominated by one large producer as 24S–T—cannot be uniformly and satisfactorily dimpled by any known tool or method at a rate that would be practical for large scale production purposes. Similarly, certain of the magnesium alloys—for example, an alloy of 3% aluminum, 1% zinc, 0.2% manganese, and 95.8% magnesium—cannot be satisfactorily dimpled with known tools, such as that of my earlier Patent No. 2,288,378, without preheating of the sheet.

Such materials would be widely used in the aircraft industry today if they were capable of satisfactory dimpling on a production basis. It is an object of my invention, therefore, to develop a method and apparatus of producing dimples in such materials, as well as others, on a production basis, and without any requirement of preheating.

It is a further object of my invention to provide a method and apparatus for the production in rivet-seating sheets of a dimpled depression having a size and a shape that will conform closely to the size and shape of the rivet head, and which will provide a sharp corner at the juncture between the plane of the sheet and the dimpled depression. In this way it will be possible to obtain a completely smooth, flush surface. It is not presently feasible in the large scale production of rivet-seating sheets to produce a dimple with sharp corners at the periphery; instead the corners are under the present practice rounded by reason of the forming action employed in producing the dimple. This leaves an opening or crack around the head of the rivet, which not only affects the airflow, but which induces corrosion as well.

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This rounding of the corner results from the nature of the dimpling operation currently employed, which consists simply of depressing the work between forming dies or tools. This is effected without spinning, and without any appreciable flow of the metal of the sheet. My present invention, however, relates to the use of a forming, spinning and burring tool which performs three distinct but cooperative operations in the shaping of the dimple.

The metal around the rivet hole is depressed and stressed by working the same axially of the opening. This is accomplished simultaneously by a forming and by a spinning operation. As the metal forming and spinning element of my tool is rotated it progressively works the metal downwardly into the shape of the dimple, thinning the metal slightly in the dimpled portion. In this operation there is a tendency to form a burr or ridge at the juncture between the plane of the sheet and the periphery of the dimple. A burrer immediately shaves or cuts away this ridge, leaving the corner sharp, clean, and flush with the rivet head when it is inserted.

In general, these and other objects are achieved according to my invention by my use of the close cooperation in time and function between the axial deformation of the metal, the spinning of the metal, and the burring operation. The necessity for this combination of functions arises from the age hardening characteristics of metal. It is well known that after a piece of metal is worked an age hardening takes place, so that the hardness characteristics of the metal vary from the instant after it is worked for a period of hours or days thereafter. If the axial working, the spinning of the metal, and the burring thereof were separate operations performed independently on each rivet hole in each sheet, all of the dimples, and the burrs raised by the spinning, would be variously work hardened and age hardened before the final burring operation took place.

My invention, however, permits the completion of each dimple in a single operation, and the time factor between the spinning and the burring of each dimple is a constant. This will eliminate the danger of variations or inaccuracies in the burring operation because of the different qualities of the metal.

The nature and operation of my apparatus will appear more fully in the accompanying drawings, wherein:

Figure 1 is a cross-sectional view of my dimpling tool, with the work in place on the anvil portion;

Fig. 2 is an enlarged end view of the spinning and burring elements of the tool;

Fig. 3 is a fragmentary detail showing the lower portion of the dimpling tool;

Fig. 4 is a cross-sectional view of a sheet of material having a dimple formed therein according to prior art methods;

Fig. 5 is a cross-sectional view of a sheet of material having a dimple formed therein according to my invention;

Fig. 6 is a cross-sectional view of an alternative form of the anvil portion of my dimpling tool; and

Fig. 7 is an enlarged fragmentary perspective view showing the spinning, burring, and pilot elements of the tool.

A preferred form of the apparatus of my invention comprises a rotating body 7 having at one end a spindle 8 adapted to be secured to and driven by the chuck of a conventional drill press 8A, and an anvil 9 maintained by a depending centering boss 10 in a suitable fixture or vise 9A in alignment with the axis of the body. The lower end of the tool body 7 is provided with an axial bore 11 internally threaded to receive the threaded shank 12A of a metal spinning element 12. The element 12 is formed near its upper end with a transverse shoulder 13 adapted to fit closely against the lower end of the tool body. At its lower end the spinning element 12 is formed with a plurality of radial ribs 14 each having a rounded outer edge shaped to spin the material surrounding a hole in a metal sheet into the conical recessed upper end 33 of anvil 9 forming the dimple die. Surrounding the spinning element below the shoulder 13, and in threaded engagement with the spinning element, is a burrer 15 formed at its lower end with a bevelled cutting edge 16 positioned to remove the burr formed around the periphery of the dimpled area as the metal surrounding rivet hole 39 is displaced by the radial ribs 14 during the spinning operation. A shim 17 may be inserted between the shoulder 13 and the burrer 15 to permit necessary adjustment of the latter to compensate for wear. Thus when the cutting edge 16 becomes worn, the shim 17 may be replaced by a thicker one to effect the necessary adjustment. This adjustment may be so regulated that the cutting of the burr takes place as the spinning of the dimple is being completed. This permits an unskilled operator to produce uniform, unscored dimples.

The spinner 12 is formed in its lower end with a hollow axial bore 18 adapted to receive the shaft 19 of a pilot 20, threaded or otherwise secured in the bore.

I have found it desirable to form the tool body 7 of an ordinary tool steel, and to use a very hard material for the spinner 12 and burrer 15, since these are used in the forming of the dimple and in the cutting of the burr formed around the periphery of the dimpled area by the spinning element 12 while dimpling the sheet W. It is, of course, obvious that a single body of hard material might be used alternatively to supplant the combination of the body, the spinner and the burrer which I have shown. The advantage of the preferred arrangement, which is here shown and described, is the reduced expense due to the use of a cheaper metal in the body, in the ease of replacement of either the spinner or burrer when they become worn or damaged, and in the convenient means of adjustment of the burrer through use and substitution of the shim 17.

I employ, in my present invention, a slidably mounted cylindrical pressure pad 21 having an axial bore for the major portion of its length and provided with a concave end surface 22 which cooperates with the convex anvil surface 31 to flex the sheet material slightly in a direction opposite that of the dimple itself, as shown and described in my Patent No. 2,288,378, granted June 30, 1942. The pressure pad is urged downwardly by a spring 23 extending from a collar 24 on the tool body 7. As is more fully explained in my earlier Patent No. 2,288,378, this slight flexing of the material upwardly prior to forming the dimple eliminates the depression which would otherwise form in the area adjacent the dimple. Where sheets greater in thickness than about .040 of an inch are being dimpled, according to the instant invention, I have found that the sheet will be strong enough to withstand the downward pressure occasioned by the spinning, and the pressure pad 21 may be omitted.

To guard against rotation of the pressure pad, which bears upon the surface of the metal being worked, I employ thrust bearings 25 about the tool body 7.

A holder 26 comprises a collar 27 extending around a reduced upper end portion of the tool body and two depending arms 28 adjacent the body and secured at their ends to the pressure pad as by screws 29. To prevent binding of the collar on the body the parts may be chamfered as at 30.

The anvil 9 is provided with a convex upper surface 31 which is complementary to the concave surface 22 on pressure pad 21, and which cooperates with the lower surface of the pressure pad in the pre-flexing of the material, as above described. The anvil is formed with a centrally located bore 32, flared outwardly at its upper end 33 to provide the die for the dimpling operation.

To remote the shavings from the burring operation I have provided holes 34 in the wall of the pressure pad 21 adjacent an annular channel 35 and a tapped hole 36 for the attachment of an air line 37, connected to a source of air which may be adapted automatically to supply air pressure whenever the dimpling device is in its raised position. A handle 38 of any conventional form may be secured onto one of the holder arms 28 to prevent rotation of the pressure pad while the tool is in operation, to avoid damage to the work in the vicinity of the rivet hole.

In certain installations the handle may not be required and where it is omitted the dimpling tool will rotate freely while it is in its raised position. In this case the centrifugal force will be sufficient to remove the burr shavings through the holes 34, and the air line attachment will be unnecessary. When the tool is lowered into contact with the work W, the frictional engagement between the work and the pressure pad 21 will be sufficient to prevent the further rotation of the dimpling tool until it is again removed from the work.

The metal spinning element 12 is, at its lower end, of a generally conical shape, and is here shown as formed with three radial ribs 14 which accomplish the working of the metal. The ribs have a lesser radius of curvature than that of the conical element from which they are formed, as shown in Fig. 7. The conical surface is indicated as 41. As shown in Fig. 7, the leading and trailing edges of the ribs 14 are curved to reduce the amount of friction resulting from the spinning operation and prevent the gouging of the metal by the rotating ribs; the spacing between the ribs permits the flow of the metal as it is being worked, whereas an unribbed conical piece would provide no relief to accommodate such a flow.

The operation of the dimpling tool embodying my invention is as follows:

The work W to be dimpled is provided with a rivet hole 39 and placed in position on the anvil 9. The dimpling tool is then lowered to place the pilot 20 through the rivet hole directly over the bore 32 of the anvil. The spring 23 forces the pressure pad 21 against the work coaxially with the rivet hole 39. The work is thus first held and bent slightly upwardly around the edges of the rivet hole. As the downward pressure is continued the spring 23 is compressed and the ribs 14 of the metal spinning element 12 and the bevelled cutting edges 16 of the burrer 15 move vertically through the opening in the pressure pad 21. The increasing pressure of the rotating metal spinning element simultaneously frictionally engages the uppermost surface of the area to be dimpled, and forms the material into the die recess 33 of the anvil 9. As a burr is formed at the upper edge of the dimple, the rotating cutting edge 16 immediately removes it, forcing the shavings into the channel 35, whence they will subsequently be removed by air pressure from the air line 37 or by centrifugal force. The extent of the burring operation is controlled by use of the shim 17.

The ribs 14, here shown as three in number, will in actual operation be controlled, both as to configuration and number, by the amount of friction necessary for the dimpling of the material involved. If heat is required for the dimpling of the material, the friction may easily be increased by using a metal spinning element having either a greater number of ribs or less rounded ribs, and thereby presenting a greater surface of contact. My invention, as shown and described, permits the easy replacement or substitution of either the spinner or the burrer, whether for the purpose of varying the nature of the dimple, for working a different quality material, or for the replacement of worn or broken parts.

My tool makes possible the dimpling of materials heretofore believed to be unsuited to this operation. In addition, by its combined spinning and forming function, it eliminates the round corners 42 previously unavoidable (Fig. 4), and produces quickly and efficiently a sharp cornered dimple 43 having walls 44 slightly thinner than the surrounding material, (Fig. 5). A further advantage of a dimple of this character is that it permits a nesting of the dimples where like sheets are stacked one upon the other.

The construction and arrangement of the parts as herein described is such that it requires no high degree of skill on the part of the operator to make uniformly satisfactory dimples. The predetermined relative adjustment of the spinning element and the burring edge limits the

extent of the spinning operation and permits the cutting of the burr as the element is bottomed in the anvil, thus avoiding the danger of cutting too deeply in removing the burr.

In Fig. 6 I have shown an alternative form of anvil. In this modification I have provided an improved means for quickly centering the rivet hole to be dimpled over the die portion of the anvil. It is frequently a time consuming operation to center the material exactly; yet it is extremely vital that this alignment be exact to avoid cracking of the dimples and injury to the dimpling tools.

According to my invention I have provided an anvil having a hollow body 45 open at the bottom and threaded interiorly to receive a plug 46 carried on a base 47 from which is depended a centering boss 48. Resting on a spring 49 within the hollow body is a head 50 at one end of a plunger 51 passing through an axial bore 52 of the anvil body to protrude beyond the upper face thereof. In operation this device works as follows:

The work W is placed over the anvil with its rivet hole 39 aligned with the plunger 51. As the dimpling tool is lowered the pilot 20 is centered on the plunger 51 and thereafter presses the plunger down into the anvil body, thereby removing it from the bore during the dimpling operation.

When the pilot is again removed the plunger is free to rise, thereby regaining its position for guiding and centering the dimpling tool in the next operation.

I claim:

1. A tool for dimpling hard sheet metal stock comprising an anvil having a conical recess and a coaxial pilot bore, means adapted to be moved toward and away from said anvil comprising a pilot to center the stock with respect to said bore, a rotatable metal spinning member rotatable about the axis of said pilot to spin the stock to be dimpled into the conical recess of said anvil as the pilot is advanced with respect to said bore, work engaging means located adjacent the outer periphery of the spinning member and adapted to press the sheet metal outside of the area to be dimpled toward the anvil, and metal cutting means carried by and adapted for rotation with said spinning member having a cutting edge placed parallel with the sheet surface to trim a flash or burr formed at the juncture between the surface of the sheet stock and the stock spun into the anvil recess.

2. A tool for dimpling an apertured hard metal alloy sheet comprising a supported convex surfaced anvil having a recess therein to form one face of a dimple in said sheet, a rotatable shaft adapted to be mounted in a rotating means, a spinning element having a plurality of radial ribs attached to said rotatable shaft and positioned to form a dimple in said apertured sheet to the shape of the recess in said anvil, a burr removing element carried by said rotary shaft and formed with a cutting edge adapted to rotate with the spinning element so as to effect the removal of a burr formed around the dimple by the spinning element, a pressure pad carried by said rotary shaft having a concave surface formed outwardly of the spinning element to match the anvil and positioned to encircle, engage and flex the area to be dimpled surrounding said aperture placed in engagement with the anvil, and a passage formed in said pressure pad for the conduction of air to a point adjacent the spinning element.

3. A dimpling tool comprising an anvil, an apertured work engaging means adapted for movement toward the anvil having an engaging area aligned with said anvil to engage and secure under pressure work placed in engagement with the anvil for dimpling, a rotary dimpling means adapted for rotation within the work engaging means to dimple said work, burring means carried by the dimpling means and located at the outer periphery of the dimpling means provided with a cutting edge to remove a burr formed around the dimple during the rotation of said dimpling means in engagement with the work, a burr-shavings outlet means carried by said engaging means having a passage formed therein leading outwardly from adjacent the cutting edge for removal of burr shavings from within said engaging means.

4. A dimpling tool comprising an anvil for supporting a work piece, said anvil being formed with a conical dimple recess, a rotatable spinning means formed with laterally projecting ribs and having a conical profile, said spinning means being mounted for advancement into the recess in said anvil, burring means carried by the spinning means and located at the outer periphery of said spinning means to remove a burr formed around a dimple in said work piece.

5. A dimpling tool comprising an anvil for

supporting a work piece, said anvil being formed with a conical dimple recess, a rotatable spinning means formed with laterally projecting ribs and having a conical profile, said spinning means being mounted for advancement into the recess in said anvil to form a dimple in said work piece, burring means carried by the spinning means and located at the outer periphery of said spinning means having a cutting edge to remove a burr formed around the dimple in said work piece, and a pressure pad surrounding said spinning means and arranged for movement to engage and secure a work piece on the anvil.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
14,878	Miller et al.	May 13, 1856
1,383,839	Mueller et al.	July 5, 1921
1,383,840	Mueller et al.	July 5, 1921
1,983,407	Scholtes	Dec. 4, 1934
2,235,582	Klema	Mar. 18, 1941
2,288,378	Veit	June 30, 1942
2,308,447	Greenbaum	Jan. 12, 1943
2,346,376	Heavener	Apr. 11, 1944